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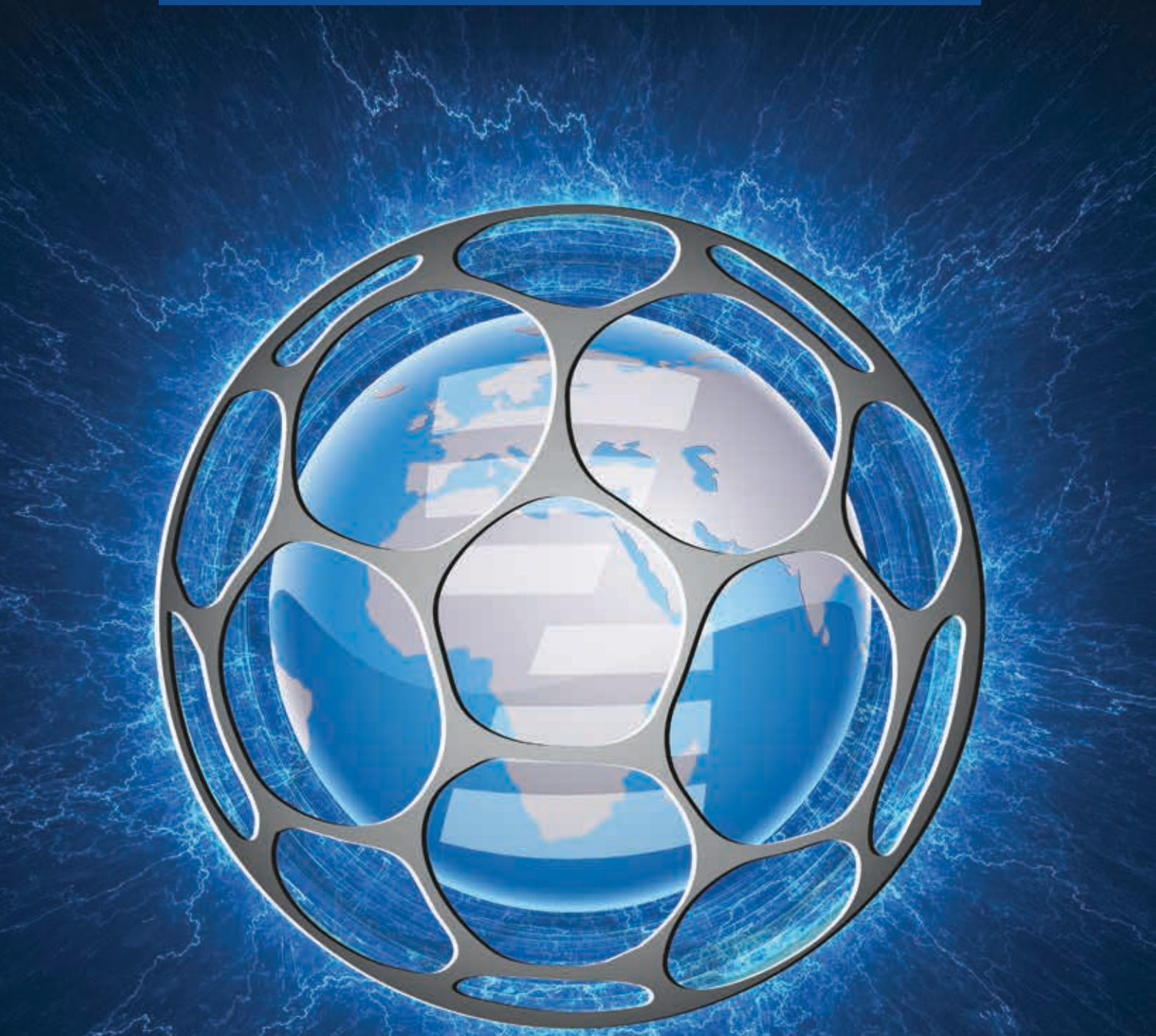
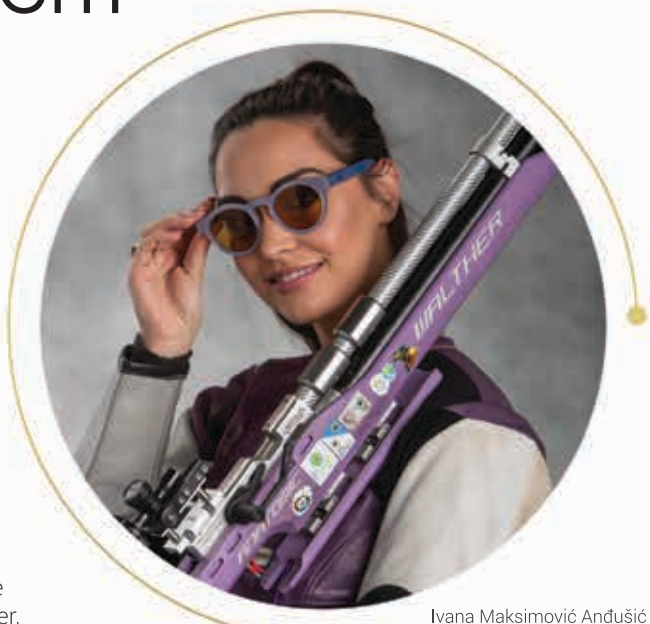


ZEPTER'S NANOWORLD

(OR FOURTH SCIENTIFIC AND TECHNOLOGICAL REVOLUTION)

ZEPTER HYPERLIGHT EYEWEAR

SEE MORE. FEEL BETTER. THINK FASTER. PERFORM AT YOUR BEST. LIVE BETTER.



Ivana Maksimović Anđušić
the Olympic vice champion
in sport shooting

WHY IS HYPERLIGHT EYEWEAR® REVOLUTIONARY?

Hyperlight® glasses are the first glasses with integrated fullerene C_{60} that produce beneficial hyperharmonized light.

That kind of light stimulates proper functioning of biomolecules in the brain, it regulates hormone secretion, so we sleep better and feel better, and it improves our physical well-being and mental state, making us smarter, healthier and happier.

Hyperlight® glasses optimize the intensity of light to the level that is most comfortable for the eyes and our brain functions. When the intensity of light is higher than the optimal one, **Hyperlight®** glasses reduce it, and when it is lower, they increase it. Light optimization is obtained by transforming harmful UV and blue light.

Hyperlight® glasses protect against harmful sunlight and artificial light sources and they provide active light therapy which revitalizes the whole body.

REVOLUTION IN OPTICS

Based on fullerene C_{60}

WHAT DO HYPERLIGHT® GLASSES IMPROVE?

HORMONAL BALANCE

They restore psychological balance and strengthen self-confidence, improve our mood and reduce stress, anxiety, depression and irritability. These glasses regulate sleep disorders and significantly reduce the effects of jet lag. In addition, they increase and maintain energy throughout the day.

COGNITIVE ABILITIES

Hyperlight® glasses improve concentration, attention and memory. They increase productivity and efficiency, as they enable us to make decisions faster. The beneficial effects of hyperharmonized light on the brain are evident during periods of intense and long-lasting mental efforts.

EYESIGHT

They provide maximum protection against harmful UV and blue light. As a result, they slow down cataracts, stop macular degeneration and delay the need for dioptric glasses. **Hyperlight®** glasses reduce light scattering inside the eye, improve visual acuity and enhance contrast sensitivity and colour intensity. They reduce fatigue and discomfort in the eyes. When you drive, they reduce glare and blinding from sudden bright light.

ANTI-AGING

Hyperlight® glasses protect the skin around the eyes from aging. They eliminate or convert harmful visible light radiation into health-promoting hyperlight structures that maintain and stimulate natural regeneration and synthesis of collagen and elastin in the skin. In that way, they reduce the existing wrinkles around the eyes and prevent new wrinkles from developing.

zepter.com

FULLERENE happened to me

A few decades ago, I met one of our greatest enthusiasts, both among scientists and non-scientists. Strangely enough – his unusual ideas do come true.

How exactly did fullerene happen to me, the first journalist in former Yugoslavia? With a little effort, I managed to remember.

Back in the socialist era, I held his unusually titled book in my hands – "Qi Engineering". It originated from his PhD thesis defended at the Faculties of Mechanical Engineering and Medicine. His mentor was a prominent academician and doctor at the Military Medical Academy, who was the first to introduce acupuncture in our country.

Unusual, right?

I recounted that to the newspaper readers in the early eighties, without any idea what the enigmatic word "qi" meant: Life energy in Chinese, to which the Westerners respond with Vis vitalis. Only later did I realize that the trinity of "qi" comprises symmetry, harmony, and perfection.

The ball of yarn of the greatest riddle of existence, Vis vitalis, begins to unravel, fullerene appears, and immediately unwinds in the middle of a large canvas of the exceptionally talented Serbian painter Dragan Mojović. We could reasonably wonder if this was fullerene's first artistic representation in the world.

It seemed to have come from nowhere, and that would be a fairly accurate description. Only ten years ago, American scientists discovered it in a galactic nebula using a space telescope. This means that it has been in existence since the beginning of time, but people did not know about it for a long time. Incidentally, it had been spotted in the lab before astronomers came across it.

Ingenious researchers named it after the famous architect Buckminster Fuller, who used to cover his buildings with a half-cut dome that irresistibly resembled one half of the fullerene atom. Divided into pentagons and hexagons, it was the most reliable roof.

At the Molecular Machines Research Center of the Faculty of Mechanical Engineering in Belgrade, fullerene was observed for the first time under a scanning tunneling microscope (STM), using unimaginable magnification. Researchers saw with their own eyes that it was composed of 60 carbon atoms. Hence its name – C_{60}, under which it is known in scientific articles.

Eventually, it crossed someone's mind, probably after a sports match, to attach another name to it – buckyball, because it irresistibly looks like a soccer "ladybug" ball.

Why so much talk on my part?

Let this serve as an introduction, of course without going into professional details, which announces the biggest research step forward in Serbia ever: the fourth scientific and technological revolution. And at the very core of that unparalleled mental endeavor lies the most harmonious and strongest molecule in the infinity, invisible to the naked eye.

In that unique coup (in scientific jargon – revolution), our hero from the beginning of the story, Professor Đuro Koruga, and the most successful Serbian businessman ever, Philip Zepter, have led a large group of scientists and experts in various fields, stationed in several countries. The group has recently been joined by young, selected Belgrade University MSc and PhD students.

Therefore, I invite you, dear readers, to take part in this unusual quest of the human spirit in the pages of "Galaksija" before you, in which – as in "1001 Nights" – the most exciting stories will unfold in the years and decades to come.

The first fruits of many years of study and testing are already sold very successfully all over the world, under the invisible baton of the conductor Mr. Philip Zepter.

And as time passes, the world market will expand faster, because products based on the mysterious C_{60} are the basis for the renewal of the disturbed flow of the "qi" energy (Vis vitalis) in our body.

Stanko Stojiljković

Content

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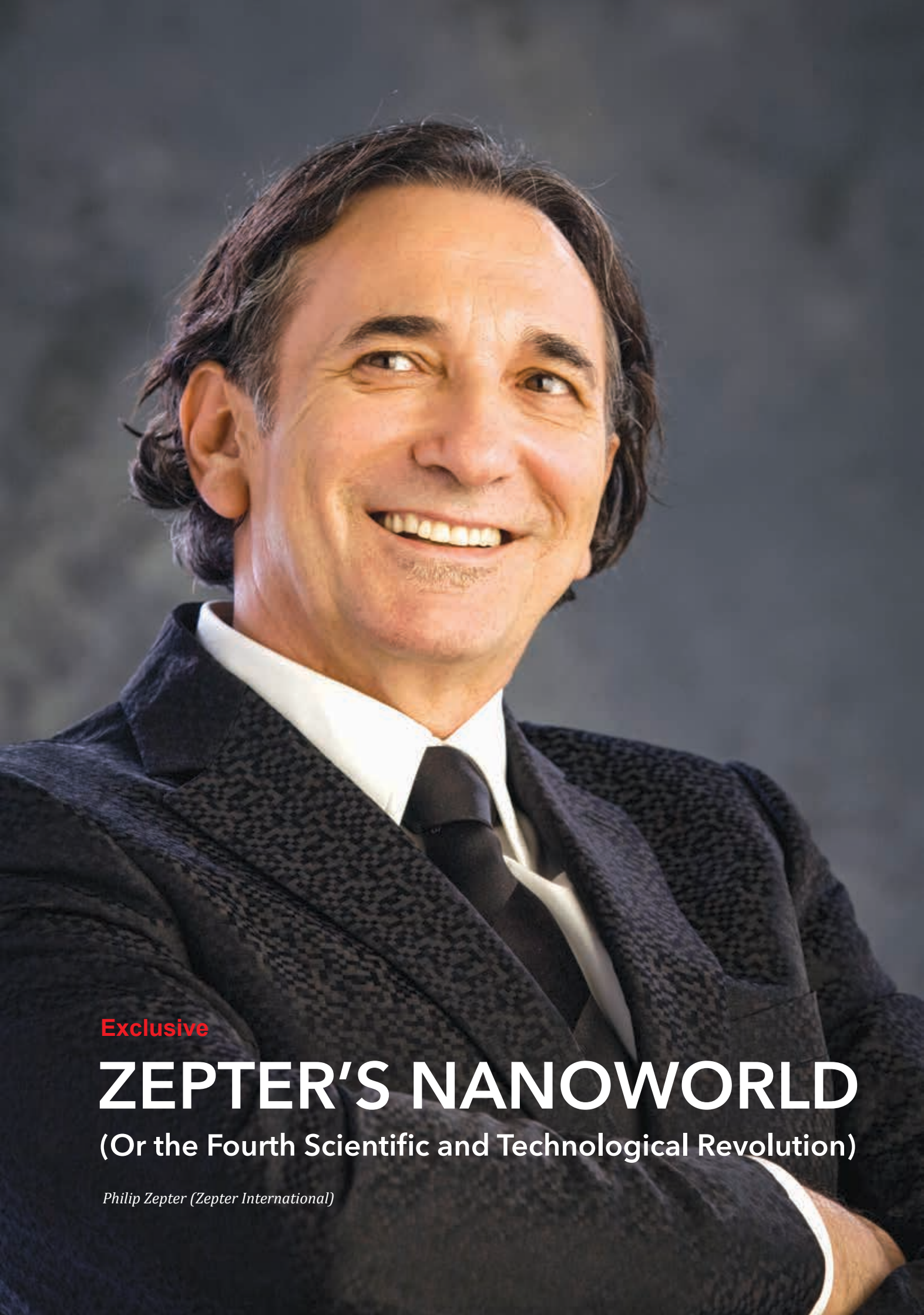


Exclusive

ZEPTER'S NANOWORLD

(Or the Fourth Scientific and Technological Revolution)

Philip Zepter (Zepter International)

"The motto 'Live Better. Live Longer' adequately substantiates our strategic direction to provide our clients wherever they are with premium innovative services and products for improving their quality of life based on the latest scientific research on light, water, air, and food. I must add that sleep quality significantly impacts how people will go about their daily routines, or how they will feel, depending on the correct dynamics of their locomotive systems. Relying on top-quality scientific research, we have developed six pillars, as you have termed them, that represent key foundations of our company. Is there any secret to them? Definitely, the specifics are not for the general public. Isn't number 6 perfect? If it is, and we aim for perfection, then you must follow nature. In fact, it is connected to the fivefold (harmonious) value of the atomic number of carbon in chemistry, and carbon 60 (C_{60}), or fullerene is a constituent of an increasing number of Zepter International products", explains in an interview for Galaksija Philip Zepter, the founder, owner, and president of this renowned multinational company.

Stanko Stojiljković

"Success is an outcome of the synergy between a healthy body and spirit. To be perfectly healthy, we must realize the majority of our own mental and physical potentials. Such health is the ultimate achievement, as it preconditions all the others. Once we achieve it, everything else becomes possible."

Philip Zepter

Fullerene (Ivana Dakić/Zepter International)

Philip Zepter's whole life can be summarized in a famous Latin phrase "Through hardships to the stars" (*Per aspera ad astra*) – both literally and figuratively: from his first wages that he earned as a boy working on the river embankment maintenance in the town of Kozarska Dubica (the Republic of Srpska) to the Zepter International multinational company worth several billions of dollars, operating on five continents – the richest and most powerful company to have ever been created by a Serb.

The reason for this interview that was so hard to fit in the all too busy daily schedule of our interlocutor, who constantly flies in his plane from one part of the world to another, lies in the top-quality products, unique in the world, which are based on the miraculous features of fullerene (C_{60}), the most perfect and the most active molecule in the universe, which has been proven in numerous studies and examinations in the most prestigious laboratories in the world – in other words, based on the latest knowledge of the Fourth Scientific and Technological Revolution in the field of nanotechnology, which subsumes the manipulation of separate atoms and mole-

cules, as the Nobel Prize laureate Richard Feynman foretold back in his day. Zepter International Company, which has been in operation for almost three decades in over 60 countries with the slogan "The global life protector", already delivers such products to its clients.

Where does this nano in the title come from? The diameter of fullerene is 1 nanometer (a billionth part of a meter; 10^{-9}), and it oscillates 18 billion times per second, with 46 distinct oscillatory states. Its numerous incredible spatiotemporal and biological features originate from these features.

NEW GALAXY: Mr. Zepter, at first glance, it seems that you have repositioned your company in accordance with the four cosmological elements as posited by the Hellenic philosopher Thales. You have chosen light, water, air, and food, while the Milesian sage opted for earth instead of food. We could subsume light under fire, I hope you'll agree.
Philip Zepter: At first, Thales did not cross my mind, but it turned out later – especially in the 21st century – that Zepter International Company in effect embraced philosophical stands of the Ancient Greek sage Thales, supplementing them with two load-bearing pillars, so to speak – with healthy sleep and with physical activity. We included these six crucial pillars for life into our company's vision statement in 2020. Why am I saying this? Every company resembles a living organism (a being), and mine is no exception. This means it has to adjust itself to various demands and challenges coming both from inside the company and at the global level. The motto 'Live Better. Live Longer' adequately substantiates our strategic direction to provide our clients wherever they are with premium innovative services and products for improving their quality of life based on the latest scientific research on light, water, air, and food. I must add that sleep quality significantly impacts how people will go about their daily routines, or how they will feel, depending on the correct dynamics of their locomotive systems.

In my opinion, a human being has a central position in all our attempts to improve life on this planet. This is why we primarily focus on humans – we should be able to live comfortably and happily regardless of age. Everything that my company has launched so far has been based on the latest achievements of human mind, and some of the products – for example, those that contain fullerene – are so much ahead of their time, to paraphrase the title of one book about Nikola Tesla.

NEW GALAXY: Why did you choose precisely these six pillars to reposition Zepter International on? Is there any secret to it? I'm sure there is.
Philip Zepter: Relying on top-quality scientific research, we have developed six pillars, as you have termed them, that represent key foundations of our company. Is there any secret to them? Definitely, the specifics are not for the general public. Isn't number 6 perfect? If it is, and we aim for perfection, then you must follow nature. In fact, it is connected to the fivefold (harmonious) value of the atomic number of carbon in chemistry, and carbon 60 (C_{60}), or fullerene is a constituent of an increasing number of Zepter International products.

ZEPTER INTERNATIONAL
(The Art of Healthy Living)

Number of continents: 5
Number of countries: 60
Zepter factories: 8
Business premises (sq. m): 320,000
Number of customers satisfied with Zepter products: 80,000,000
Number of sold product items: over 760,000,000

In my opinion, a human being has a central position in all our attempts to improve life on

this planet. This is why we primarily focus on humans – we should be able to live comfortably and happily regardless of age. Everything that my company has launched so far has been based on the latest achievements of human mind, and some of the products – for example, those that contain fullerene – are so much ahead of their time, to paraphrase the title of one book about Nikola Tesla.

I often like to say that having spent a long time in different parts of the world and having studied the world closely, I managed to understand the root of my business philosophy, which I had taken from my hometown of Kozarska Dubica. As a boy, I used to daydream about changing and improving everyday circumstances, processes, and occurrences that I was observing. The first such attempt and the damage I caused earned me a few slaps from my paternal uncle, but, obviously, that has not deterred me (laughter).

NEW GALAXY: The impression that prevails is that you didn't have a role model in today's business world, did you?
Philip Zepter: I didn't used to have role models at all. Unfortunately, I was the first in the world with the concept that I successfully realized. Even when they exist – role models, good concepts, and some general ideas – we are expected to improve on them and to surpass them. I often like to say that having spent a long time in different parts of the world and having studied the world closely, I managed to understand the root of my business philosophy, which I had taken from my hometown of Kozarska Dubica. As a boy, I used to daydream about changing and improving everyday circumstances, processes, and occurrences that I was observing. The first such attempt and the damage I caused earned me a few slaps from my paternal uncle, but, obviously, that has not deterred me (laughter).

I assume that he closely followed our research and examination focused on the miraculous fullerene (C_{60}) molecule, and that that was the reason why he classified them as belonging to the Fourth Scientific and Technological Revolution. Contemporary findings by scientists from Serbia and from abroad unequivocally point to that conclusion. In fact, this research has given rise to several top-quality technological products by Zepter International, which clearly exemplify our slogan "Live longer. Live better." In all honesty, we have been unprecedented and unparalleled in that.

Philip Zepter (Zepter International)

NEW GALAXY: I suppose that it was this fact that motivated Ljubiša Milović to single out you and Elon Musk as the two most important entrepreneurs of the Fourth Technological Revolution in his book "Work and Capital Organization: From Adam Smith to the Fourth Technological Revolution". Do you have any comment on that?
Philip Zepter: Ljubiša Milović used to head the Work Productivity Institute for years, and as far as I know, he managed to bring to socialist Yugoslavia Shigeo Shingo, busi-

ness guru from Toyota, who revitalized that company with his philosophy *Just in time*. Everyone, including me, feels good when they are associated with such great men that the author included in his book (Nikola Tesla, Adam Smith, Henry Ford, James Watt, Marvin Minsky, Richard Feynman, and so on), who changed the economic, scientific, and technological world to a significant extent.

I assume that he closely followed our research and examination focused on the miraculous fullerene (C_{60}) molecule, and that that was the reason why he classified them as belonging to the fourth scientific and technological revolution. Contemporary findings by scientists from Serbia and from abroad unequivocally point to that conclusion. In fact, this research has given rise to several top-quality technological products by Zepter International, which clearly exemplify our slogan "Live longer. Live better." In all honesty, we have been unprecedented and unparalleled in that.

NEW GALAXY: How was this new vision welcomed in the world market, and, above all, in the stock market, all the more because it seems to me that it represents a unique direction of one multinational company?

Philip Zepter: Due to the pandemic caused by the corona virus, the global market has been rather turbulent, shaken, and uncertain, so perhaps this is not the right moment for a global assessment of any kind. We have already built and established a new business philosophy based on the aforementioned nanomaterial – fullerene. As far as I know, we have been the only ones and the unique ones so far. But this doesn't mean that the other multinational companies will just kick their heels. In any case, we can see a great international success taking shape right before our eyes. I really think that we have the wind at our back, to use a maritime idiom, because we have already mastered the technologies that significantly contribute to the improvement of everyday life. We offer products that nobody else is making, and that every individual on the planet should have.

NEW GALAXY: Such commitment demands complete reliance on the latest scientific and technological achievements. Does that mean that you have had to strengthen the company's think tank?

Philip Zepter: Precisely, and I have suggested that in my previous answer. We have gathered a remarkable team of Serbian and international scientists and experts in the field of nanotechnology, fullerene in particular, who are the best that Serbia and the world can offer today. In collaboration with the Faculty of Mechanical Engineering, we have formed a research circle comprised of the students with the highest GPA in the field of biomedical engineering, most of whom are PhD students, and we have provided them with optimal conditions. They have already offered their first high-technology solutions and improvements. The think tank you have mentioned comprises all generations: the oldest are the members of the Serbian Academy of Sciences and Arts and university professors, scientists are in the middle, and the students are the youngest. The renowned Serbian member of the Academy, Ljubiša Rakić, is the chairman of Zepter's Scientific Board.

I've been collaborating with Professor Đuro Koruga from the Faculty of Mechanical Engineering for over 20 years, and he, together with his younger associates, was the first in the world who managed to photograph C_{60} carbon in atomic resolution using the scanning tunneling microscope (STN), and that image was published in the first book dealing with this field of study. It also appeared on the cover of Science, one of the best scientific journals in the world.

NEW GALAXY: It seems that everything is based on the miraculous features of the C_{60} carbon molecule, or fullerene, which is in-

corporated in the latest products by Zepter. When did you become inspired by it?
Philip Zepter: I've been collaborating with Professor Đuro Koruga from the Faculty of Mechanical Engineering for over 20 years, and he, together with his younger associates, was the first in the world who managed to photograph C_{60} carbon in atomic resolution using the scanning tunneling microscope (STN), and that image was published in the first book dealing with this field of study. It also appeared on the cover of Science, one of the best scientific journals in the world. After that, he headed a team of four distinguished world scientists and published the first monograph in the world dedicated to carbon C_{60} as the first author and editor. As you can see, we have a leader with imagination, knowledge, and experience several decades long, who has registered several patents in this field in the USA and in other countries.

NEW GALAXY: Could you tell us in brief which products contain C_{60} as a key component improving their features?
Philip Zepter: All products that, so to speak, influence the wellbeing and vital processes in an organism do. Our main principle is biophysical effect on biomolecules, cells, and tissues that is then manifested in the regulation of biochemical processes. So, for instance, Tesla Hyperlight nanophotonic glasses help to protect eye structures from the harmful ultraviolet (UV) and high-energy blue light, but with them we also impact the brain, which regulates the secretion of serotonin, melatonin, dopamine, cortisol, and other substances. It has been shown and proven that the positive effect they have on the brain is then transferred to the endocrine-immune system, because in reality, and according to scientific findings, we seem to have a single neuro-endocrine-immune system.

If you add the derivatives of fullerene C_{60}, such as our HyperLightFusionFluid, to creams or other cosmetic products, then by electronic, vibrational, and rotational modes this substance will resonantly influence biomolecules that possess these modes as well. This is possible because this substance was designed in accordance with the need of 85% of biomolecules that have icosahedral symmetry (water, collagen, elastin, clathrin, microtubules, cilia, flagella, centrioles, etc.). If biomolecules are deranged in this aspect, our substance will repair them and return them to their natural healthy state by means of mode fusion.

Yes, we really are a "global protector of life". Everything that comes out of our production lines anywhere in the world has a most sublime purpose: health comes first! You know how they say, "a healthy person has a thousand wishes, a sick person only one – to be healthy". It all boils down to preventing falling ill by inhaling clean air, preparing healthy food, drinking pure water, sleeping well, and doing regular physical activities. And Zepter products enable you to do so. Is there any bigger fortune than living a life with dignity? I am positive that there is not. A healthy man is a free man.

NEW GALAXY: All in line with the slogan you have come up with: "Live better. Live longer". You have even declared that the company, which you have been leading successfully for almost three decades, is a "global protector of life". How do you substantiate that?
Philip Zepter: I haven't come up with that slogan only; you seem to have forgotten, for instance, the previous one. "Work, order, result". Guided by these two slogans, my company has been making this vision true for over three decades, as can be seen from our activities on five continents, with over 70,000 employees. Yes, we really are a "global protector of life". Everything that comes out of our production lines anywhere in the world has a most sublime purpose: health comes first! You know how they say, "a

healthy person has a thousand wishes, a sick person only one – to be healthy". It all boils down to preventing falling ill by inhaling clean air, preparing healthy food, drinking pure water, sleeping well, and doing regular physical activities. And Zepter products enable you to do so. Is there any bigger fortune than living a life with dignity? I am positive that there is not. A healthy man is a free man.

Philip Zepter with Prince of Monaco (in the middle) and Guido Capelini (Zepter International)

Zepter International company has shown with its unique products, such as nanophotonic Tesla glasses, HyperLight Fusion Fluid, and Bioptron (Hyperpolarized light) what business direction it believes in. Not to mention that in the last two years we have won numerous awards in Europe, China, and Russia.

NEW GALAXY: Do you consider the aforementioned business philosophy superior in the 21st, or even 22nd century, in view of an increasingly fierce international scientific and technological competition?

Philip Zepter: High-tech products based on fullerene and light will be in focus in the 21st century, and I think in the 22nd century as well, no doubt about that. That is a structure that has existed in the Universe since time immemorial, embodied in this material. It was a very good idea to come on board this planetary, or even interplanetary spaceship that is gaining speed. I think that Serbia has a good chance to succeed, which is why we have founded our research center here, ZeptoHyperTech. This is a once-in-a-lifetime opportunity for a nation, which ought to be understood by both academic community and the authorities. Belgrade could become a world hub of nanotechnological research, technologies, and products based on fullerene. Zepter International company has shown with its unique products, such as nanophotonic Tesla glasses, HyperLight Fusion Fluid, and Bioptron (Hyperpolarized light) what business direction it believes in.

Not to mention that in the last two years we have won numerous awards in Europe, China, and Russia. If everything goes according to our plan, we will probably base our state-of-the-art scientific research center in the future Zepter City, on the bank of the Sava River in New Belgrade (old Shipyard). Instead of traditional boats, we will be making products for the 21st and 22nd centuries, guided by imagination, scientific rigor, and a need to improve human health and comfort.

NEW GALAXY: Is one of the ways to fight off the competition a constant inflow of young, highly educated experts?
Philip Zepter: Definitely. Such people are always welcome to join us, and the "Work, order, result" slogan will await them in their posts.

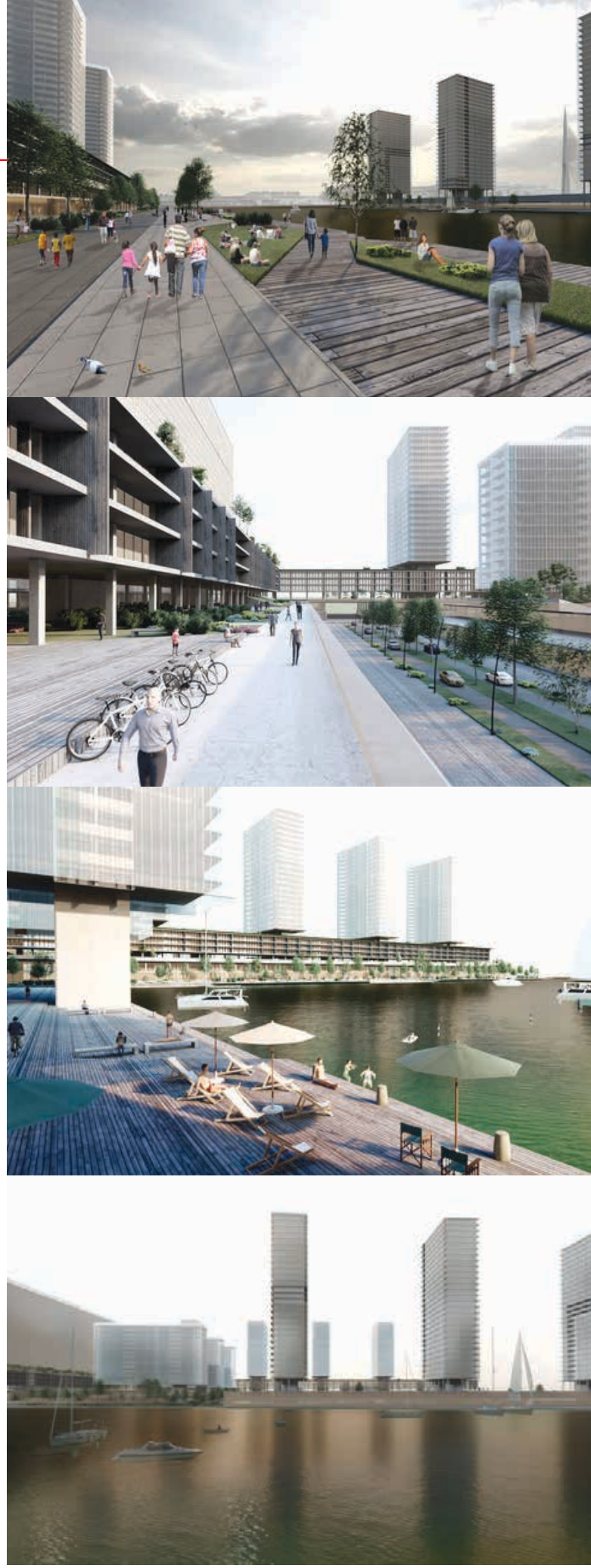
NEW GALAXY: There has been talk, and in the previous answer you mentioned it yourself, that the future Zepter City, which will be built on the ruins of the former Belgrade Shipyard will house, among oth-

er things, an ultra-modern scientific and technological park, or center, principally devoted to research and application of nanotechnology and other future particle technologies.
Philip Zepter: We'll see about the precise location. We are weighing the arguments for and against. If not there, our Scientific-Research-Production Park will be somewhere else. We need such a center in order to remain the leading company for healthy life products. I would like to create an all-around program: nanotechnologies in everyday products necessary for life.

NEW GALAXY: Is the first family factory in Serbia under the name of Zepter going to be built there? The predecessor of all the existing factories was built in Kozarska Dubica a long time ago.
Philip Zepter: It couldn't have and shouldn't have been any different. Everything starts from one's homeland and one's childhood dream, doesn't it?

NEW GALAXY: What is Zepter City going to look like? In the available pictures of architectural designs, it resembles the most luxurious residential areas in the richest countries.
Philip Zepter: If the stars favor us, it should be one of the most modern urban areas in terms of architecture and facilities. We are doing our best, and we will continue in order to make it so, and time will tell if we are right. The idea is excellent, but, as Victor Hugo put it, "Nothing is more powerful than an idea whose time has come". Whether that time is in the next 5, 10, or 50 years remains to be seen.

NEW GALAXY: What can quite logically be inferred now is that you must have wanted to become a scientist when you were a child; how else can a number of registered patents under your company's name be explained?
Philip Zepter: There are several dozens of them; you'll be given a short description of each, so you can include them in our interview.



Future Zepter City (Zepter International)

PHILIP ZEPTER'S PATENTS

Philip Zepter has submitted patent applications for the following patents to the United States Patent and Trademark Office (USPTO). This list includes both pending patents and registered ones:

- System and methods for providing generating compensation information for a dynamically structured organization (No. 20160267607)
- High-functionality bowl structure (No. 7086552)
- High-functionality bowl structure (No. 20030230588)
- Vacuum packaging device (No. D506214)
- Pan (No. D492880)
- Handle for cookware (No. D689736)
- Handle for cookware (No. D689737)
- Electric lamp (No. D794854)

NEW GALAXY: In that sense, you resemble several business giants, if I am not mistaken, although you have already surpassed the majority of them?
Philip Zepter: Since you are posing such a provocative question, let me answer in an equally provocative way: we have something to boast about, and, as you know, it is not a mean feat. You simply can't waste somebody's time without a good reason, and that is something that I really like. You can see whether a person is worth his or her salt after three to five sentences they have spoken.

NEW GALAXY: It all started with an incredible unique stainless steel cookware bottom patent that has not been surpassed to this day.
Philip Zepter: That story takes me back to my youth, when I audaciously but confidently stepped into the world of business. I knew I had to succeed. When I made my departure, I made a promise to my mother that I would come to Kozarska Dubica to get her in my own plane. And I kept that promise.

I get a spark of an idea, and then I carefully examine it from all angles. I don't leave anything to chance. Expectations and trust of millions of Zepter product consumers are at stake, which means that millions and billions of dollars are as well, so there is no room for offhand decisions. Over the years, I have been recording a few sentences about everything that seems interesting to me with my smartphone. When I am alone, I listen to that at my own pace.

NEW GALAXY: Do new ideas come to you suddenly, or are they a result of a long thought process?
Philip Zepter: Both. I get a spark of an idea, and then I carefully examine it from all angles. I don't leave anything to chance. Expectations and trust of millions of Zepter product consumers are at stake, which means that millions and billions of dollars are as well, so there is no room for offhand decisions. Over the years, I have been recording a few sentences about everything that seems interesting to me with my smartphone. When I am alone, I listen to that at my own pace. I don't let anything slip into oblivion, because, as Goethe put it, "All intelligent thoughts have already been thought; what is necessary is only to try to think them again".

NEW GALAXY: How did you earn your first million dollars? Does it have anything to do with your first wages you earned by working on the river embankment maintenance right after middle school?
Philip Zepter: Of course it does. Childhood imagination and a wish to succeed in life are a foundation of life. He who is not motivated to succeed will not succeed. He who strongly desires success, has creative (not fantastic) imagination, and a predisposition (talent) for something will succeed, to some extent at least. He might fail, but he will

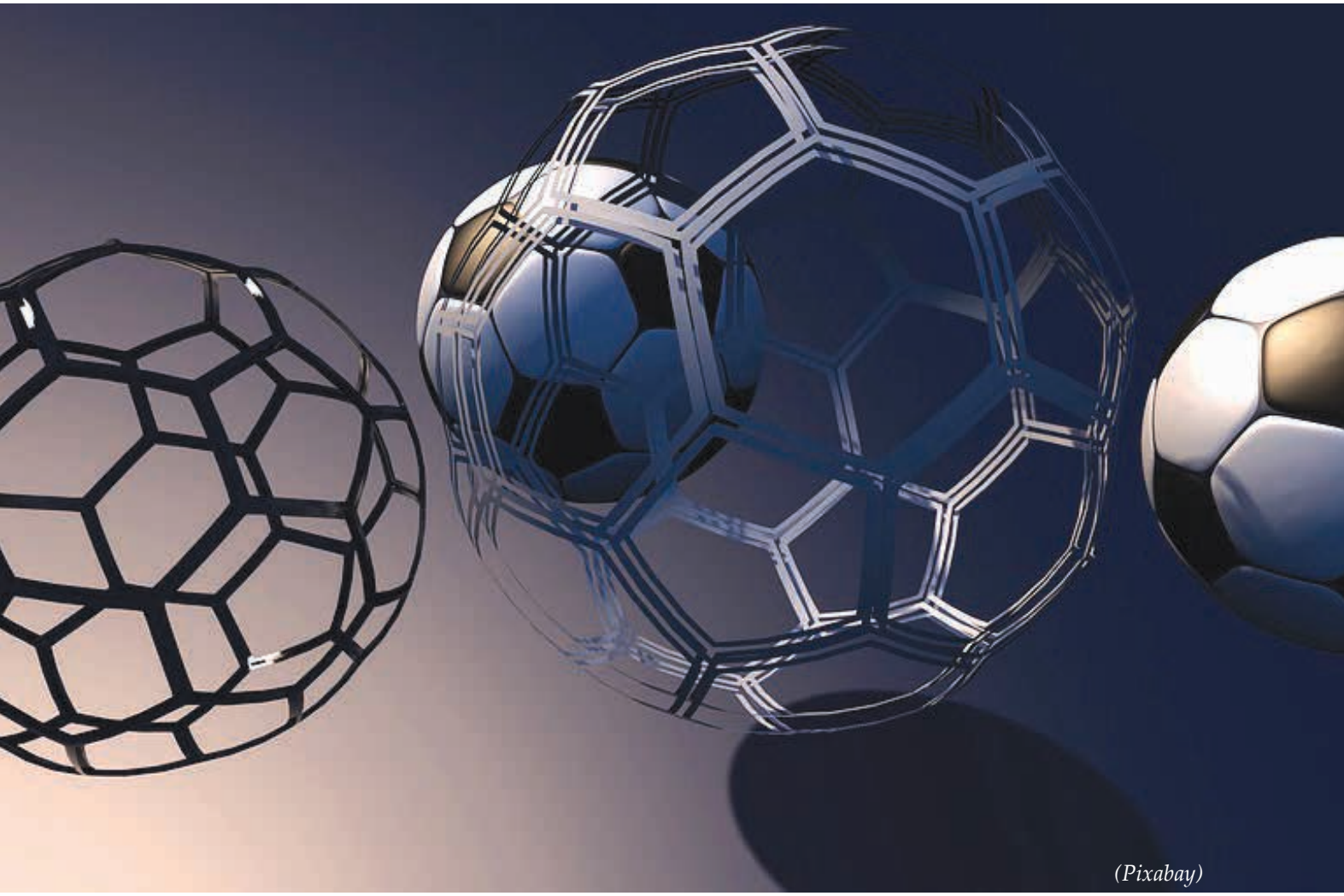
have learned how to rise again. Doesn't our everyday life teach us what walking, falling, and stopping is? Therefore, you should find a mechanism how to fall as less frequently and as painlessly as possible. With one foot, you make a step with the products you sell on the market, while with the other you make a step by developing and creating new ones. And you do so day after day, year after year… Only work, order, and results in the present directed towards the future can be a guarantee for success.

We are a company that transforms what at a first glance seems impossible into something possible in order to provide a healthier, longer, and more comfortable life. In science even everyone has to adhere to a famous adage "Publish or perish", right?

NEW GALAXY: You once said that enjoying little things is "hedonism as an endless inspiration". What did you intend to convey by that?
Philip Zepter: To this day I haven't changed this attitude. Every moment in which I come up with an idea how to change or improve something makes me happy. I haven't given up on that – I study carefully every step Zepter International takes, which new products it will put on the world market. In the world of multinational companies, failure is not an option; there is a constant fierce battle for new products, new customers, and new markets. There is no other way to survive. Long time ago, the wise Prince-Bishop Petar Petrović Njegoš summed it up in a cry "Let the struggle go on without respite!", and I would add, "Let it be what men thought could never be". We are a company that transforms what at a first glance seems impossible into something possible in order to provide a healthier, longer, and more comfortable life. In science even everyone has to adhere to a famous adage "Publish or perish", right?

NEW GALAXY: While flying from one continent to another, do you manage to grab a moment to exchange views with your wife Madlena?
Philip Zepter: Not very often face to face, but virtually, by phone, I do. You know, female intuition and a sense of beauty and the sublime is invaluable in some situations. She herself contributed to the fact that today Belgrade, as well as other cities in Europe, has museums, theaters, and numerous cultural events. It all cost not only hundreds of millions of dollars, but also a great personal effort, ingenuity, knowledge, and energy. But a pursuit and love of the beautiful and the sublime outweighs the material component.

Philip and Madeleine Zepter (Zepter International)



(Pixabay)

NEW GALAXY: You still haven't given up on the idea of buying the Red Star Sports Club, which you have been lavishly supporting for years. How does it fit in with this futuristic nanoworld that you have largely been making true?
Philip Zepter: I don't have a precise answer. It depends on the systematically structured circumstances that are still lacking. It cannot be forgotten that Red Star was the first Yugoslav club that was a European and world champion. To my Mind, Red Star is a grand national monument of sports (analogy to a monument of culture). Add to that the fact that I am a Red Star fan, and it becomes easy to understand why I have been supporting it. In the end, it might turn out that there has been a secret connection all along, as the C_{60} molecule incredibly resembles a soccer ball, in Serbia also called a ladybug, with its pentagonal and hexagonal structures.

NEW GALAXY: When you put on a false moustache in Belgrade, do you do so with your mother Nada's words in mind, who urges from your homeland, "Take care, Milan, my son!"?
Philip Zepter: I don't do that as often as I used to, because I don't go out much. I found myself in some unpleasant situations, so I had to.

NEW GALAXY: And the last question: Why did you choose Winston Churchill's quote "Never give in" to be your credo?
Philip Zepter: "This world order, the same for all", as Heraclitus of Ephesus said, "no god made or any man, but it always was and is and will be an ever-living fire, kindling by measure and going out by measure". That is a constant struggle, kindling and going out, and therefore, giving in is not an option…
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One of the biggest challenges in contemporary science is the question of activating one's own bioregenerative potential. Biomedicine strives to reach an ideal of resetting biosystems to the optimal level of adaptability to harmful agents. Integrative medicine studies the complex regulatory processes of the functions of organism as a whole in both physiological and pathological circumstances. Damage to cells, tissues, and organs results in a cause-and-effect chain of alterations in function and morphology that are often incompatible with survival.

Ljubisav Rakić
Svetlana Žunić

FULLERENE in biomedicine

(Dragan Lončar)

Now more than ever since the time of their creation, human beings are exposed to harmful effects of a number of physical and chemical agents that not only affect the physiology of their organisms but also their environment, including both the living and non-living things. These modifications in humans' immediate surroundings impose the necessity of new adjustments and super-adaptations that may lead to the breakdown of the highly conserved regulatory mechanisms.

What follows here is a simplified conceptual representation of changes originating from the surroundings, whereby a rise in air temperature causes the organism's response – for instance, an elevated expression of heat shock proteins (HSP).

What happens at the level of cellular molecular structures? The absorbed photonic energy increases the energy state of a molecule, while in the process of de-excitation heat is released, which in turn induces the expression of heat shock proteins (Figure 1).

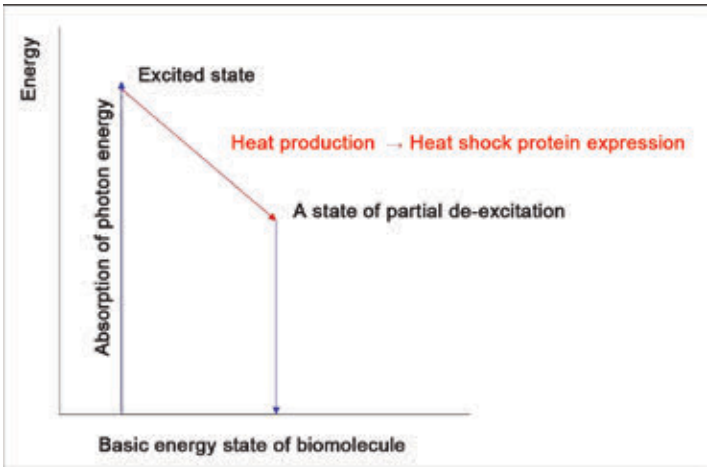


Figure 1 Photon absorption in cellular molecular structures. According to: Koning, RE. 1994. [Light.] Plant Physiology Information Website. Available at: http: //plantphys.info/plant_physiology/light.shtml. (2-28-2016). Graphically adapted in the monograph "Early and delayed health effects of depleted uranium" Media Center ODBRANA, Belgrade, 2016. According to the primary source: S. Zuni , Lj. Rakic. Depleted Uranium Induced Petkau Effect - Challenges for the Future. Nova Science Publishers, Inc. New York USA, 2016.

These molecules have a complex role within a cell. They are involved in the cell's protective stress response, which has been discussed in terms of the interconnectedness and interaction between the environment and biosphere. They also play a part in transmitting signals via steroid hormones. The receptors for steroid hormones are located in the cytoplasm and nucleus, and they contain HSP sequences. Once a steroid hormone enters a cell, HSP is dissociated from the steroid hormone receptor complex, while the receptor-ligand (steroid hormone) complex is translocated to the nucleus. This receptor-ligand translocation to the nucleus is facilitated by a signaling pathway which activates only after HSP is dissociated.

The impact of the inadequate outer electromagnetic field activates the cellular stress response. Just like other biopolymers, DNA is a molecule that can absorb incident energy. The HSP70 promoter contains two distinct DNA sequences, one of which is activated by non-thermal stimuli (electromagnetic field – EMF), while the other is activated by thermal stimuli. EMF prompts direct electron excitation in DNA. According to Blank and Goodman (2009), the induction of HSP70 expression is quick – it develops within five minutes of action of extremely low energy, with a threshold around 14 times lower than that of thermal stimuli. If the heat shock protein expression is elevated, there is a possibility that the signal transmission mediated by steroid and thyroid hormones will be disturbed both at the tissue level and other hierarchical levels, as a result of the neuroendocrine regulation. Due to the aberrations in transcription regulation, an inadequate target tissue reaction to the hormonal action is to be expected. Thus, a useless cycle is created, in which the stressor induces the expression of heat shock proteins and hormones that guide an adaptation to stress, but their effect in target tissues, where the elevated expression of heat shock proteins occurs, is insufficient. The question that arises is whether the signal pathways would be revitalized after the noxious agent action has ceased, or the pathogen processes

would progress, nonetheless. The way the tissue response would develop depends on the cell type, radiosensitivity, genetic predisposition, and other individual features of both the tissue in question and the organism as a whole.

Most harmful physical and chemical agents interfere with the fine architecture of neuro-immuno-endocrine regulatory system in an organism. The biological effect of slow low-dose ionizing radiation is mostly produced by breaking hydrogen bonds (Dertinger and Jung, 1970). Although weak, hydrogen bonds help to keep DNA intact, which is crucial for preserving molecular mechanisms for fundamental cell processes and inheriting.

(Pixabay)

Electromagnetic radiation interferes with information structures of live cells (with nucleic acids, proteins, and membranes). The cytotoxic effect of ionizing radiation is related to alterations in metabolic and signaling features of a cell. The presence of this interfering radiation in the environment can disrupt information systems, depending on the initial state of the organism (Reshetnyak et al., 1996). External coherent wave irradiation leads to cell membrane deformities, with a consequent formation of coherent resonant frequency waves via molecular antennae. These changes occur quickly, significantly disrupting cell functions, and they are enabled by the molecules with the molecular antennae function. A number of biomolecules can act like molecular antennae, including enzymes (whose active centers are surrounded by globular polypeptide chains) – chlorophyl, hemoglobin, or myoglobin, which have an architecture similar to that of a metal ion in the geometric center (for instance, magnesium ion in chlorophyl, or iron ion in hemoglobin). In fact, reactive potential of these molecules depends on the excitation of their center.

There is often a span of several months or years between the initial changes at the biomolecular level and the moment the disease resulting from the action of frequently unidentified harmful agents is manifested. It is this period of time that represents a challenge and provides an opportunity to reset the chain of these chaotic changes in the regulatory processes of life systems to a harmonized physiological regulatory pattern by stimulating one's own bioregulatory cycles.

For months, we have been exposed to a serious viral disease of a pandemic type caused by Covid-19. In the past, pandemics like this used to break out once in 100 years. At the same time, the incidence of chronic, non-contagious diseases is rising, including degenerative, autoimmune, and malignant ones. Essentially, in all these diseases there are aberrations in posttranslational modifications at the molecular level. Misfolded proteins that have not formed a functional, three-dimensional structure affect the cell's ability to remove them. By accumulating such artefacts, numerous cellular processes are jeopardized, which is the underlying cause of diseases.

A rapid development of advanced technology in the fourth industrial revolution enabled the synergy of medical and technological sciences, allowing an upswing in diagnostic and treatment possibilities. Still, a need to find the means to incite one's own bioregenerative powers has remained all this while. Biomedicine is an interdisciplinary science, whose aim is to stimulate and preserve health and normal functioning of the biosphere, including humans. The largest number of biomedical inventions con-

tains theoretical and/or practical aspects of Nikola Tesla's scientific achievements based on electromagnetism, or light.

In the history of science, it is not a rare occurrence that a sequence of groundbreaking discoveries is crowned with a new, epochal one, which results from the ingeniousness in the space-time universe. One of the most significant discoveries in the contemporary biomedicine is the application of hyperpolarized light. In his works, Professor Đuro Koruga presents the timeline of discoveries since the therapeutical properties of light were discovered.

Niels Ryberg Finsen (Wikipedia)

1. The Nobel Prize in physiology and medicine was awarded to Niels Ryberg Finsen in 1903, for his contribution to the treatment of diseases with diffuse directional light in the UV-A domain (the effects were achieved because of the resonant absorption of photon energy of 380–800 nm, i.e., 1.50–3.85 eV).

2. The other type of light used in medicine is linearly polarized (LP) light. Light is linearly polarized when the diffused light hits a surface at Brewster's angle. This is how vertical linear polarization is formed, when photons are arranged in accordance with their energy intensity in the plane of polarization. The high level of vertical linear photon polarization is achieved by using a system of mirrors, as in the case of BIOPTRON LP, when the angle of incidence is Brewster's, and the angle between the incident light and reflected light equals 90 degrees (secular reflection). The effect of such light on biomolecules and tissues is twofold: (1) molecules resonantly absorb the necessary energy (the electrical component of photons), and (2) in the cells and tissues, molecules are arranged linearly (regularly), which is of utmost importance for all lipids in the membranes, for the lipid layers in the epidermis that prevent a quick flow (or loss) of water from the skin (TEWL – Trans-Epidermal-Water-Loss), as well as for all the biomolecules that by means of dipole moments form liquid crystals (collagen, elastin, microtubules, cytoskeleton, etc.) In the course of BIOPTRON application, LP light was shown to have an effect on ATP, on the intercellular energy increase, on the improvement of microcirculation and cellular activity, on the enhancement of fibroblast proliferation, on the reduction of swelling and inflammation, on dermatological conditions, on wound healing, on sports injuries, and so on. BIOPTRON with an LP filter functions within a wavelength range of between 400 and 1170 nm, i.e., 1.15–2.90 eV, with a prominent peak at 720 nm, or 1.70 eV). BIOPTRON device, with the luminous energy of 2.4 J/cm2 per minute, has a CE marking and is registered as a medical device, while over three million units are currently being used for medical purposes.

In the meantime, in 1985, the nanomaterial C_{60}– a miraculous crystal displaying icosahedron symmetry – was discovered. In 1990, Professor Koruga with his research team managed to obtain the first pictures of a C_{60} molecule in atomic resolution in the Nano Laboratory of the Faculty of Mechanical Engineering, University of Belgrade. The results were published in an international journal. Also, at the invitation of the pub-

lishing house Elsevier, Professor Koruga, in collaboration with four American scientists, published the first book about the C_{60} molecule. Kroto, Smalley, and Curl were awarded the Nobel Prize in chemistry for the discovery of C_{60} in 1996.

The third allotropic modification of carbon, C_{60}, better known as fullerene, is the only molecule consisting of one chemical element (carbon) that forms a structure shaped like a spherical cage. By adding hydroxyl groups, Hyper-harmonized Fullerene Water Complex – 3HFWC – was patented, which is characterized by a significantly higher solubility and improved effects in comparison to other fullerene forms and modifications. It has been proven that this new substance, 3HFWC, possesses remarkable biological features as well, such as antiviral, antibacterial, antitumor, antioxidative, and immunomodulating effects, as quoted in the studies by Danijela Maksimović-Ivanić, PhD from the Institute for Biological Research "Siniša Stanković" and Marina Malenković, MD, PhD from the Department of Microbiology of the Faculty of Pharmacy, University of Belgrade.

The initial research conducted by a team led by Selma Kanazir, PhD from the Institute for Biological Research "Siniša Stanković" points to the potential application of 3HFWC substance in preventing the onset of Alzheimer's disease. At the same Institute, a team led by Angelina Subotić, PhD investigated the effect of 3HFWC on plant growth, yield, and fruit quality. The results unequivocally show that the application of the 3HFWC substance in agriculture is possible.

Further upgrade has made use of the positive aspects of the C_{60} nano molecule, resulting in the development of the nano-photonic filter for generating hyperpolarized light (HPL) (Koruga, Đ. Hyperpolarized light: Fundamentals of NanoBiomedcal Photonics, ZEPTER BOOK WORLD, Belgrade 2018, patent EP 3 469 406 B1, June 12, 2020). Instead of a classic filter that blocks UV radiation, a new filter based on the nano-photonic material was designed. Nano-photonic filter hyperpolarizes linearly polarized (LP) photons with an efficiency of 82%: in addition to the vertically linearly polarized light itself coming from the BIOPTRON device, a horizontally polarized light is created as well. The combination and arrangement of these two polarizations in accordance with the Fibonacci Law (like sunflower seedlings) renders the phenomenon of hyperpolarized light. From the biological point of view, by adding the fullerene nano filter to the BIOPTRON® device, light features are improved, as linearly polarized light is transformed into hyperpolarized light. It has been shown that HLP has better effects than diffuse, linearly polarized, or laser light, while its effects on microcirculation, wound healing, and the immune system are remarkably positive.

A team of scientists led by Professor Koruga sponsored by the Zepter Company has been researching the application of C_{60} in biomedicine through coordinated studies, whose aim is to show the feasibility of using C_{60} for maintaining good health, as well as for delaying, reducing, or eliminating negative effects of various agents originating from the environment or the organism itself.

The results of these studies are presented in this issue of Galaksija by their respective directors, and here we will provide a short review of two studies not covered in this issue.

STUDY 1: Investigating the Effect of the Visible Light Spectrum on Organism through Nano-optical C_{60} Lenses (Director **of the** study: Branislav Filipović, MD, PhD, Faculty of Medicine, University of Belgrade). The principal aim of this study was to conduct an initial research on the impact of the BIOPTRON hyperpolarized light in the visible, infrared, and hyperpolarized ranges of light within the domain of the visible spectrum (GLASSES), as well as on the impact of their combinations on the change in the level of neuroendocrine parameters. The subjects of this study were informed volunteers, who had signed con-

sent forms for participating in this research. The visible light spectrum the subjects were exposed to through the C_{60} lenses was generally shown to have a positive effect on the subjects' brains, reducing anxiety and depressive behavior, improving sleep quality, and positively influencing their behavior. The results of the study point to the fact that BIOPTRON-HPL can be used as a prevention (before a stressful event, for instance), as well as a support to prescribed therapy in people who suffer from a sleep disorder. Positive effects of wearing glasses or of being stimulated by BIOPTRON-HPL are also expected in people who change time zones. A significant drop in anxiety has been observed, even in subjects whose anxiety levels were well within normal reference range. Fluctuations in serotonin and melatonin levels during treatment are significant for the potential preventive application of glasses and BIOPTRON-HPL, that is for increasing adaptability to stressful events, as well as for improving the circadian rhythm regulation and quality of sleep.

(Zepter International)

STUDY 2: Comparison Between the Impact of Zepter Nano-photonic Lenses on Objective and Subjective Parameters of Asthenopia and the Impact of Commercially Available Lenses with the Same Physical Characteristics (Directors of the study: Vesna Jakšić, MD, PhD, Assistant Proffesor and Mirko Jankov, MD, PhD, Senior Research Associate). The aims of the study were the following:

1. Comparing the impact of Zepter nano-photonic lenses on asthenopia with the impact of the existing medical filters and lenses which are labeled to block harmful blue light, and which are already used in everyday ophthalmological practice; 2. Establishing whether wearing the aforementioned lenses alters the comfort levels, i.e., whether it reduces eye strain. ZEPTER nano-photonic lightly tinted glasses have been rated as the best by the subjects, while it has been established that the comfort of wearing ZEPTER lenses 2 is far greater than that of medicinal filters. None of the lenses tested influences the number of absolute scotomas in the field of vision.

In addition to the aforementioned research and studies, we believe that this paper should include the innovative activities and products developed by the ZEPTER Company, which are primarily directed towards environmental, water, and air protection:

1. ZeptoHyperTech, ZEPTER's innovation company, in collaboration with the Department of Biomedical Engineering from the Faculty of Mechanical Engineering, University of Belgrade, has designed a device for sterilizing surfaces, water, air, footwear, clothes, foodstuff, etc., due to the necessity of preventing the corona virus spread. Two solutions have been offered: the use of UV-C lamp (mercury-based, with a wavelength of 245 nm), and the use of UV-C LED diodes for generating this light).

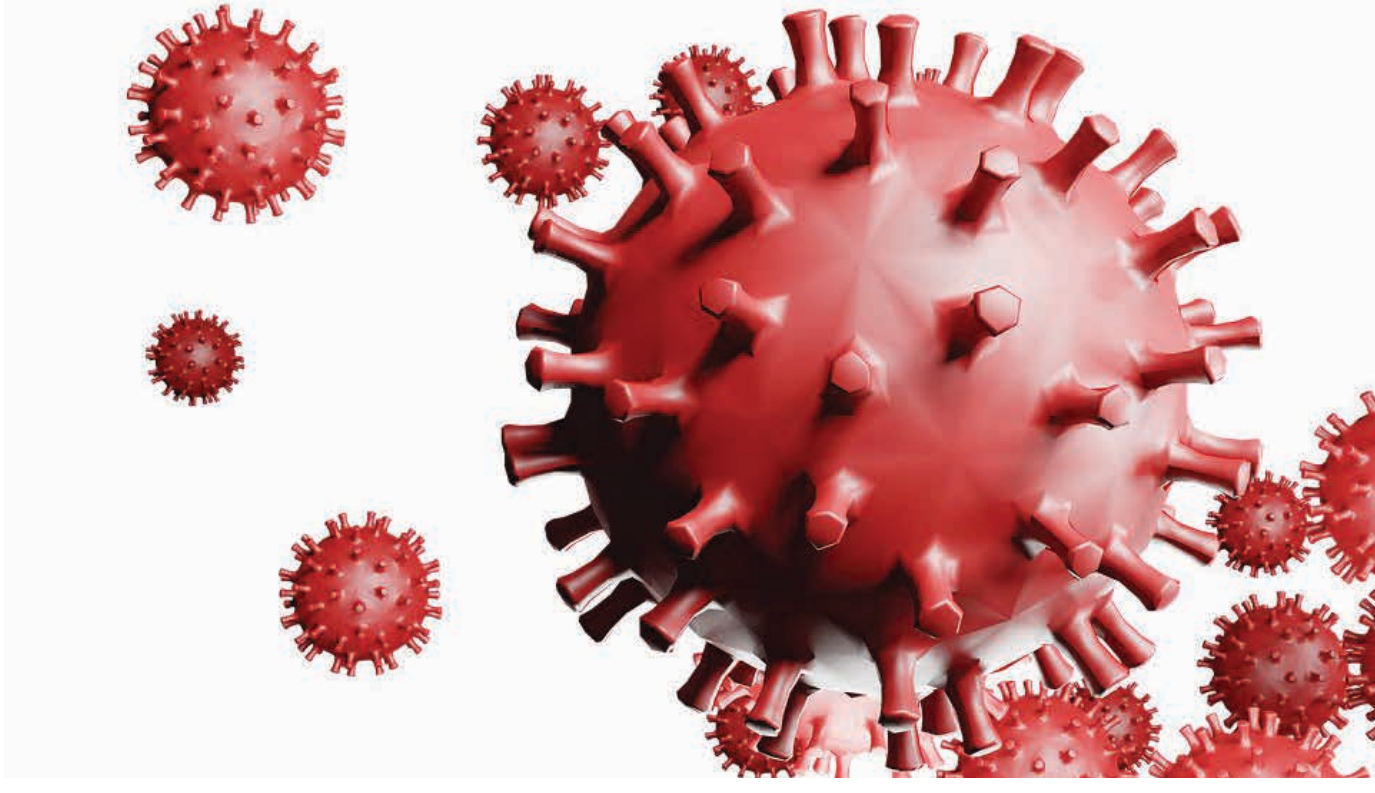
2. The existing air purifier Therapy Air iOn is a highly effective air purifier that

acts as an ionizer at the same time, which means that the clean air is enriched with negative ions, the particular concentration of which is a very significant factor in preserving human health. Negative ions have a beneficial effect on increasing the level of physical energy, on improving the immune system, and on neutralizing the effects of stress, while upgrading metabolic processes and blood circulation. Although this device was pronounced the best air purifier on global market by an independent body of German experts (expertentesten.de in 2016 and 2020), the ZEPTER Company designed innovations, installing a highly sophisticated magnetic filter that eliminates even the smallest nanoparticles present in the air.

3. There are a number of water purifying devices. ZEPTER's AqueenaPro device contains five filters: 5 μm polypropylene filter, granulated carbon filter, 1 μm polypropylene filter, reverse osmosis membrane, and coconut shell activated carbon filter. The new UV-C filter is attached to the AqueenaPro device as an additional unit that provides the highest quality of water, making this device even more effective.

AqueenaPro (Zepter International)

Through its ZeptoHyperTech innovation company, the ZEPTER Company designs innovations in the existing products and develops new ones in collaboration with scientific institutions from Serbia and abroad with an aim to preserve and improve the quality and length of life. Via its ZeptoHyperTech company, the ZEPTER Company managed to create junior and senior research and development teams consisting of 18 members from the fields of optics, electrical engineering, mechanical engineering, mechatronics, and biomedical engineering. All prototypes of devices and appliances designed by this research and development unit are tested by a team of 9 physicians employed at ZEPTER MEDICAL. Only after these devices and appliances have undergone biomedical evaluation by ZEPTER MEDICAL and other biomedical institutions are they given the green light for use.



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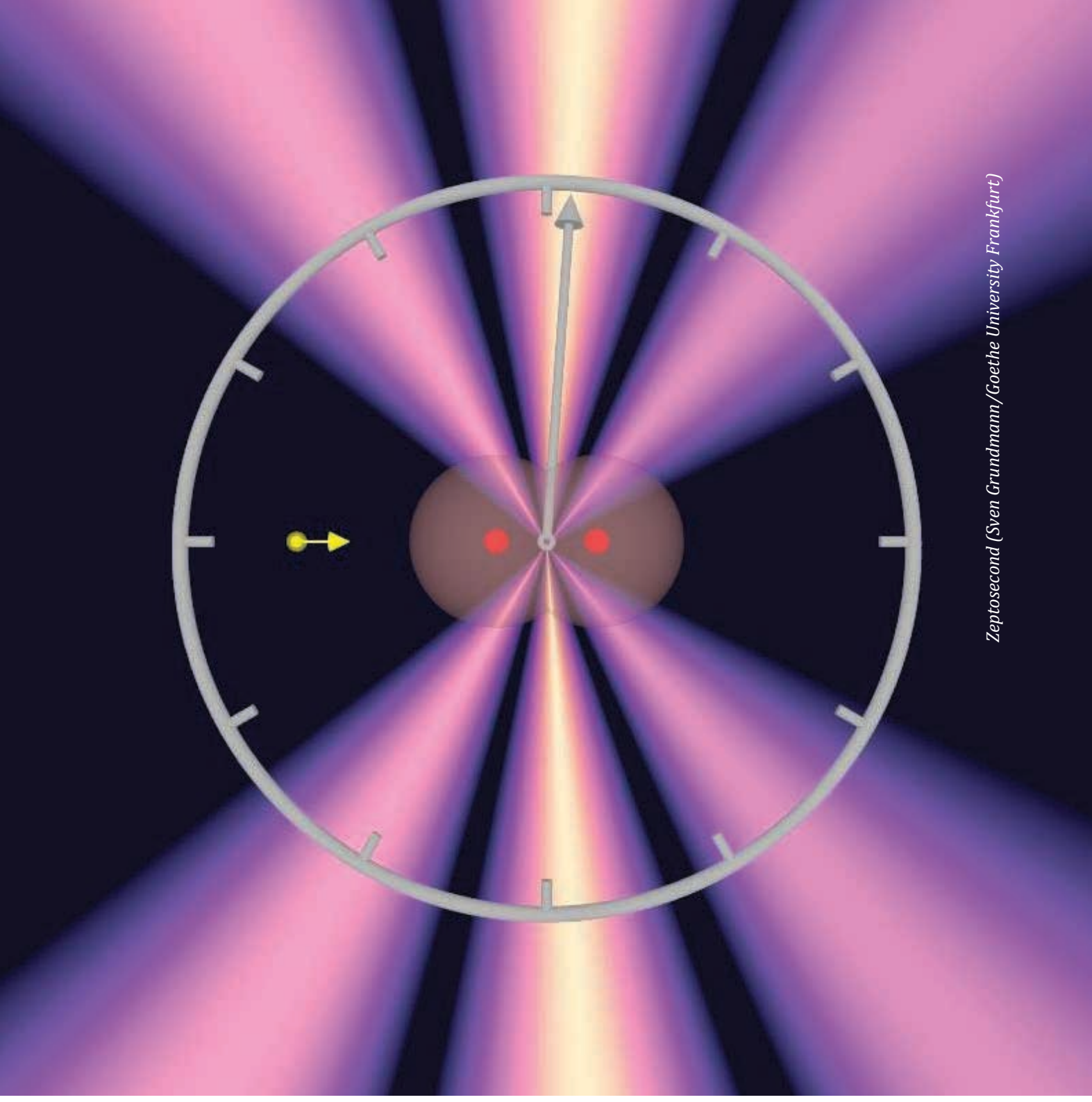


Zeptosecond (Sven Grundmann/Goethe University Frankfurt)

A STEEP PATH TO KNOWLEDGE – The Goat Trail

(or: a challenge the established nano-zepto spacetime science and technology)

Đuro Koruga

"Science is for those who learn.
Poetry is for those who know."
Jacques Roux, French revolutionary (1752-1794)

It is a challenge for nano–zepto scientists to try to improve our brain structure, brain organization and functionality by light in which photons are coupling with excitons by icosahedral symmetry, giving polaritons (hyper-harmonized and – polarized light).

Please do not think that I am a Capricorn in the zodiac just because of the title. You should not even think that I believe in the zodiac, at least not in the way that it is presented and interpreted today by most of those who practice it. This does not mean that it has not been known that the celestial bodies of the solar system have an impact on biological systems, and even on humans. But such mechanism of action is completely different. This is a phenomenon of nanogravity, which was discovered in 2002 by a group of researchers from the University of Belgrade (Koruga, Tomić, Ratkaj) and experimentally confirmed by a research group from Grenoble (Nesvizhevsky, Abele, Krantz) which examined the effect of the Earth's gravitational field on cold slow neutrons (Quantum States of Neutrons in Earth's Gravitational Field, Nature, Volume 415, 2002).

These two groups investigated independently of each other (they did not even know one about the other until they published the results) and both groups got the same result, a value of 0.110 ng, with one approaching the problem from classical mechanics (Belgrade) and the other (Grenoble), from the perspective of quantum mechanics. It turned out that the nano level is the meeting place of classical and quantum action. At that level, these two actions are recognized and act synergistically, giving a new quality to the action, because in addition to the pure energy effect of biological coding structures (DNA, proteins, etc.), they also model information processes.

The inevitability of the meeting of classical and quantum action was overlooked in 1997 by Penrose (Roger Penrose, 1934-), the winner of the 2020 Nobel Prize in Physics, when he published the book *The Large, the Small and the Human Mind*, published by Cambridge University Press. Systematized physics from Galileo (Galileo Galilei, 1564-1642) to the present day stands on the basis of three universal physical constants: speed of light (c), Planck's constant (h) and gravitational constant (G) (Figure 1). He showed that further progress of science, including the definition of the "theory of everything", will not be possible until the "meetup" of classical and quantum mechanics, i.e. of Newton (Isaac Newton, 1643-1727) and Schrödinger (Erwin Schrödinger, 1887-1961). What is certain for the future "science of everything", according to Penrose, is the existence of quantum gravity. In addition to this, his scheme clarifies a conflict in science, which has lasted since 1924, since the defense of Louis de Broglie's doctoral dissertation (Louis de Broglie, 1982-1987). On the occasion of his dissertation, there was a discussion between Bohr (Niles Bohr, 1885-1962), who had objections to the main thesis and Einstein (Albert Einstein, 1879-1955), who defended the correctness of the thesis. To end this dispute, they gave the task to the 27-year-old Schrödinger (Erwin Schrödinger, 1887-1961) to show mathematically whether Bohr's remarks stand, or not. After some time, Schrödinger sent the manuscript to Einstein, who, when he read it, said it was no good, without adding any remarks. In fact, the reason for this was that the author did not include the theory of relativity in his new concept. Despite the negative opinion, Schrödinger published the paper, but that is why Einstein ignored quantum mechanics. Figure 1 shows exactly why the misunderstanding occurred: Schrödinger designed a mathematical apparatus for quantum mechanics based on Planck's constant, as a logical step in continuation of Galileo's physics, but not based on the quantum field theory, which emerged later as a synthesis of quantum mechanics and the theories of relativity.

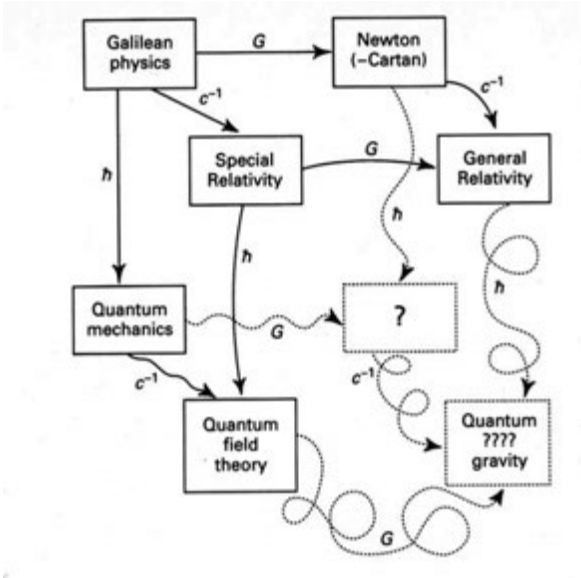


Figure 1 Penrose's vision of the unity of classical (Newton-Cartan) and quantum (Schrödinger) mechanics and the prediction that quantum gravity will be an integral part of the "theory of everything" that has not yet been created, because before that the science of quantum mechanics needs to occur (Rodger Penrose, The Large, the Small and the Human Mind, Cambridge University Press, 1997)

What is nano?

We all have heard about *nano*, and the younger generations are learning about it in schools today. As a reminder, it should be said that this word originates from Greek and it means: dwarf. As for the modern understanding, it is the one billionth part (10^{-9}) of something; length, time, weight, force, action, including gravity, of course. It is most often used for spatial size, length, and usually as a ratio to one meter. If we compare the size of one millimeter to a thousand kilometers (approximately the distance between Belgrade and Munich, 938 km), the same is the ratio between one nanometer and one meter. A 180cm man is 1.8 billion nanometers tall; if there is a nanoworld in us, then we are real giants in comparison with it. And is there a nanoworld in us?

Without hesitation of making a mistake, the answer is positive: yes. It exists. Not only is there a nanoworld within us, but we are made of billions of nanoworlds. One strand of DNA, which forms the basis of our genetic material, is only 2 nm in diameter, the water molecule is less than 1 nm, and water makes about 70 percent of the human body. And not only that, these days and months, the whole world has been at war with the COVID-19 virus, which is only 120 nm in size, and a "dwarf" like this is giving us all the trouble. In other words, nano is a "double-edged sword". Therefore, according to Goethe, it's not a wonder, "because the most difficult thing is to see (understand) what is (happens) in front of us". To prove that this statement is true, let us consider an everyday phenomenon, the falling of rain, from a new point of view. The raindrop is one to two millimeters in size (of course, it can be either larger or smaller), and the diameter of the Earth is about 12,000,000 meters, which roughly gives that the ratio of a raindrop to our planet is in the order of a billion times. So, rain is a nanotechnological process in which a participant (Earth), which is a billion times bigger than a drop of rain, takes part. Yet on the other hand, billions and billions of raindrops participate simultaneously in in one local process. In Nature, through the inverse symmetrical elements, a harmony between size and quantity is created.

If we look at Earth globally, then the weather situation would, in fact, represent the orchestration of local nanotechnological processes (rainfall in various regions). That is why the nanoworld is not only in us, it is around us, but we usually do not recognize it.

Sublime structure

However, Plato did not give the icosahedron (the C_{60} molecule — is a truncated icosahedron), but – from the aspect of symmetry – he gave its dual, dodecahedron, the honor of representing the order of the Universe. Either way, until recently, we did not know that the universe was full of nano objects made up of carbon atoms. Perhaps this would not be so significant, if that object, the C_{60} molecule, was not the most perfect symmetrical structure based on point symmetry. For example, we, and especially women among us, admire the beauty (the arrangement) of a diamond that has 48 symmetrical transformations. What could we say, except

that our breath stops, when we find out that the C_{60} molecule – the buckminsterfullerene, or the buckyball – has 120 symmetrical transformations?!

We can freely say that the era of nanoworld began in our heads with the experimental discovery of this molecule in 1985, by an Anglo-American team led by Harold Walter Krotoschiner (1939-2016). It is especially interesting that there is a complex protein structure in our brain, which has the same icosahedral symmetry as the C_{60} molecule, and it is called clathrin. However, the C_{60} is 1 nm in size and clathrin is about 70 nm in the brain but may be 300 nm in other bodily tissues. The discovery of the C_{60} molecule and the determination of its properties is reminiscent of a detective story, of which we shall mention a few key moments: it was theoretically predicted in 1970 by a Japanese scientist Eiji Osawa (Eiji Osawa, 1935-, in Japanese 大 澤 映 二); It was created in the physics laboratory at the University of Arizona in 1972, however, professor Donald Huffman (1935) and his team were unaware of this until 1991, when they decided to look again at the 1982-1983 spectra, which they did in their laboratory at that time. A similar thing happened to the author of this text: since 1978, he has been searching for "artificial clathrin", which was hypothesized by Japanese researchers (Kaneseki/Kadota) in 1969, and in 1992 he and his team in Belgrade made the first image of the C_{60} molecule with atomic resolution using STM (scanning tunnelling microscopy – a technology based on the Schrödinger equation from quantum mechanics and in direct connection with the phenomenon of electron tunnelling). Then the C_{60} molecule became visible to the human eye, not just the mind, on the basis of mass and UV-IR spectroscopy (Fig.2).

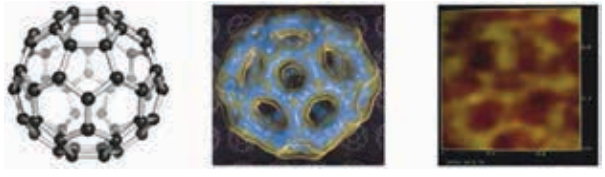


Figure 2 Model of the C_{60} molecule with 60 carbon atoms, arranged on the surface of a sphere in 12 pentagons and 20 hexagons (left), quantum-mechanical model of the C_{60} published in 1991 on the cover of Science (middle) and the first STM image of C_{60} molecule made in April 1992 at the Centre for Molecular Machines as part of the University of Belgrade Faculty of Mechanical Engineering (right).

And just when we thought we had found out everything, its rapid anisotropic rotation ("twisting"), about 10 billion times per second, came on the scene. This phenomenon has been attracting the attention of researchers for years, repeatable results have been obtained experimentally, but there has been no fundamental breakthrough in their understanding and explanation. The author of this text (with four other American scientists), after publishing the first book in this field (*Fullerene C_{60}: History, Physics, Nanobiology, Nanotechnology*, Elsevier, 1993) spoke in May 1993 with the famous mathematician, Đuro Kurepa (1907-1993) on the transformations of space (from 0D to 3D) and time, which take place in this molecule. Based on exhaustive considerations, professor Kurepa proposed that a new categorical apparatus be introduced into mathematics, as he did by introducing the left factorial, because he felt that the existing one was not sufficient. However, his death, at the beginning of November 1993, interrupted further work and cooperation and other events influenced the suppression of all this. As "every time carries its own burden", the time has come to start solving the problem, especially since researchers from the University of Vienna, led by Zeilinger (Anton Zeilinger, 1945-), experimentally showed the dual, corpuscular-wave nature of the C_{60} molecule in 1999.

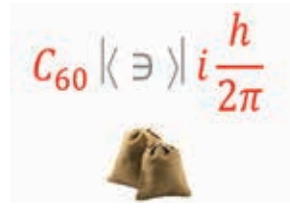


Figure 3 The C_{60} as two bags tied, one classic, the other quantum, with this entanglement needing to be untied. Bearing in mind that this is not just a spatial transformation of geometric figures in time, but a simultaneous spatial and temporal codeogenic phenomenon, we must, before embarking on a research adventure, get acquainted with another quantity, and that is zepto.

What is zepto?

Until recently, it was just an abstract unit in the SI system, which had no practical value, as it is only 10^{-21} of something (meters, seconds, kilograms, etc.). It comes from the Latin word *septem*, meaning seven, because it is equivalent to 1000^{-7}. If we wanted to express ourselves in zepto units, then we could say that the charge of one electron is 160.21 zeptoculons (*zC*) or that a zeptomol (*zmol*) of a substance contains 602 particles. As you know, this order of magnitude has not yet been used in practice. On the other hand, the highest known accuracy of measuring spatial quantities is in the domain of femto (10^{-15} m) and ato (10^{-18} m) and in temporal quantities, in the domain of femto (such as the speed of joining and separating hydrogen bonds). However, the recent result of measuring time of 242 zepto seconds in the interaction of light and hydrogen molecules has opened new possibilities for experimental work (Zepto birthtime delay in molecular photoionization, *Science*, Vol. 370, Issue 6514; pp. 339-341, 2020). This opens a new question, especially when we talk about time, that relates to why one revolution of Earth is divided into 24 units (*hours*), then one hour divided into 60 units (*minute*) and finally one minute into 60 units (*seconds*). We inherited this 5,000 year old unit (number) system from the Sumerians. It is interesting that the human race has changed a lot in its history, but the system of counting time has remained intact. Why? It is difficult to give an answer, but everything indicates that the system of counting time is woven into us, just as the numbers system itself is?

"What are numbers and where do they come from?"

When it comes to modern scientists and pertaining numbers, Feynman (Richard Feynman, 1918 – 1988) asked himself seriously, "We use numbers in all our theories, but we do not understand them – what they are and where they come from. I believe that from a fundamental point of view this is a very interesting and significant problem". We look at what is always in front of us and we see only one "side of the coin", we see individual numbers and their relations, but we do not see the system (the whole). Our mathematics is based on the numerical line R^1; it is our current view and the basis of our analytical approach, starting from the number theory to the practical application of numbers. However, if we want to do a synthesis of the system, to see the whole, then we must take into account the basic cell of the decimal system (0, 1, 2, 3..., 9), i.e. from the open numeral system R^1, we have to move to the closed (cyclic) numeral system C^1 (Figure 4).

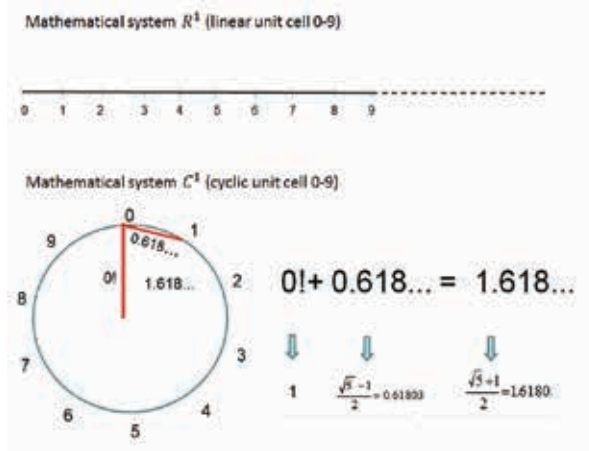


Figure 4 Two approaches to the decimal system of numbers, analytical through via R^1 and synthetical, through the basic cell of the decimal system C^1. The number manipulation on the numerical line R^1 is known to everyone, because it is an integral part of our education (mathematica instrumentalis – how our mind manipulates the numbers of the decimal system). However, the synthetic approach is not taught in schools and it is related to the code genesis of nature, i.e. how Nature "calculates" (mathematica naturalis: 0!, ϕ, Φ, $-\phi$, $-\Phi$). That is why "decoding reality" is one of the challenges and significant problems that the human race needs to solve.

As we know, the Nature, including water, does not use the numbers 1, 2, 3, ...n, but the unit values (etalons, 0! and 1) of something and the values 0.61803..., 1.6803... in relation to the selected unit value (Koruga, Hyperpolarized Light: Fundamentals of Nanomedical Photonics, ZEPTER BOOK WORLD, 2017) as well as their inversions through a point, which we denote as -0.6803... and -1.61903... . Nature harmonizes structures and processes through: (1) selected unit

quantities at a given level, (2) the symmetry of structures and processes, (3) as well as the harmony of the whole and its parts (perfection). Nature applies the same principle of order horizontally and vertically, uniting hierarchical levels according to the pattern of self-similarity (for example: in mythology, man first created gods in his own image, and then there was inversion, reversal, so in religion God created man in his own image). The numbers 0, 1, 2, 3 ...n, are an invention of the human mind made possible by water as a necessary condition and a matrix of biomolecules of brain structures, under the influence of the environment, as a sufficient condition. By combining the numbers of mathematica naturalis: 0!, 0.61803..., 1.6803..., -0.6803... and -1.61903 .... (0!, ϕ, Φ, $-\phi$, $-\Phi$), we can count through all the numbers of 1, 2, 3, ...n, of *mathematica instrumentalis* (Figure 5).

$$\Phi - \phi = 0!$$
$$\Phi^0 - \phi^0 = 0$$
$$\Phi^1 - \phi^1 = 1$$
$$\Phi^1 + \phi^2 = 2$$
$$\Phi^2 + \phi^2 = 3$$
$$\Phi^3 - \phi^3 = 4$$
$$(\Phi + \phi)^2 = 5$$
$$2(\Phi^2 + \phi^2) = 6$$
$$\Phi^4 + \phi^4 = 7$$
$$2(\Phi^3 - \phi^3) = 8$$
$$3(\Phi^2 + \phi^2) = 9$$
$$2((\Phi + \phi)^2) = 10$$
$$\Phi^5 - \phi^5 = 11$$
.....
$$\Phi^6 + \phi^6 = 16$$
.....
$$(\Phi^3 + \phi^3)^2 = 20$$

Figure 5 Numbers of mathematica naturalis (0!, ϕ, Φ, $-\phi$, $-\Phi$) can generate numbers of mathematica instrumentalis in our brain in a few pico- or femtoseconds, because these are the rates of coupling and decomposition of hydrogen bonds in water and between water and biomolecules that are responsible for the dynamics of the mathematical matrix in the brain. Here we have a similar situation as in the understanding of the functioning of our organism, everything was complicated, we could not understand anything fundamental, until it was discovered that the five basic elements: adenine, thymine, cytosine, guanine and uracil in DNA and RNA encode amino acids. We will be not in a position to understand the functionality of the Nature-based mathematics of numbers until we are aware that all numbers of the decimal system have a source in ϕ, Φ, $-\phi$, $-\Phi$, while 0! has a special status, like uracil in RNA.

In the book Hyperpolarized Light, it has been shown how water can form and decompose bonds based on the numbers: 0!, ϕ, Φ, $-\phi$, $-\Phi$ in 50 femtoseconds through non-covalent hydrogen bonds. The numbers 0, 1, 2, 3, ...n are an invention of the human mind made possible by water, as a necessary condition, and the matrix of biomolecules of brain structure, under the influence of the environment, as a sufficient condition. So, in addition to the potential we have (water and code biomolecules; DNA and proteins) to create a new numeral system in relation to the nature from which we emerged, we must also take into account of the effect of the environment. The entire history of evolution shows how important the influence of the environment is on the biological plane, and in a lifetime of man, how much the social environment has an impact on the mental plane. There are known examples that children who were isolated until the age of 12 and did not learn to speak, with all the effort and influence of the external environment did not speak later, they remained at the level of mumbling. This means that in order for something to be created, there must be a synchronization of spatial and temporal actions. It is the same with the emergence of numbers, they could only be produced by a young civilization, if we count that the trigger of civilization in the human race happened about 10,000 years ago.

Our system of counting time comes from the Sumerians and the Babylonians, although the way of writing numbers and counting with them comes from the Indian civilization, while we got hold of them through the Arabs. Exactly when the decimal system came to Europe cannot be determined, but it is believed that the year 1202 and the appearance of Fibonacci's book by Abaci marked a turning point: Roman numbers were abandoned and "Arabic" ones began to be used.

However, the Sumerians did not use the decimal system but a sixty-digit system (sexagesimal) and hence the system of calculating time is based on the number 60. Then we come to the enigma: what could

initiate water and biomolecules from the external environment to form the sixties in the mental world of man at that time? For the first mythological gods, created by man, water was in its image, that is, a reflection of the image of the beings of our ancestors in water. The artistic creative potential of our ancestors created the characters of the gods first from wood, and then from stone. Out of helplessness due to the influence of the cruelty of nature, man transmitted to the gods his desires and needs for protection. During the primordial creation (art), hands with 10 fingers were the basis of creation. Since the need for quantity began to develop in people during this work, it is understandable that man began to use what was available to him, the 10 digits on his hands. So, for the decimal system we can find some rational explanation: 10 fingers are the external driver for the formation of the decimal system in the human thought system.

In the base 60 system, things look much different and more complex. For now, the only possible external driver of the base 60 system in the human thought system may be the Moon and its quantum-mechanical or nanogravity action on Earth's surface (influence on non-covalent hydrogen bonds in water and inter biomolecular interactions; ion-ion, ion-dipole, dipole-dipole ...).

One revolution of Earth in our mental world is divided into 24 parts (why?), so that the $1/24^{th}$ unit contains a smaller unit that is 60 times smaller than it, which is 1/1,440 of one revolution (why?); this new unit is divided into 60 smaller units and amounts to 1/86,400 of Earth's rotation (why?). Based on what we know, we can say that the rotation of the Earth around its axis is divided into two parts, a pair of darkness-light, i.e. night-day, as 12 + 12 = 24 units that we call hours. Now comes the key point: if the laws of symmetry are the foundation of nature, then the symmetrical structure of the icosahedral clathrin that is responsible for information processes in the brain (release of neurotransmitters at synapses), and its dual dodecahedron (by which biological water can be clustered – $(H_2O)_{20}$), it makes sense, because both have 12 pentagons, so in addition to space, we also have a temporal icosahedral system in us. But, where did smaller units of time than hours come from: minutes and seconds, being twice divided into 60 units of their own? One of the possible and most probable reasons is that this system is woven into us through external natural actions, relationships and rhythms. It should be borne in mind that the state of human consciousness in ancient civilizations is not the same as today. Today we are *homo technicus* (we broke away from nature, we create machines, technical means, we dramatically change the planet), whereas before, in early civilizations, man was much more attached to nature, man was *homo naturalis*. This is similar to the mother–child relationship: for the first six months after birth, the child is completely attached to the mother, and only later becomes independent. We can say that the early civilizations were much more connected to nature than we assume today.

What natural phenomena (rhythms) can produce the "60" phenomenon? The closest explanation may be found in the gravitational cooperation between Earth and Moon. One should know that the Moon does not orbit the Earth, as is commonly thought (and said in everyday life), nor does the Earth revolve around the Sun according to Kepler's law, rather, the Earth–Moon system, as a dual system, revolves around a common center called the barycenter and such a barricade moves around the Sun according to Kepler's law. When the Moon is at its zenith, the barycentre is 4,467 ± 460 km from the center of the Earth, or 1,904 ± 460 km from the Earth's surface in the direction of the center of the Earth. The radius of the Earth is 6,378 km, the mass is $5{,}972 \times 1{,}0^{24}$ kg, the Moon's radius is 1,738 km, the mass is $7.34 \times 1{,}0^{22}$ kg and the average distance of the Moon from the Earth is 384,400 km. As the centripetal forces F_1 (Earth), F_2 (Moon) are equal to the gravitational forces between the Earth and the Moon (F), the relation $F_1 + F_2 = F$, i.e. $m_1r_1\omega_1 = m_2r_2\omega_2 = F$ holds true. Bearing in mind that the centripetal acceleration of the

Moon is the same, what gives the Moon the force of gravity is $F = m_2 g_2$, which ultimately leads to the solution that:

$$g_2 = \frac{1}{60^2}\, g$$

i.e. the distance between the Earth and the Moon is about 60 times the radius of the Earth, which implies that the distance of the Moon from the center of the Earth is about 60 times greater than the distance between the center of the Earth and the object on the Earth's surface, so the Moon will act 3,600 times weaker. In other words, a "burst of 3,600 gravitons" of the Moon is needed to balance with one graviton of the Earth on the surface of the Earth. But these gravitational "bursts" seem to go in salvos of 60, and each of those 60 salvos has 60 lunar gravitons. This rhythm of salvos and the rhythm of the elements of salvos is similar to fireworks in which we successively launch 60 rockets into the ionosphere at regular intervals and each of them disperses into 60 smaller luminous parts the light signals of which reach the Moon in about 1 second. The ionosphere and the space between the Earth and the ionosphere oscillates and excite (animate) in us the rhythm that we experience as a measure of the change in the conformational states of our biomolecules, that is, as a measure of time.

Interestingly, wedge symbols denoting 1, 12, 60, 3,600, 1/60, and 1/3,600 were particularly important to the Sumerians (Dirk Struik, A Concise History of Mathematics, Dover Publications, New York, 1960). If something contained 12 pieces, it was called a "dozen", which is a measure that remained among us to this day. Also, the division of the circle into 360 degrees originates from the Sumerians and it is considered that the positional system, as well as the zero, originate from them, because as the historian of mathematics Dirk Struik says: "… It can be assumed that they and the Indians, just like the Greeks, met during the caravan journeys through Babylonia… The Babylonian tradition could have influenced the formation of all later positional systems." In any event, we are interested in what external influence could have influenced the Sumerians to create such a system. One is the safe natural environment and economic activity between the two rivers, the Tigris and the Euphrates, and the other that gave birth to Sumerian astrology (which was different because it included astronomy). Sumerian astronomy came to Greece via Egypt and enabled Thales (Θαλῆς, 626-545 BC) from Miletus to predict a solar eclipse on May 28, 585 BC, which first brought him inconvenience (they treated him as a witch), and later fame, because they proclaimed him one of the seven sages of antiquity.

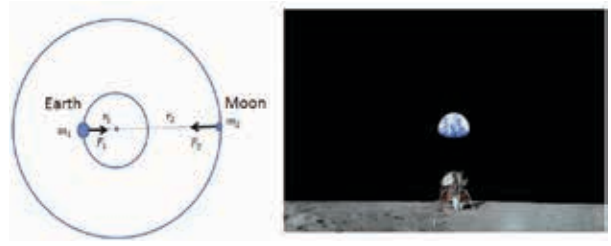


Figure 6 The Earth–Moon system of the sixties (left) and image of the Earth from the Moon (right) (Wikipedia: Earthrise, taken on December 24, 1968, by Apollo 8 astronaut William Anders).

As Nature does not know how to calculate on the basis of a decimal system (mathematica instrumentalis) but does everything in proportion (distance, mass, quantity, etc.) on the basis of quantities that harmonize relations (1, ϕ and Φ), then the sexagesimal system is a combination of the decimal (10) and the hex (6) system. What we can notice is that the decimal system is defined as a pair of squares of the sum Φ and ϕ: $2(\Phi + \phi)^2 = 10$ (Fig. 7a), and the hex pair of sums of the squares Φ and ϕ: $2(\Phi^2 + \phi^2) = 6$ (Fig. 7b), so that at the end we get an ordered four of the square sum and the sum of the squares Φ and ϕ: $4[\,(\Phi + \phi)2 \times (\Phi^2 + \phi^2)\,] = 4 \times (5 \times 3) = 60$. Thus, the Sumerian numeral system is a synergy of perfection (number 6 is the first perfect number: the sum of its factors 1 + 2 + 3 is equal to 6, and harmony (the cycle of number 10 which is a harmonic: the ratio of parts and whole is harmonized so that the dynamic system oscillates stably, the parts cannot overpower the whole, nor can the

whole become dominant in relation to the parts (Fig. 7d). This can also be seen as a relationship between the part and the environment, because the part is an integral part of the environment, which in this sense is the widest whole.

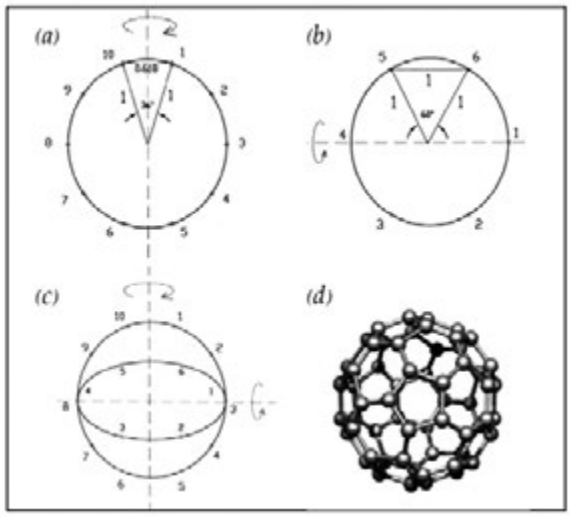


Figure 7 (a) A unit cell of the decimal system rotating about the vertical axis, with a section value of 0.618… (b), rotating unit cell of the hexagonal system around the horizontal axis, with section 1, (c) orthogonal rotating ("twisting") hexadecimal system, (d) an orthogonal "twisting" system with 60 (6 × 10 = 60) nodal points on the surface of the sphere.

Tesla's world of creativity

It is known that Tesla was obsessed with the number 3, and according to him: "I counted the steps on my walks, calculated the volume content of a plate of soup, a cup of coffee and a piece of food – otherwise I would not enjoy eating. All my repeated actions or operations had to be divisible by three, and if I was wrong, I would start from the beginning, even if it would take me a few hours" (Nikola Tesla, My Early Life, Electrical Experimenter, 1919).

Because of these statements, as well as other character traits, they considered him, to say the least, a weirdo. However, he was a "slave" of mathematica naturalis, because that trio is not number 3 from our mathematica instrumentalis, but number three from mathematica naturalis: $\Phi^2 + \phi^2 = 3$, so he has the most harmonious triangle that can exist (picture 8)

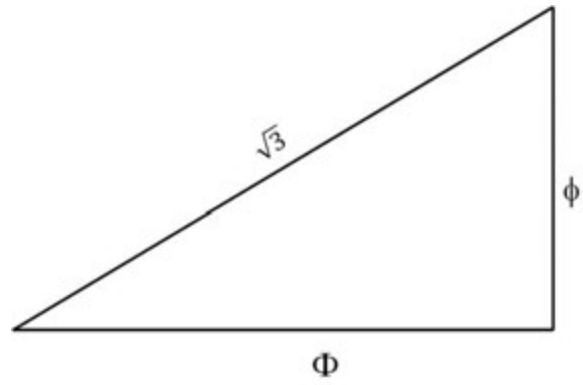


Figure 8 Tesla's triangle with sides Φ, ϕ, and hypotenuse, √3 which is at the same time the value of the spatial diagonal of the cube. "Prometheus of the Modern Age", as Tesla is increasingly called, with his triangle, stood side by side with the great Pythagoras.

Tesla believed that all his activities had a stimulus, that is, a cause in the environment. He said "Our bodies are of similar construction and exposed to the same external influences. This results in likeness of response and concordance of the general activities on which all our social and other rules and laws are based. We are automata entirely controlled by the forces of the medium, being tossed about like corks on the surface of the water, but mistaking the resultant of the impulses from the outside for the free will. The movements and other actions we perform are always life perspective and the seemingly quite independent from one another, we are connected by invisible links" (Tesla, *My inventions,* 1919)
manual, mental, routine, creative

Why did Tesla experience reality in this way and work on these principles? We cannot find the answer until we understand the building blocks ("bricks") of our daily activities and they can be: manual, mental, routine, creative. Imperceptibly from our waking consciousness (awareness), they happen in our daily life, weave a life thread, as do adenine, thymine, cytosine, guanine in DNA or the organization of water in our brain by ϕ, Φ, -ϕ, -Φ, which generates all numbers in our mind (the decimal) system. Tesla is one fundamental combination of the above four combinations, of which there may be 64, with the creative-mental-routine being dominant of his being. From this aspect, we

can understand not only the working type of one person but also the technological revolutions. Thus, for example, the first technological revolution is the replacement of human manual-routine work by machine (steam engine), the second is replacement of human routine-mental work by machine (computers), the third replacement of human creative-mental work by machine (artificial intelligence) and the fourth is replacement of creative-manual activities into materials (emergence of intelligent materials and machines based on self-organization, from the nano level trough the micro to the macro).

Contraria sunt complementa **(touching extremes)**

The base 60 numeral system (sexagesimal) and the numerical measurement system of the ratio of time units by the Sumerians and Babylonians, on the one hand, the creative thinking system of Nikola Tesla on the basis of when he created his works, on the other, and the appearance of C_{60} molecules, on the third, are such extremes. They have no points of contact, but in fact they are the root, tree and branches of one and the same tree. We have not seen the root because in the earth (our forgetting about the Sumerians), the tree (as created by Tesla) is obscured by leaves, a multitude of people who deal with science and technology in a different way than Tesla, but what appeared as the fruit of a tree, the C_{60} molecule, initiated the clarification and merging of something that at first glance could not be merged. But now we can understand that, we can also understand those who do not understand, because they are used to thinking on the principle of the numerous system R^1. To clarify, let us take a banal example, let us say we need to say how much three plus four is. We will all say that 3 + 4 = 7. This is true if we use the numeral system of the numerical line R^1 ($3^1+4^1=7^1$), but imagine now that someone tells you that 3 + 4 = 5, our reaction would be that such a person did not even finish elementary school, they do not know how to perform simple addition. Did we make a mistake and hastily label a person as ignorant? Yes, the person will tell you that they used the numeral system R^2, and that is true, because $3^2 + 4^2 = 5^2$. Tesla's thought system just worked on the principle of R^2, not on the numbers of our decimal system, but on Φ and ϕ, so he is an exception in relation to all of us. Only an exception can bring a crucial novelty in something, such as Tesla in creation, or water in nature for the appearance of biological life. For water we say that there are about 40 anomalies, i.e., it is drastically different from other matter in nature, it is an exception, but that is exactly why it could give birth to biological life.

Let us return to the first few sentences of this text: why is today's astrology and Sumerian astrology not the same? The reason is simple, because two different systems, decimal and sexagesimal are used. Again, to clarify this, let us take a banal example, add two numbers together, 102,515 and 15,455. As per usual, in the decimal system the result will be 117,970 but in the sexagesimal system it will be 122010 and will represent 12h, 20 min, 10 sec. In reality, each one of us, the classically-quantum gravitational one, is excited by the base 60 system of the Earth-Moon, and we, like the rest of Nature, explore this system with the help of the decimal system (which is a hidden part of the base 60 system) and express our knowledge by use of it. All our knowledge is locally true and accurate because we indirectly use the sexagesimal system of time calculation, but it is not absolutely true because space in our mental world is decimal and time is sexagesimal. Our mental world is both in harmony and in division. In other words, our mental system works on the principle of separation of space and time ("picture of reality", based on reflection), and natural processes are all about the unity of space-time ("the reality"). How to help our mental world to overcome this gap and improve our mental abilities: to better connect things, to be faster in unlearning, to come to better knowledge, to see real reality?

It is known that the ancient Greeks, when they did not have solutions to some problems, in theatrical performances when the

time came for the story to unfold, introduced *deus ex machina* on the stage, an object that descends "from heaven" to the stage and resolves the situation. What is it in this case of ours? As researchers and scientists go where artists and poets have already been, let us first read the poem "C_{60}: *Deus Ex Machina*", written by Maja Matija, in 2000, and then continue with science.

C_{60}: Deus Ex Machina

Reveal yourself to the star of bright knowledge
and landed on fertile land.
Remove the darkness with a golden hand,
make the truth come true
and pour me rays blue.
Discover the secret of your existence
you are fire, also dust,
do not be afraid to cross from the world of silence,
remove fear
through the thread of truth and trust.

Free yourself from the shackles of transcendental secrets
Your time has come to reveal the truth
Open the calm point of your own bill,
let the voice sing ,
spread your wings.

C_{60}: Nano-zepto space-time molecular machine

When the C_{60} molecule (Figure 1) interacts with photons, it works with electrons that are a combination of sp^2 and sp^3 hybridized orbitals of carbon atoms. In C_{60}, π-orbitals are oriented in the direction of the plane in which the atoms lie, and π-orbitals are orthogonal to them, both externally and internally, providing a vacuum inside the molecules together with π-orbitals. Due to its configuration and size, the C_{60} is considered a zero-dimensional (0D) object that has a sphere-sized vacuum of about 0.3 nm inside. The space between the carbon atoms, which form a hexagon, pulsates so that it is completely closed by thick hybridized orbitals with thickness from δ_0 = 77 pm to very thin δ_n = 26 pm. In order for light to penetrate into the interior of C_{60} and cause quantum excitations in the cavity of the molecule, the time needed for this is about 266 zeptoseconds (zs = 10^{-21}s), or 86 zs for δ_n. The entry of a photon into the cavity of C_{60} causes the effect of an exciton that is coupled to the photon, so the output light is of the polariton type (photon + exciton = polariton) (Figure 9). A photon is defined by laws on the Poincare sphere, an electron on the Bloch sphere, while polariton light, due to the twisting of C_{60} molecules according to Fibonacci law, creates an ordered polariton light defined by the Fibonacci sphere (Koruga, Hyperpolarized light, ZEPTER BOOK WORLD, 2018).

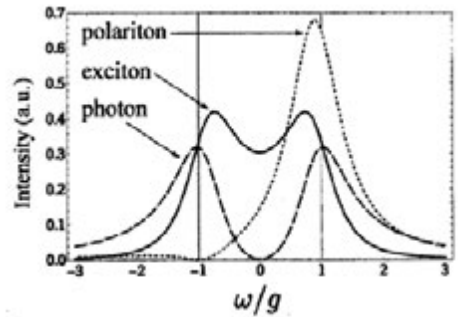


Figure 9 Model of polariton formation after the interaction of a photon with a material having a quantum cavity (0D)

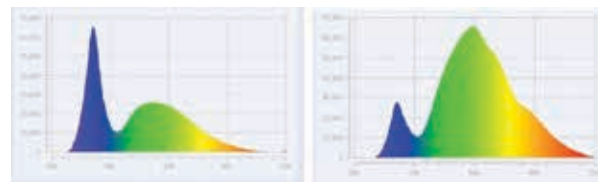


Figure 10 Spectrum of white LEDs before (left) and after interaction with C_{60} molecules (right). It can be seen that the formation of polaritons took place, that light changed the spectrum in the relative ratios of photon energy.

It was experimentally determined at the Max Planck Institute that C_{60} as a 0D quantum cavity generates exciton in the region of 600-800 nm, with a dominant peak at 728 nm (Exciton dynamics of C_{60}-based single-photon emitters explored by Hanbury Brown-Twiss scanning tunneling microscopy, *Nature communications*, 6 (1): 1-6, 2016), while at Nano-Lab, at the Faculty of Mechanical Engineering of the University of Belgrade it was found that C_{60} molecules, organized in multilayer planes (0D + 2D), generate a polariton in the domain of 400-900 nm, with two dominant peaks: one at 550 nm and the other at 720 nm.

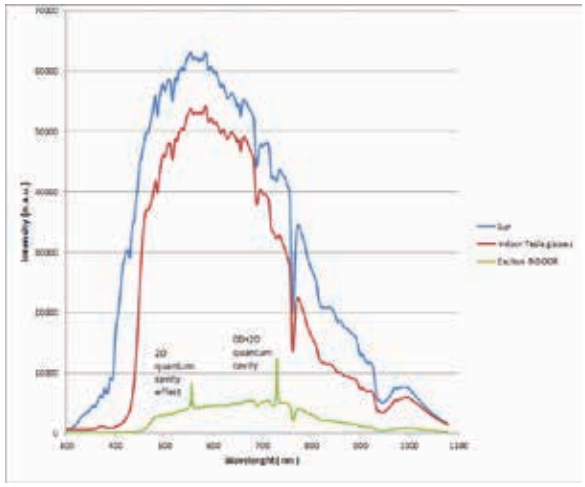


Figure 11: Spectral characteristics of the Sunlight, INDOOR Tesla glasses and the Exciton. Nano photonics glasses based on C_{60} under influence of the sunlight blocked UV radiation, reduce both high energy blue and infrared light, and generate polariton as a coupling of a photon and an exciton. It is a unique sortie of light which is completely adequate to eyes and human brain. Excitons, as quantum cavity effects, are identified as two peaks on 550 nm and 720 nm.

Figure 12: (left) Indoor Tesla Hyper light glasses for LED, halogen, neon light and computer work (right). Outdoor Tesla Hyper light glasses that reduce the power and brightness of sunlight from 70 to 75 percent and let you see objects in a much more agreeable way. Both glasses possess properties of new structural light based on quantum cavity effect of excitons of 0D and 2D space-time. This effect gives the glasses a unique property to make a new relationship between neurons and astrocytes networks in the brain. Even more, after long term use of Tesla Hyperlight glasses, the number of astrocytes will increase in the brain and the ratio to neurons will eventually be 1:5, despite the fact that right now it is probably, usually 1:9. It will increase all mental properties of our mind, our brain system.

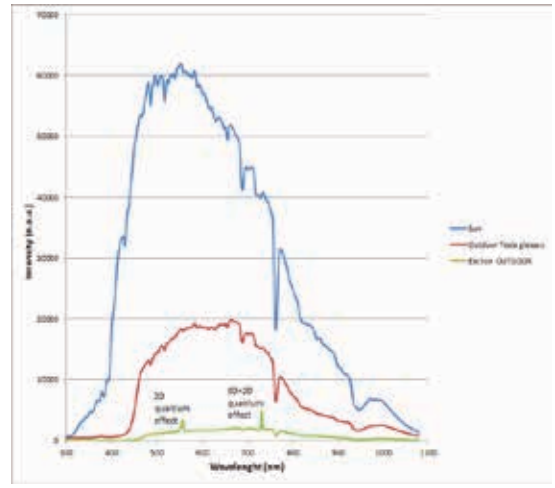


Figure 13: Spectral characteristics of sunlight, OUTDOOR Tesla glasses (72% dimming glasses) and the Exciton. Nano-photonic glasses based on fullerene C_{60} under influence of the sunlight blocked UV radiation, reduced both high energy blue and infrared light, and generated polaritons as couplings of photons and excitons. It is a unique sort of light which is completely adequate to eyes and human brain. Excitons, as quantum cavity effects, are identified as two peaks the 550 nm and 728 nm wavelengths.

It is well known that the infinitely complex interactions between neurons, astrocytes, and oligodendrocytes in the human brain highlight the balance that heterogeneous cell populations must establish and maintain to prevent disease. This has, however, been well studied for neurons, but to a much lesser extent for their astrocyte counterparts. In a recent study, published in Science Translational Medicine, DOI:10.1126/scitranslmed.aam9858, a previously unappreciated amount of heterogeneity for astrocytes in the adult brain with direct functional implications in the normal and neoplastic states was found.

Also, when scientists applied a light, it activated the cells supporting synapse formation between neurons. A key question is what role the astrocytes play in a neuron state. Understanding what kind of light source drives astrocytes could help better understanding of brain functions and offer new nodes of therapeutic intervention. It was learned that glial cells are involved in learning and memory, and their special way

of communicating would be at the roots of our creativity and imagination. Basically, neuronal activity without astrocytes would just be simple reflexes, in response to external stimuli. The activity of glial cells could then explain dreams, daydreaming, and other phenomena. Our opinion is that incoming light has to be compatible and complementary with electromagnetic waves of centrioles that control cytoskeletal network of cells and activate synapses.

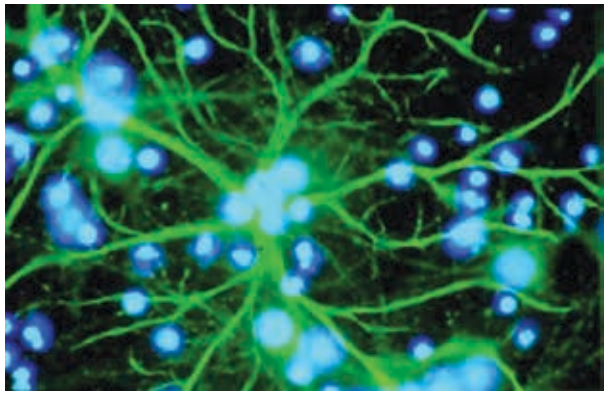


Figure 14: Astrocytes (blue) surround the neurons (green): Neurobiologists from the University of California, compared the ratio of glial cells in Einstein's brain with that in the preserved brains of 11 men. They found out that Einstein's brain had more glial cells relative to neurons in all areas studied, but only in the left inferior parietal area was the difference statistically significant. This area is part of the association cortex, region of the brain responsible for incorporating and synthesizing information from multiple other brain regions.

Will being smart as Einstein be usual one day?

Initial research has shown that glasses containing lenses based on C_{60} molecules have positive effects on ophthalmic and neurological conditions of the brain (secretion and regulation of the ratio of serotonin, melatonin, cortisol and dopamine). Many individual observations of volunteers relate to their impact on depression, hyperactivity, memory, as well as on playing sports, performing daily activities, driving a car (in strong sunlight or at night due to the headlights of cars that approach us), observing objects, making-out precise contours, etc.

We usually say "time will tell" whether something works or not, but it will certainly be interesting and important for us to see if the sexagesimal system of the fullerene C_{60} molecules will have an impact not only on our circadian rhythm, but also on our mental world from the aspect of space and time, the use of the decimal system, and calculation of time according to the base 60 (sexagesimal) system. In other words, will C_{60} molecule-based devices help us return to natural reality, in which instead of the division of space and time (as separate entities), we can get closer in our mind, and even achieve the unity of space and time (space-time).

In terms of space and time, we are in a similar situation today ("local truth") as with our understanding that "the Sun rises in the East at 5:45 and sets in the West at 19:50" and if we know this is not true, for the Sun neither "rises" nor "sets but that this rather a consequence of our perception of our "picture of reality", because this is a "local truth" that came about as a consequence of the rotation of the Earth around its axis.

If we identify the causes of this situation ("split" of space and time) in our mental world and adequately apply nano photonic devices based on C_{60} molecules, we can expect positive effects, which may change our today vision "picture of reality" to setup our brain/mind system (for example increase astrocytes and harmonized neurons-astrocytes networks) to see future as "real reality" (unity of space-time) It is challenge for new scientific action, which will follow Faraday's words, "theory leads, experiment decided".

For now, we can, as in a fog, glimpse the cause, because based on previous knowledge: everything indicates a discrepancy (incomplete coordination) of work, both of individual neurons and astrocytes, and their networks in our brain. Usually, one astrocyte serves about 9 neurons, but from the information theory we know that 3 to 5 is optimal, which indicates that for some reason we have a shortage of astrocytes.

We usually say "one swallow does not

make spring", but we also know for sure that at least one swallow must appear in order for spring to begin. Do we have a "swallow" that indicates that we are on the right path?

The answer is, yes, and that swallow is Albert Einstein. Why?

He is the creator of the theory of relativity in which there is a space–time unity in the physical world. His brain was examined posthumously and differed anatomically from the brains of ordinary mortals in that that he had much more, three times the amount of astrocytes as the control group of 11 people in the parts of the brain responsible for cognition. (Experimental Neurology, 88 (1): 198-204, 1985)

In other words, Albert Einstein was destined to discover the phenomenon of relativity and the unity of space–time in the physical world, because his brain structures (neurons/astrocytes) in the left hemisphere of the brain, region 39, generated the space–time unity in his mental world. This was also the reason why he was completely calm when he was attacked because of his new theory, when 100 of the most eminent scientists of the time signed a letter refuting his theory of relativity. He calmly told reporters who asked him what he had to say in his defense, and he said "If they are right, it would have been enough if only one had signed." In other words, Einstein was completely sure of what he was doing because his brain (neurons/astrocytes) was structured the way it was. A similar case is with Spinoza, who wrote his book *Ethics* according to the law of geometric progression and stated "He who has a true idea knows at the same time that he has a true idea, and that he cannot doubt its truth." (The Ethics, Part II, proposition 43)

If we identify the causes of this situation (the "split" of space and time) in our mental world and adequately apply nanophotonic devices based on the C_{60} complex, we can expect positive effects; particularly for us as individuals but generally on our offspring, too, who may naturally change our contemporary vision of the "picture of reality" (of separate space and time) by setting up trough embryogenesis of the brain system (increased astrocytes in brain responsible for cognitive functions) to see the future as "the reality" (of the unity of space-time). It is a challenge for nano–zepto scientists to try to improve our brain structure, brain organization and functionality by light in which photons are coupling with excitons by icosahedral symmetry, giving polaritons (hyper-harmonized and – polarized light)..

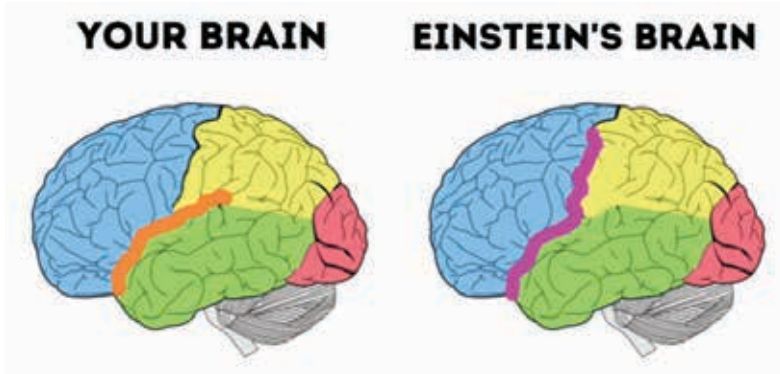


Figure 15: Schematic illustration of the difference between our brain and Einstein's brain. It was found that some parts of Einstein's brain had a larger mass and a higher than usual ratio of astrocytes (cells that help neurons transmit nerve impulses) to neurons. Another study found out that Einstein's parietal lobes had very unusual patterns on it. A team of scientists compared his brain with 85 other people, and found that Einstein's brain was special in that its folds in the gray matter were noticeably different. Einstein had an extra fold in his parietal lobe. This is different than the fold being shaped differently. Having an extra fold is like having brain and a piece of another one! Scientists claims this could have happened while he was in the womb or it could be genetic. This is a very interesting thought.
https://sites.psu.edu/siowfa12/2012/11/27/no-wonder-einstein-was-a-genius/)

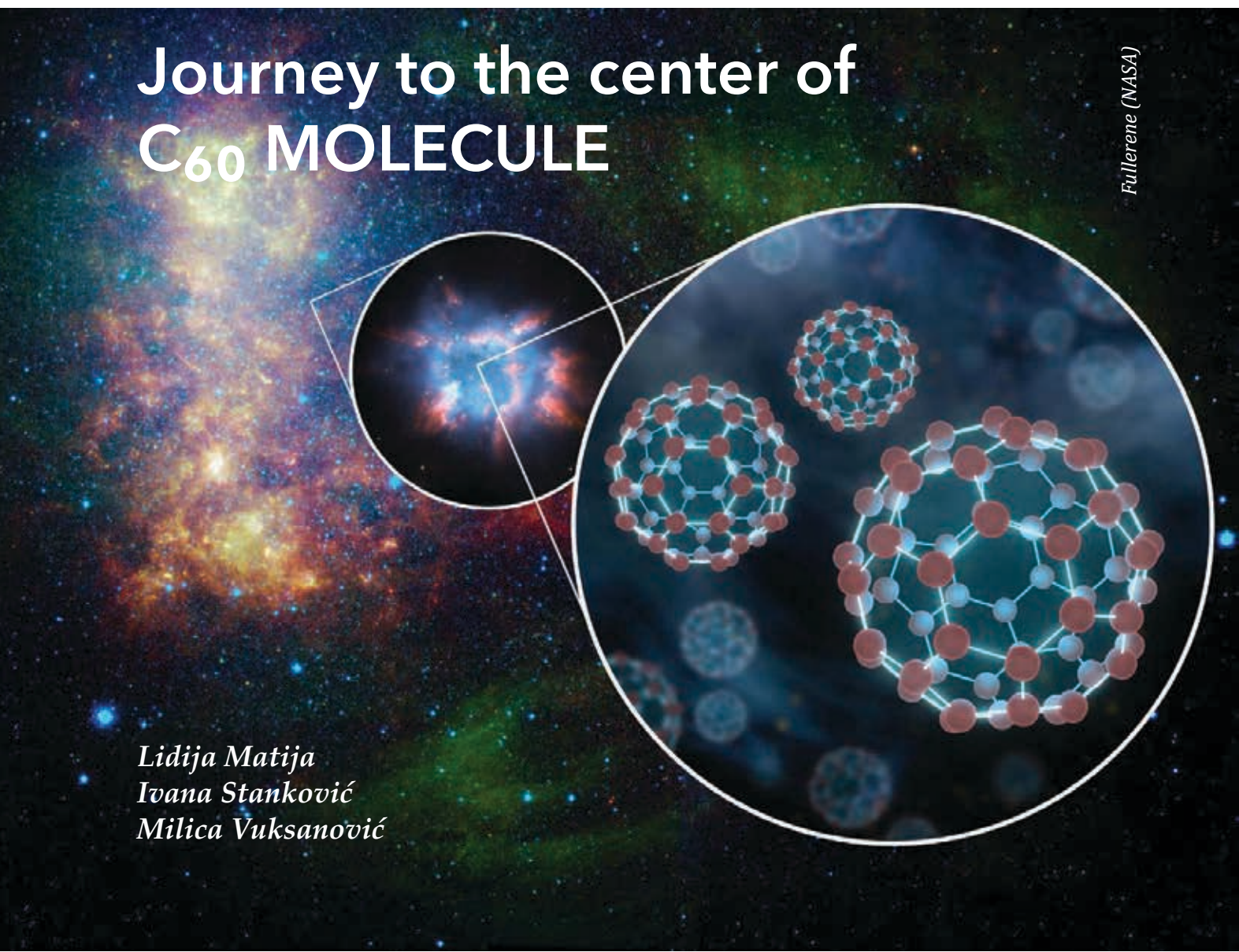
Journey to the center of C_{60} MOLECULE

Lidija Matija
Ivana Stanković
Milica Vuksanović

The aspiration of the human race to understand and subdue Nature has created science and produced many laws that govern it, but it all comes down to the fact that we are just readers of Nature. And how does our brain really process information? Are we able to really understand our own consciousness and the possibilities it brings? Are there limits to consciousness? How do we determine them? How much can today's physics explain, as the queen of basic science? Perhaps the solution lies in connecting classical and quantum physics, where we lack appropriate laws of universality? Perhaps linking quantum physics, biomolecular science and nanotechnology is one of the possible solutions to understanding the many dilemmas we have, including understanding consciousness? Is it possible to invent a super-intelligent machine and would it help us understand consciousness? Will such a machine, if it is possible to make it, surpass its creator? Nanotechnologies could offer a solution, because they are essentially all around us and in ourselves. A man is nothing but a perfect nanotechnological machine (made up from DNA, proteins, water, ions…) that works in real time and is adapted to survival in a world where the laws of classical physics are dominant. However, quantum physics is always silently present. What are nanotechnologies? The topic is not something completely new, it has been popular for the past thirty years and yet its exploitation has not gone far. Why? One of the reasons is the relationship between quantum and classical physics. Similar to the connection between DNA and the whole body.

Promising fullerenes

In the 1980s, a vast number of researchers in the United States, Japan, and Europe initiat-



Fullerene (NASA)

A man is nothing but a perfect nanotechnological machine (made up from DNA, proteins, water, ions…) that works in real time and is adapted to survival in a world where the laws of classical physics are dominant. However, quantum physics is always silently present. What are nanotechnologies? The topic is not something completely new, it has been popular for the past thirty years and yet its exploitation has not gone far. Why? One of the reasons is the relationship between quantum and classical physics. Similar to the connection between DNA and the whole body.

ed programs called "Molecular Electronics and Bioelectronics." One of the basic starting points was an attempt to explain whether knowledge of molecular biology can be applied to high technologies and how to use biomolecules to create new information devices. Silicon-based VLSI (very large-scale integration) microelectronics was prominent at the time, but researchers faced many problems given that design and manufacturing improvements were hampered by a limit of about 0.1 micrometers (μm). Nevertheless, there were some unacceptable changes in device properties when operating at higher temperatures. For the creation of technology similar to biomolecules, it was necessary to overcome the difficulties related to materials, design, logic, self-organization and management at the molecular level. In order to cut across all of this, a new type of material with specific properties was needed. A new hope was brought by the discovery of C_{60} molecules and a whole family of closed carbon clusters, which were named fullerenes after the famous architect Richard Buckminster Fuller. The C_{60} molecule was discovered in 1985 at Rice University in Houston, by H. W. Croto, R. F. Curle, and R. E. Smalley, who won the Nobel Prize in Chemistry in 1996. That event was the spark that lit the fire of a new scientific and technological approach and thus a new field of nanotechnology was created. The name nanotechnology itself consists of two words – nano, which in Greek means dwarf, something very small, and technology. Essentially, the term nano denotes the relative relationship of two entities, e.g. space, time, or physical properties (magnetism, current, etc.). Of all possible relativistic relations, the most interesting for us is the one that, in a way, takes a human being as a system of reference.

So, for example, when it comes to the notion space, for us, it will be a nanometer (10-9 meters). To understand this in the best possible way, it is easy to take an obvious example: one nanometer to one millimeter is like one millimeter to one kilometer. Accordingly, for the notion of time, for us, this would be 10-9 seconds (ns), so if we observe a second as a moment of events that took part in front our own eyes within the outside world, then a nanosecond would be a moment that happened in a cell (cellular "eyes" are the centrioles). Physicists and material science experts will say that nanocarbon materials appeared with fullerenes, introducing characteristics that had not been familiar in science until then. This primarily refers to some of their properties, such as crystallization around a point, the symmetry axis of the fifth order, rotation in the crystalline state faster than the liquid state rotation, the ability to form various compounds without disturbing the symmetrical structure and many more. For biologists, on the other hand, nanoscience is not new because they have long been studying DNA and RNA, which are essentially nano-scaled. The same goes for chemists who have been synthesizing molecules of these sizes for centuries. Although they deal with nano-sized molecules, chemists usually do so with molar quantities, which is a huge number of molecules, so statistical thermodynamics comes into the play. However, in 1959, Richard Feynman set the condition to observe and manipulate only an individual atom, not billions of them, which turned out to be a great challenge.

Figure 1 Buckminster Fuller geodesic dome, the USA pavilion in Montreal exhibition 1967, is a structure which was inspiration, as mimicry, to Kroto who named molecule C_{60}: fullerene. Icosahedron is composed of 20 triangles and Buckminster cupola is composed of 20×n triangles as optimization of design, mass and energy (light). (Wikipedia)

Miraculous self-organization

Why is nanoscience, along with nanotechnology, unique and represents a true revolution not only in science, but also in technology? The essence of it is in the fact that nanoscience deals with the boundaries where behavior (traits) of certain substances change radically. And where are those boundaries? The boundary between classical and quantum mechanics represents the basic division between the micro- and nanoworld. The electron wave separates microscience from nanoscience and the light waves separate microtechnology from nanotechnology. For example, we will take photolithography or photo engraving, which is based on the use of light, i.e. small light sources, where engraving is done by limiting the focus of light with a lens or by passing through it the desired masks that create shadow. However, the light wave cannot be limited to be less than its own wavelength. It is known that the wavelength of visible light that we use for photolithography is in the range of 400-750 nanometers and the wavelength of electrons is only 10 nanometers and less. If we know that the diameter of the DNA helix is about two nanometers, the diameter of the benzene ring is 0.28 nanometers and the diameter of fullerene (molecule C_{60}) is 0.71 nanometers, it is perfectly clear that we cannot manipulate them within classical physics, we must also include quantum physics. If we want to move atoms, which is one of the advantages of nanotechnology, we must go below the level of visible light.

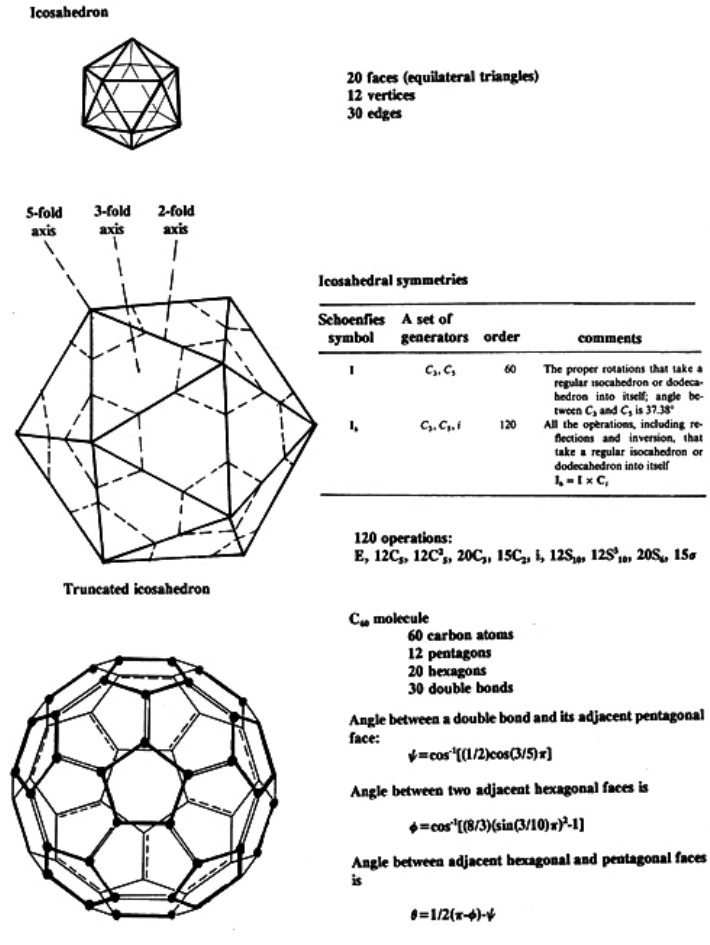


Figure 2 Icosahedron as a 3D body composed of 20 triangles (upper image), then truncated icosahedron with 120 symmetrical operations (the diamante has 48 symmetrical operations) (middle image), and stick model of C_{60} molecule with strictly defined angle between bonds (down image) (From book: Koruga et al, Fullerene C_{60}, Elsevier, 1993).

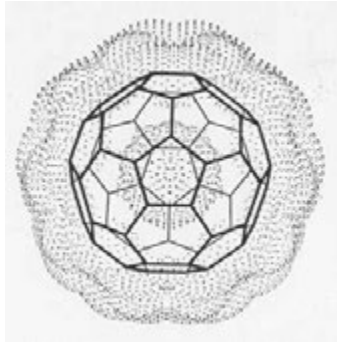


Figure 3 A stick model of molecule C_{60} composed of 12 pentagons and 20 hexagons with π electrons (outside and inside of cage – dots on image). Diameter of ground state of C_{60} (position of carbon atoms in π electrons cloud is 0.71 nm). The size of C_{60} with π electrons cloud is about 1 nm. (Arizona Daily Wildcat, page 3, 4th September 1991.)

So, at the higher limit of visible/UV light spectrum and above that, we can use photolithography-microfabrication with existing lighting techniques. But below the new (electron wavelength) limit: we cannot! We must then resort to nanofabrication or nanotechnology and it is an open secret that we have little control over it. We have mastered the production of small quantities at very high prices, but we still do not know how to produce efficiently, that is, we have not yet mastered the production that is profitable. In other words, there is a big difference in the behavior of objects (things) below the size of ~10 nanometers, when classical Newtonian physics is replaced by quantum mechanics, or so to say – fully defined, understandable objects are replaced by electronic waves – "electron clouds", so our intuition and knowledge, based on empiricism, become fundamentally wrong. Conclusion: in order for nanotechnologies to really come to life, we need to find ways to combine classical and quantum physics in a unique way. To achieve this, we must return to human beings again, because Nature has already done that by giving birth to a unique system such as the human body, from one molecule of nanometer size, DNA. How did she do that? This is a primordial question and a great puzzle for all of us, but by pushing the boundaries of science and connecting different scientific disciplines, some possible explanations have been reached.

Generally, nanomaterials are materials with dimensions ranging between approximately 1 nanometer and 100 nanometers. The lower limit in this definition was introduced in order to prevent independent and small groups of atoms being considered as nanoobjects or elements of nanostructures. The term nanomaterial includes materials that are nano-sized, nanophase materials in which the phase or component is at the nano level, and nanostructured materials that have the structure or properties at the nano level. However, within nanomaterials, a distinction must be made between nanostructured materials and "intelligent" nanomaterials. Characteristics of nanostructured materials is that the material has improved properties in relation to their macro state, which occurs by crushing standard materials to nano-scale sizes. "Intelligent nanomaterials", in addition to their small dimensions, have the property of self-organization and self-assembly. Material self-organization is one of the fundamental principles of nanotechnology. The principle of self-organization already exists in Nature, at the macroscopic level, and in biological systems, at the micro level and at the nano level. Self-organizational processes in biological systems bear crucial significance to nanotechnologies, because a matrix of wide range of energy and information possibilities is imprinted in the structure of the material, which is activated under the influence of the environment. With such properties and under such conditions, the material exhibits intelligent properties. Self-organization implies that discrete quantities (basic cells of nanomaterials) interact with each other to create more and more complex structures. This can be understood if we understand self-organization as a natural phenomenon in which mass, energy, information, organization and management participate: the first two are purely real, information is fractal and two are functional quantities. If the system we are considering is separated into an object and a management system, then we are talking about a classical system to which organization and management are imposed from the outside. In that case, these five elements

are interconnected by a circle (external phenomenon, i.e. system repulsion). However, if the object and the control are immanent to the system, then they cannot be separated, so one of the five elements becomes central and permeates all four others. This property bears information, which along with mass forms corpuscular code creating systems, with the energy of wave code-creating processes, with the organization of functional flows, while with management it achieves the harmony of the system, i.e. achieves system goals through optimization. That is why we can consider self-organization as an attractive-repulsive phenomenon, with a small asymmetry, because five elements participate in the first step, and four in the second. The self-organizing system is functionally realized according to module 9.
We can say that the Universe is the most complex self-organizing system, while biological systems are the most complex technology of the local self-organizing process. It is known that the basis of biological life is DNA (deoxyribonucleic acid). DNA possesses the structural-information code, the code of the biological way of life, which is transformed into proteins in the energy-information code-creating process. However, during embryogenesis, DNA remains unchanged in each nucleus of the cell, despite the fact that the cells change in their shape and content and specialize in performing their functions in various tissues and organs. DNA has created the body as a complex organization of cells with complex functional flows, while through the brain and spinal cord it manages the biological system through optimization.

Information about information

The information contained in the DNA is "dissipated" throughout the body structurally, energetically, organizationally and managerially. It strives to achieve harmonized processes until the disturbing factors (internal and/or external) disrupt the process. When there is a disturbance of harmony, a feeling of pain arises and the indication signals an initiated pathological condition. Depending on the type and degree of disturbance of harmony, different pathological conditions appear. Although understanding this process is important for every human being, for engineers in order to create self-organizing materials and of self-organizing nano-systems, it is important to understand the principles of self-organization according to module 9 and to find the laws that generate harmony, i.e., the mechanisms that ensure its stability.

Biological systems are therefore an inexhaustible inspiration to engineers and an object of research. This becomes especially significant with the advent of nanotechnologies for which the preconditions for self-organization can be provided (phase one of the five elements per module nine) and the creation of naturally-like intelligent materials and systems. It may be necessary to say here that there are many examples in which scientists often go where poets and artists have already been. Like that in this case, we have something similar because Laza Kostić in his work "Basic Principle" said that "harmony is a synthesis of symmetry, and symmetry is an analysis of harmony". We know that science, thanks to the laws of symmetry, came to today's knowledge, but we must also not forget that "the laws of the nature of information about information", as Vlatko Vedral, professor of quantum information physics at the University of Oxford and the writer of the paper above us, would say.

One of the promising materials for the realization of the engineering concept based on the fractality of information (reality) is the C_{60} molecule, as the most pronounced representative of fullerenes. It represents the third crystalline form of carbon, next to graphite and diamond. While the first two forms (diamond and graphite) crystallize within 32 crystallographic groups, this molecule builds a form that is from a symmetrical point of view at a higher level of order. In order to create such a structure in the system of point symmetry, to which the basic 32 crystallographic groups otherwise belong, a fifth-order axis had to be formed, which does not exist in classical crystallography,

and this molecule possesses it. In addition to the fifth-order axes, which refer to the pentagon, it has third-order axes — hexagons and second-order axes — double bonds, as well as an inverse point of symmetry.

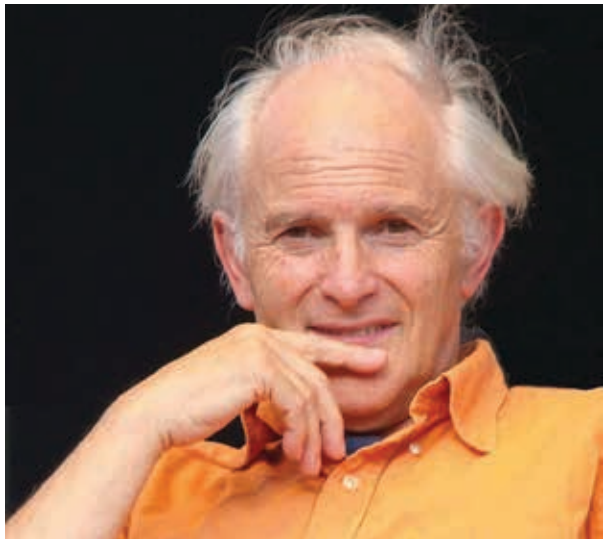


Figure 4 Harold Kroto, leader of research team, who serendipitously discovered the C_{60} molecule in 1985 and who gave it the name fullerene (buckyball) to molecule C_{60} because during investigation of the structure of C_{60}, scientists had a problem to understand how to cover a surface of a ball with hexagons. Kroto recalled in his memory when his kids studied about Buckminster Fullerene capsule, that it also includes pentagons. (Wikimedia Commons)

It consists of 60 equivalent spherically organized carbon atoms, distributed over the surface of the ball in 12 pentagons and 20 hexagons. This organization and symmetrical arrangement gives the molecule the property of dimensionality 0D, so the center of inversion becomes the main symmetrical element of the structure arrangement. The carbon atoms in the five-membered rings (pentagons) are bound by single C-C bonds and are poorer in electrons than the six-membered rings (hexagons) in which the carbon atoms are interconnected alternately with three C-C bonds and three double C = C bonds. It can bind to other C_{60} molecules, atoms, ions and other molecules in two ways: covalent bonds (strong bonds) and π bonds (weak bonds). These weak connections allow for very quick reactions and open up a new "spheroid" chemistry of the future, similar to the one we have in enzyme biochemistry. Given the structure of fullerenes, especially C_{60} molecules, it is very interesting to say that these molecules can build a wide variety of compounds, some of which have so far been in the domain of science fiction for researchers. The types of compounds that fullerenes form can be roughly divided into:

(1) Exohedral (endohedral), in which some of the double bonds are broken and various chemical elements and/or compounds are added;
(2) endohedral, in which atoms, ions or small molecules are inserted into the fullerene cavity by various procedures ("science fiction"); and
(3) substitution reactions, wherein one or more carbon atoms are replaced by other elements. Fullerene C_{60}, as an individual molecule, is stronger than diamond, but when more of these molecules crystallize according to the laws of translational symmetry, it is arranged in a centrally cubic crystal lattice that gives this material softness similar to graphite. However, if C_{60} molecules were to bond to each other with two C-C bonds in four directions, then they would form a 3-D fullerene structure that would be harder than diamond. Experiments have shown that its rotation in the crystal is faster than in solution (the rotational diffusion constant in solution is 1.8×1010 per second, and 3×10^{10} per second in the solid state). As this molecule has a fifth-order axis, its structural and energy states are determined by the properties of the golden section. This is very important, because for the first time, a material substance was created that structurally and energetically mimics the law of the golden section.


LETTERS TO NATURE

C_{60}: Buckminsterfullerene

H. W. Kroto, J. R. Heath, S. C. O'Brien, R. F. Curl & R. E. Smalley

Figure 5a Paper published in Nature, 1985 about serendipitous discovery of C_{60}, so that that people know about its existence.

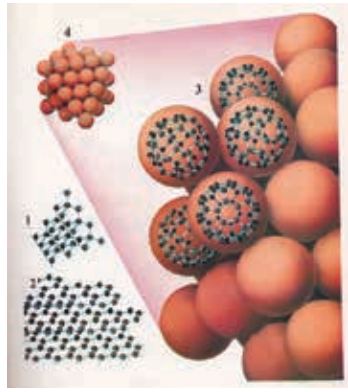


Figure 5b Five years later people compared the three forms of carbon structure: [1] diamond as a 3D structure, [2] graphite as a 2D structure , and [3] C_{60} as 0D structure in 3D space. As can be seen, carbon atoms of two C_{60} molecules are not in connection. The barrier between them are the π electrons, which separate two or more C_{60} molecules with repulsion force between them (negative charge). It gives possibility for fast rotation of C_{60}, about 1010 s-1. The C_{60} is a molecular crystal but can be ordered in classical crystal form [4] (Source: Adapted from Arizona Fullerene Consortium, 1994)

The law of the golden ratio

One of the basic indicators of self-organization and self-assembly is, precisely, the law of the golden ratio, which is determined by the axis of the fifth order. In the scientific literature, through examples of clathrin, collagen, microtubules, cilia, centrioles and water, it has been shown that these structures are organized according to icosahedron/dodecahedron symmetry. For the corresponding energy states of such organized structures, such as T_{1u}, T_{2u}, T_{1g} and T_{2g}, the laws are given by ϕ and Φ. In bibliography, this is known as Fibonacci numbers and the law of the golden ratio, so we will now get a little more acquainted with the significance of Fibonacci for modern science. To be immediately aware of its significance, let us just say that Roman numbers were in force (in the Western world) until 1204, and that with Fibonacci came the Indo-Arabic numbers that are the basis of science today. When we have headache, drowsiness, some mental or motor-neural functional disorder, most of these things involve one of the neurotransmitters such as: serotonin (5-HT), acetylcholine (ACh), melatonin, catecholamines, GABA etc.

Thus, for example, serotonin, or popularly called "the hormone of happiness", is formed from the amino acid tryptophan, by oxidizing this amino acid in 5-oxytryptophan, decarbonization of which yields serotonin. It has a very important regulatory function in the body, and is stored in presynaptic vesicles, clathrin. When the action potential reaches the presynaptic end, then the depolarized presynaptic membrane interacts with the vesicles, clathrin, opens them and releases the contents (neurotransmitters) into the intrasynaptic space to activate the postsynaptic membrane. Clathrin is a complex protein structure, composed of two main protein chains – "light" (25,000D) and "heavy" (190,000D). The total molecular mass is about 215,000D (dalton: 1D~1H), the size of which is 20-80 nanometers. In humans, chromosome 17 is responsible for the synthesis of the "heavy" chain, and chromosome 22 for the synthesis of the "light" chain. These two protein chains form a more complex structure called a tri-skeleton (trimmer). It was discovered in 1969 by the Japanese researcher Toku Kanaseki and Ken Cadote using an electron microscope (Kanaseki, 1969), first isolated in 1975 by Barbara Pierce. It is found in many tissues of the human body as a carrier of substances, such as neurotransmitters, but it also performs the function of a scavenger of matter from the cell into the extracellular space (tri-skeletons form pentagons and hexagons, so clathrins in the central nervous system (CNS) are composed of 36 tri-skeletons. They form 12 pentagons and 20 hexagons, while in other tissues they are composed of 12 pentagons and different numbers of hexagons (Fig. 6).

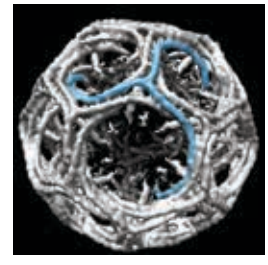


Figure 6 Clathrin, a complex biomolecule in brain, with same icosahedral symmetry as molecule C_{60}. It was mimical inspiration to Koruga to make similar structure based on carbon atoms in 1978. (Wikimedia Commons)

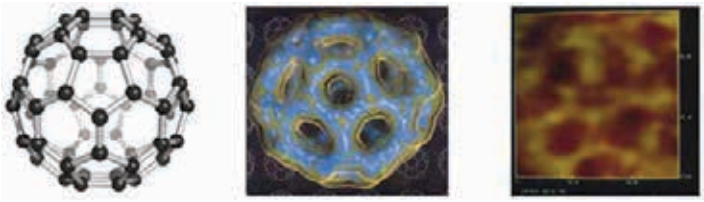


Figure 7 Model of the C_{60} molecule with 60 carbon atoms, arranged on the surface of a sphere in 12 pentagons and 20 hexagons (left), quantum-mechanical model of the C_{60} published in 1991 on the cover of Science (middle) and the first STM image of C_{60} molecule made in April 1992 at the Center for Molecular Machines of the Faculty of Mechanical Engineering University of Belgrade (right).

Clathrin in the central nervous system (CNS) is the most perfect symmetrical structure that can exist in Nature based on the law of point symmetry. It is an icosahedron symmetric group (two dodecahedrons), whose energy states T_{1g}, T_{2g}, T_{1u} and T_{2u} are determined by an ordered four of numbers Φ, -Φ, ϕ, -ϕ (1.61803…, -1.61803…, 0.61803…, -0.61803). The first researcher to see fibrous cell structure under a microscope was Sigmund Freud. As a student, he stayed at the Erest von Brucke Laboratory of the Institute of Physiology of the University of Vienna from 1879 to 1881, so he experimented during the summer. He was able to record the structures of the cytoskeleton, and among them, as the largest, microtubules. That is why it can be said that he was a cytologist in the beginning, but he became known to the scientific public as a psychiatrist, especially the part that refers to the subconscious. Little attention was paid to microtubules until 1974, when the New York Academy of Sciences organized the first scientific conference on the subject, primarily on the structural and biochemical aspects of microtubules. This gave impetus to researchers around the world, so the same institution organized a scientific conference in 1986 where the main topic was the dynamic aspects of microtubules (Soifer, 1986). Microtubules have been shown to play a significant role in biology – intracellular transport, participation in the formation of cell shapes, the main component of the dividing spindle of cells. Microtubules form more complex structures, such as cilia, flagella, and centrioles (Dustin, 1984). The structural (spatial) packaging of α and β tubulins in a protofilament of 13 subunits has the orderliness of 1, 2, 3, 5, 8, 13... then 4, then 6.7 and finally 9, 10 ,11 and 12. From this order we see that the ratios are 1:2=0.500, 2:3=0.666, 3:5=0.600, 5:8=0.625, 8:13=0.615, 13:21=0.619, which oscillates between 0.5 and 0.66., and as a convection they belong to the category of number ϕ=0.61803. If we invert the relationship, then we have 2:1=2,000, 3:2=1,500, 5:3=1,666, 8:5= 1,600, 13:8=1,625, 21:13=1,615, and as a convergence they belong to the category of number Φ=1.61803. As microtubules are structured as thirteen, the biophysical values (dipole moments, temperature, magnetism, etc.), which depend on them, will be in the range of 1,615 ≤Φ≤ 1,625.

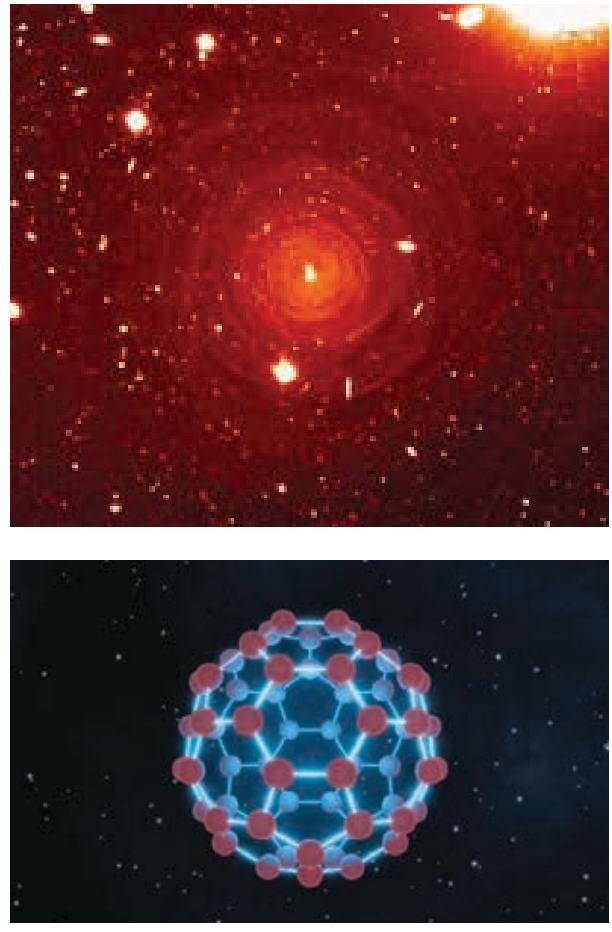


Figure 8 (top) Becklin et al. discover the Red Giant Star IRC+10216 (Astrophysical Journal 158: L133); (bottom) The C_{60} in space is ionized because the ultraviolet light emitted from stars strips an electron from the C_{60}. (NASA/JPL-Caltech, 2019)

History of sexagesimal (base 60) system: Icosahedron and C_{60}

Year	The first time	By who or what	Reference
Pre-historical period of C_{60} (before 1985)			
Millions of yrs. ago	C_{60} is physically created	Giant red stars at the Universe	The paper "Confirming Interstellar C_{60}+ Using the Hubble Space Telescope. *Astrophysical Journal Letters* on April 22nd, 2019.
2500 BC	Sexagesimal system: created by human mind	Sumerian people	Dirk J. Struik, A concise history of Mathematics, Dover Pub. New York, 1948
360 BC	Icosahedron as solid object	Plato	"Timaeus"
1500	Icosahedron as a cardboard sheet	Albrect Dürer	German artist who made an early model of a regular truncated icosahedron
1509	Regular truncated icosahedron	Luca Pacioli	Book "De Divina Proportione"
1933	Point group symmetry for Icosahedron	L. Tisza	L.Tisza,Zeitschrift für Physik, 82,48,1933
1969	Clathrin: Biological icosahedron (complex of C-N-O-H-S atoms)	Toku Kanaseki and Ken Cadote	Kanaseki, T and Cadota,K., The "vesicle in a basket", J. Cell Biol. 42:202-220, 1969
1970	Theoretical prediction of C_{60}	Eiji Osawa	Eiji Osawa, Cornannulene, Kagaku, 25:854, 1970
1970	Corannulene: starting structure for chemical synthesis of C_{60}	Barth, W.E and Lawton, R.G.	Barth, W.E and Lawton, R.G., The synthesys of Corannulene, Journal of the Am Chem Soc 93(7):1730, 1971
1972	Dual form of C_{60}: Synthesis of dodecahedron	Philip Eaton and Richard Mueller	Eaton, PE and and Mueller, RH, The Peristylane system, Journal of the Am Chem Soc 94(3):1014, 1972
1973	Theoretical prediction: Dodecahedron-carbo-s-icosahedron (C_{60})	Bochvar , D.A and Gal'pern, EG	Bochvar , D.A and Gal'pern, EG, Hypothetical systems: carbo-s-icosahedron, Proc. Acad. Science 209: 239, 1973
1973	C_{60} production (1% wt) (not aware until 1989)	Donald Huffman (he did not know at that time that he produced C_{60}).	Day, KL, and Huffman, D., Measured excitation efficiency of graphite smoke in the region 1200-600 Å, Nature Physical Science, 243:50, 1973
1978	Mimicry from clathrin to C_{60} (carbon dream)	Koruga, Đ.	Koruga, Đ., et al.: Fullerene C_{60}, North-Holland, Elsevier Sciences Pub, 1993
1984	C_{60} production (not aware until 1985)	Exxon Research Group They did not know that they produced C_{60}).	Rohlfing, E.A, Cox,D.M and Kaldor,A., Production and characterization of supersonic carbon cluster beams, J. Chem. Phys 81(7):3322, 1984

Historical period of C_{60}			
1985	C_{60} serendipitous synthesis and identification by mass spectrometry	Kroto Research Team	Kroto, H.W., Heath, J.R., O'Brien, S.C., Curl, R.F., Smalley, R.E., C_{60}: Buckministerfullerene, *Nature*, 318:162, 1985
1986	Theoretical prediction of electronic structure of C_{60}	Haddon, R.C., Brus, L., Raghavachari, K.	Haddon, R.C., Brus, L., Raghavachari, K., Electronic structure and bonding in icosahedral C_{60}
1989	Quantum mechanical model of C_{60}	Harter, W.G., and Weeks, D.E.	Harter, W.G., and Weeks, D.E. Rotation-vibration spectra of icosahedral Molecule I: Icosahedral symmetry analysis and fine structure. J. Chem Phys 90(9): 4724-4743,1989
1990	Production C_{60} in grams (dust, yield 3%)	University of Arizona USA/Max Planck Institute, Germany	W. Krätschmer, Lowell D. Lamb, K. Fostiropoulos & Donald R. Huffman, **Solid C_{60}: a new form of carbon,** *Nature*, 347 :354–358, 1990.
1990	Isolation, separation and characterization C_{60}	Taylor, R, hare, J.P., Abdul-Sada, A.K	J. Chem Soc Chem Commune 20:1423-5, 1990
1991	C_{60} Rotation $1.8\text{-}3.0\times10^{-10}$ s^{-1} NMR and μSR	Four research groups: Yannoni, 1991 Tycko, 1991 Haddon, 1991 Johanson, 1991	J Phys Chem 95,9.1991 J Phys Chem 95,518.1991 Phys Rev Lett 66,2633, 1991 Science , 255, 1235, 1992
1991	C_{60}:Molecule of the year	Science (cover page)	*Science* , December 1991
1992	STM image of C_{60} with atomic resolution, measure size	Koruga Resarch Team	Koruga, Đ. Simi-Krstic,J., Trifunovic, M., Jankovic,S., Hameroff,S., Withers, J., Loutfy,R., Imaging Fullerene C_{60} with atomic resolution using a scanning tunneling microscope, Fullerene Science and Technology, 1(1):93-100, 1993
1993	The first book about C_{60}	Koruga,D, Hameroff,S., Withers, J., Loutfy,R., Sandareshan,M	Koruga, Đ, Hameroff, S., Withers, J., Loutfy, R., Sandareshan, M., Fullerene C_{60}: History, Physics, Nanobiology, Nanotechnology, North-Holland, Elsevier Sciences Pub. 1993
1996	Nobel Prize in Chemistry 1996	Kroto, H.W., Curl, R.F., Smalley, R.E	

1999	C_{60}: Wave–particle duality	Anton Zeilinger Research Team	Markus Arndt, Olaf Nairz, Julian Vos-Andreae, Claudia Keller, Gerbrand van der Zouw & Anton Zeilinger , Wave–particle duality of C_{60} **molecules,** *Nature,* 401: 680–682,1999
2002	Sun glasses based on thin film of C_{60} (influence on EEG signals)	Koruga, Đ	"APPARATUS FOR HARMONIZING LIGHT,"US Patent App. :12/025,654, 2008, USA Patent Pub. number: 2008/0286453
2002	NHS: Nano harmonized substance based on C_{60}	Koruga, Đ	"COMPOSITION OF MATTER CONTAINING HARMONIZED HYDROXYL MODIFIED FULLERENE SUBSTANCE", Patent US 8,058,483 B2, Nov. 15, 2011.
ZEPTER NanoWorld based on C_{60}			
2016	BIOPTRON Hyperpolarized filter based on C_{60}	Koruga, Đ ZEPTER GROUP	Koruga, Đ., Optical filter and method of manufacturing an optical filter, Patent EP 3 469 406 B1,2020
2018	The book: Hyperpolarized light based on C_{60}	Koruga, Đ. ZEPTER GROUP	Koruga, Đ. Hyperpolarized light: Fundamentals of nanobiomedical potonics, ZEPTER BOOK WORD, 2018.
2019	Quantum cosmetics based on C_{60}	Koruga, Đ. ZEPTER GROUP	Koruga, Đ., Compositions comprising hyper harmonized hydroxyl modified fullerene substance, PCT/EP2019/083307
2019	Quantum cavity optics based on C_{60}	Koruga, Đ. ZEPTER GROUP	Koruga, Đ. Optical filter based on ligt.matter coupling in quantum-confiend cavity spaces, Patent PCT/EP2019/065365

Figure 9 TFT (Thales-Fibonacci-Tesla) Nano Center (ZEPTER GROUP) where researchers make new ZEPTER products according to the light properties of C_{60}.

(Pixabay)

FULLERENES

Do they have therapeutic potential in Alzheimer's disease?

The potential of fullerenes to interact with Aβ and to exert an effect on the diseased AD brain in experimental animals is particularly important considering that extracellular irregular protein aggregates are also present in the specific age-related form of neurodegeneration defined as mild cognitive impairment (MCI). The potential of 3HFWC to slow down protein aggregation and decrease the speed of subsequent neurodegeneration is intriguing. These findings substantially broaden the potential therapeutic value of 3HFWC, particularly as a general prophylactic in aging population.

Sanja Ivkovic
Milka Perovic
Đuro Koruga
Selma Kanazir

Alzheimer's disease - is it an epidemic?
Alzheimer's disease (AD) is a debilitating disease. It is characterized with the irreversible and progressive brain deterioration, slow destruction of memory and thinking skills and, finally, the ability to carry out the simplest life tasks. It is currently affecting about 50 million people worldwide and this number is estimated to increase 62% by 2030. Nowadays, with the substantial advances in modern medicine, our life-span has been significantly increased (Figure 1). The United Nations estimates a global average life expectancy of 72.6 years for 2019 – the global average today is higher than in any country back in 1950. Paradoxically, advanced age is the single most major risk for AD with the prevalence doubling every 5 years between the ages of 65 and 95 years and increasing from 2% at 65 years of age to 40% at over 85 years of age. The elderly experience minor changes in memory and thinking capacities but these changes are not severe enough to affect daily living and functioning. Most importantly, the ability to live independently is not affected.

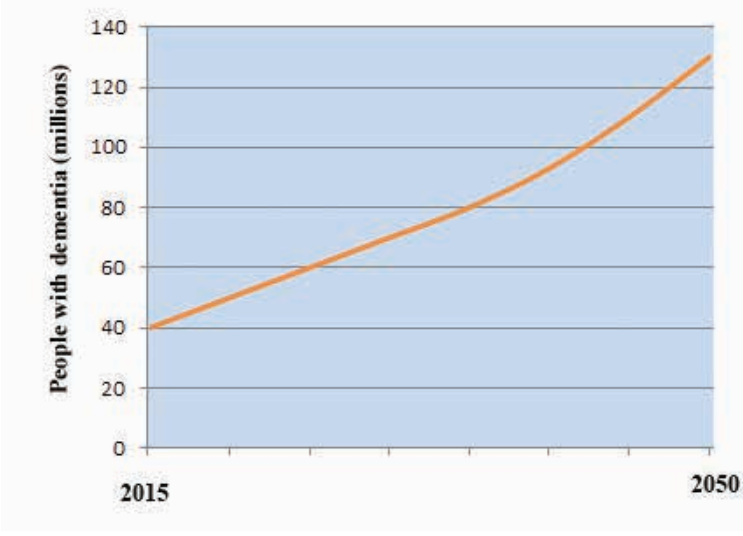


Figure 1.

However, AD patients are being gradually stripped of their ability to make decisions and participate in everyday life and as the illness progresses they become completely dependent on help from family members and other caregivers. The typical first signs of AD are memory problems, although initial symptoms may vary from person to person. A decline in other aspects of thinking, such as finding the right words, vision/spatial issues, and impaired reasoning or judgment, may also signal the very early stages of Alzheimer's disease. These results in inability to perform everyday things like driving a car, cooking a meal, or paying bills. People with Alzheimer's disease often ask the same questions over and over, they get lost easily, lose things or put them in odd places, and find even simple things confusing. As the disease progresses, some people become worried, angry, or violent. Although memory loss and dementia, in general, are progressive and irreversible, the rate of progression of these symptoms is highly variable and impossible to predict.

The complete helplessness of often otherwise healthy AD patients is devastating and heartbreaking. On the other hand, as the aging population progressively increases in modern society, the high incidence of AD among the elderly poses a substantial socio-economic burden to patients, caregivers, and the healthcare system. The estimated total healthcare costs for the treatment of Alzheimer's disease in 2020 in the USA is $305 billion, with the cost expected to increase to more than $1 trillion as the population ages. Most of the direct costs of care for Alzheimer's disease are attributed to skilled nursing care, home healthcare, and hospice care. Indirect costs of care, including quality of life and informal caregiving, are likely underestimated and are associated with significant negative societal and personal burdens.

Alzheimer's disease was discovered in 1906
The disease was discovered in 1906 by Dr. Alois Alzheimer, a German psychiatrist and neuropathologist. Dr. Alzheimer performed a postmortem examination of the brain from a woman who had died of at that time/then unfamiliar mental illness. She had symptoms that included memory loss and language problems, accompanied with the unpredictable behavior. He described many

abnormal clumps (now called amyloid plaques) and tangled bundles of fibers (now called neurofibrillary, or tau, tangles) in the patient's brain. These unique pathological features in the brain are still considered some of the main hallmarks of Alzheimer's disease, although other features, such as the loss of connections between nerve cells (neurons) in the brain are considered as some of the AD pathological changes (Figure 2). This general malfunction of neuronal communication is responsible for the subsequent behavioral changes.

Although AD was discovered more than one hundred years ago, the full clarification of its pathogenesis is not yet achieved. Nevertheless, specific anatomical markers of AD are known and are helpful in understanding the disease pathogenesis and for the development of possible therapies. These are macroscopic damages such as the atrophy of specific brain regions, and microscopic changes, such as accumulation of irregular protein deposits (plaques), and the formation of specific structures - neurofibrillary tangles.

Although the brain atrophy most often starts in the hippocampus, a brain region responsible for the control of memory, it is now known that this process begins decades before the first symptoms. At the late stage of the disease there is a significant shrinkage of the brain. The formation of plaques and neurofibrillary tangles is the result of the abnormal production and processing of two brain proteins, Amyloid beta and Tau, that are the focus of the worldwide research efforts executed in the dozens of laboratories. Amyloid-beta (Aβ) is a fragment of a larger protein – amyloid precursor protein (APP). Irregular processing of this protein at the surfaces of neurons leads to the abnormal production of extracellular amyloid-beta fragments. When these fragments cluster together, they form larger deposits called amyloid plaques which appear to

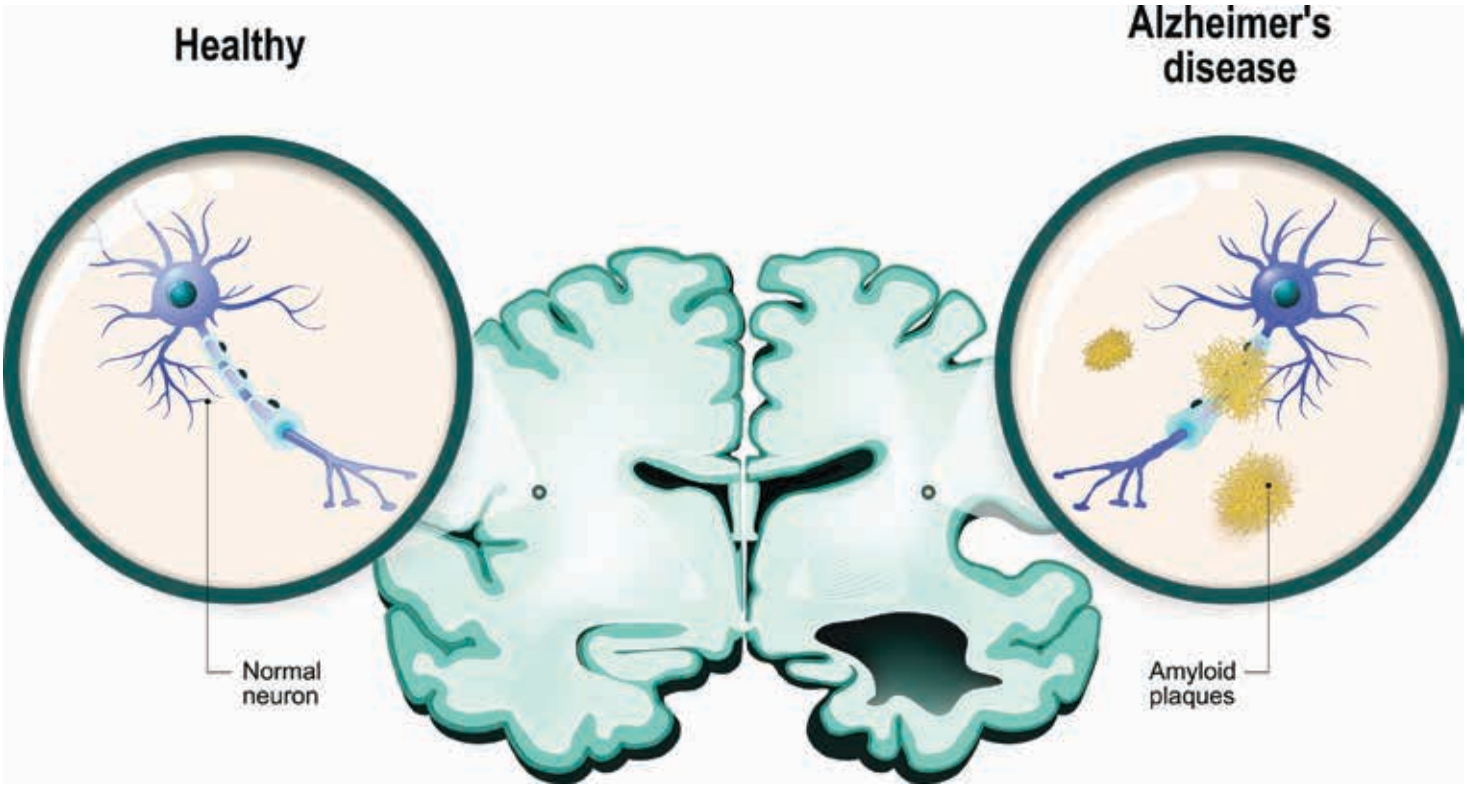


Figure 2. The brain of Alzheimer's patients is characterized with macro and micro changes. Macro changes include atrophy of specific brain regions and micro changes are the formation of amyloid plaques. (Image Credit: Designua/Shutterstock)

have a toxic effect on neurons and disrupt cell-to-cell communication. Tau proteins play a part in neuron's internal support and transport system. In Alzheimer's disease, due to hyper-phosphorylation tau proteins change shape and organize themselves into structures called neurofibrillary tangles. These tangles disrupt the transport system and are toxic to neuronal cells. How these changes occur and why they are present in some people and not in others remains still unsolved.

What causes Alzheimer's disease?

There are several different types of AD that are classified based on the time when symptoms start to appear - late onset (LOAD) and sporadic (SAD), or early onset (EOAD) and familial AD (FAD). FAD and EOAD is manly associated with genetic mutations in the amyloid beta precursor protein (APP), presenilin genes (PSEN1 and PSEN2), and apolipoprotein E gene (APOE). Although one variation of the APOE gene, APOE e4, increases the risk of Alzheimer's disease, and approximately 25% to 30% of the population carries this particular mutation, not everyone with this variation of the gene develops the disease. Nevertheless, although there are other genetic mutations that virtually guarantee that person who inherits them will develop AD, these mutations are responsible for less than 1% of people with AD. Thus, there are other factors that are necessary for AD to develop and they can be environmental, metabolic, viral etc. Nevertheless, aging remains the greatest risk for developing AD. Among health conditions, one of the significant risks for developing AD is mild cognitive impairment (MCI), characterized by a decline in thinking skills and memory that is greater than normal for a person's age, but MCI is not preventing normal social and work functioning. In addition, people who suffered a severe head trauma classified as *traumatic brain injury* (TBI) also have a greater risk for AD. Interestingly, this risk is the highest within the first six months to two years after the TBI suggesting a window of opportunity for the development of preventive therapeutic strategies.

Environmental factors can influence or cause AD as well, and the important one is air pollution. Studies in animals have indicated that air pollution can augment the degeneration of the nervous system. Human studies have also found that air pollution exposure - particularly from traffic exhaust and burning wood - is associated with a greater dementia risk. Researchers have also shown that consummation of large quantities of alcohol can be linked to the increased risk of dementia, particularly the early-onset dementia. Poor sleep patterns such as having difficulties falling or staying asleep are also associated with the higher risk of AD.

Finally, the large group of life style factors such as lack of exercise, obesity, smoking or exposure to secondhand smoke, high blood pressure, high cholesterol, and poorly controlled type 2 diabetes are also strongly associated with the increased risk of AD. The good news is that at least in case of these life style factors we have the power to alter the odds in our favor. For example, regular exercise and a healthy low-fat diet rich in fruits and vegetables are associated with a decreased risk of developing AD. Lastly, scientific studies have established a sound association between lifelong involvement in mentally and socially stimulating activities and a reduced risk of AD.

Diagnosis of Alzheimer's disease

The time from diagnosis to death varies depending on the age of the person. If the person is older than 80 when diagnosed the prognosis is 3 or 4 years, but if the person is younger than the prognosis can be as long as 10 or more years. Alzheimer's disease is currently ranked as the sixth leading cause of death in the United States. However, it can be ranked as third, according to the recent estimates, as a cause of death in elderly, just behind heart disease and cancer. The important part of diagnosing AD includes the ability of the patient to explain the symptoms, as well as the information obtained from family members, friends, and caregivers about symptoms and how are they affecting the everyday life. Finally, a diagnosis is based

on tests that doctor administers. These tests are designed to assess memory and thinking skills. The additional laboratory and imaging (PET scans) tests can also rule out other potential causes and/or help the doctor to identify more precisely particular symptoms important for diagnosing AD and to distinguish among similar symptoms that characterize other types of dementias such as vascular, senile and others.

Nonetheless, AD is only diagnosed with complete certainty after death when the postmortem microscopic examination confirms the presence of specific plaques and tangles in the patient's brain.

Treatment of Alzheimer's disease

Although treatment can help manage AD symptoms in some people, currently there is no cure for this devastating disease.

Current medications prescribed for the treatment of AD can initially help with memory symptoms and other cognitive changes. There are two types of drugs in use for the treatment of AD - cholinesterase inhibitors and memantine (Namenda). Cholinesterase inhibitors work by increasing levels of cell communication through the preservation of a specific messenger molecule (acetyl choline) that is depleted in the AD brain. Most people see modest improvements with this treatment. However, these drugs have serious side-effects such as diarrhea, nausea, loss of appetite and sleep disturbances, and in some cases cardiac arrhythmia. Memantine (a NMDA receptor antagonist) works on another line of communication in the brain and this treatment is able to slow the progression of symptoms in moderate to severe cases of AD. Relatively rare side effects include dizziness and confusion. Sometimes these two treatments can be combined.

Therefore, the choice of treatments that AD patients face after diagnosis is very limited and the outcome is not very prospective - they decelerate, but not cure the disease. Because of that, the development of new treatments has been an urgent focus of research labs and clinics in the last decades. A number of governmentally and privately funded grants exist with a sole mission of finding the cure for AD. They invest in all the studies that carry the hope of finding a solution for this debilitating disease that is more than a century present in human population.

Nano-technology applications – Fullerenes

Nowadays, the nano-technology is omnipresent in our everyday life. Therefore, with the urge of discovering new treatments for AD, it does not come as a surprise that attempts are made to harness the potential of this powerful methodology if not to cure, than to diminish/curtail/contract the devastating effects of this disease. One such study examined the effects of a patented fullerene derivative, hyper-harmonized-hydroxylated fullerene water complex - 3HFWC (developed in TFT Nano Center, Belgrade as a part of ZEPTER GROUP International) (Figure 3). Fullerene is the third pure crystal carbon form, besides graphite and diamond. It is an allotrope (a structurally different form of the same element) of carbon whose molecule consists of carbon atoms connected by single and double bonds forming a closed or partially closed mesh, that consist of fused rings that contain five to seven atoms. The molecule may be a hollow sphere, ellipsoid, tube, or many other shapes and sizes. The fullerene family is named after buckminsterfullerene (C_{60}), the most famous member, which in turn is named as an homage to Buckminster Fuller, an American architect, systems theorist, author, designer, inventor, and futurist (who used the similar structural principles for architectural objects that he designed). The closed fullerenes, especially C_{60}, are also informally called buckyballs for their resemblance to the standard soccer ball.

Fullerenes had been predicted for some time, but only after their accidental laboratory synthesis in 1985 were they detected in the nature and outer space. Sir Harold Kroto, Robert Curl and Richard Smiley were awarded the 1996 Nobel Prize in Chemistry for the discovery of this class of molecules.

Since then fullerenes have been the subject of intense research, both for their chemistry and for their technological applications, especially in materials science, electronics, and nanotechnology.

C_{60} is able to produce a large number of derivatives. Considering that fullerenes have pour water solubility, the focus was put on developing chemical modifications such as the addition of hydroxyl groups creating fullerenols, compounds soluble in water.

Therapeutic properties of fullerene and its derivatives were first shown in 1993, when Friedman and colleagues, demonstrated their ability to inhibit the activity of HIV protease, the key enzyme responsible for the formation of infectious HIV virus. The other important property of these compounds is the ability to inhibit bacterial binding to the host cells through the interaction with the adhesive molecules on the membrane. These compounds can interact with the immune system and cancer cells. It was shown that they can inhibit the growth of specific cancers in experimental conditions but to also modulate the activity of some cytotoxic drugs. One of the most important characteristics of fullerenes is that they have anti-oxidative properties absorbing free radicals and protecting cells from their toxic effects.

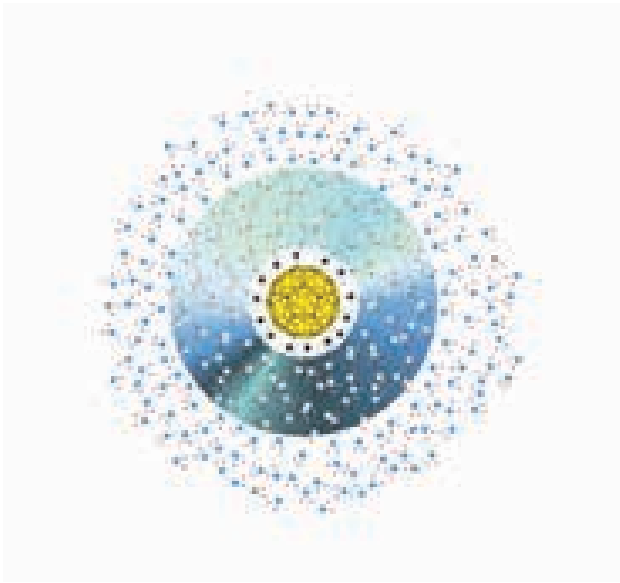


Figure 3. 3HFWC, Hyper harmonized hydoxylated fullerene water complex $C_{60}(OH)_x$ @ $[(H2O)^l]^{\Phi/\phi}$

However, fullerenes can be activated with different wavelengths of light generating free radicals and damaging membranous lipids and proteins. This ability of fullerenes and its derivatives is used as the base for photo-dynamic therapy where fullerenes act as sensitizing substances and exert beneficial effects in different systems.

In order to understand the ability of 3HFWC to interact with amyloid-beta (Aβ), the culprit protein of AD, numerous studies were done, mostly in solution and in the cell culture conditions (i.e. *in vitro*). These studies showed that water-soluble fullerenes are able to interact with Aβ protein's 3D structure inhibiting their aggregation, the same process that initiates the formation of plaques.

Fullerenes' potential in AD: the results from animal studies

The potentially beneficial actions of 3HFWC fullerene on the development and progression of AD was analyzed in the brains of experimental animals, rodents, in in vivo conditions. Considering that rodents do not develop AD, scientists have designed specific genetic modifications in mice in order to mimic the development and progression of familial Alzheimer's disease (FAD). One such model is 5xFAD mouse that bears 5 mutations in 2 genes whose altered functions are implicated in the development of AD. These genes are amyloid precursor protein (APP) and presenilin 1 (PSEN1). Previous studies have established that 3HFWC given orally, dissolved in drinking water, did not have any overall harmful effects on mice. However, fMRI scans of the CNS in treated wild-type mice showed increased activity of specific brain regions when compared to the control mice. The next step was to determine the effects of 3HFWC in an animal model of AD, the 5xFAD transgenic mice. The important fact to take into account when looking for the potential treatment for AD is that in humans, this disease can start many years before visible symptoms.

This period when the disease has already started but the patient is asymptomatic is

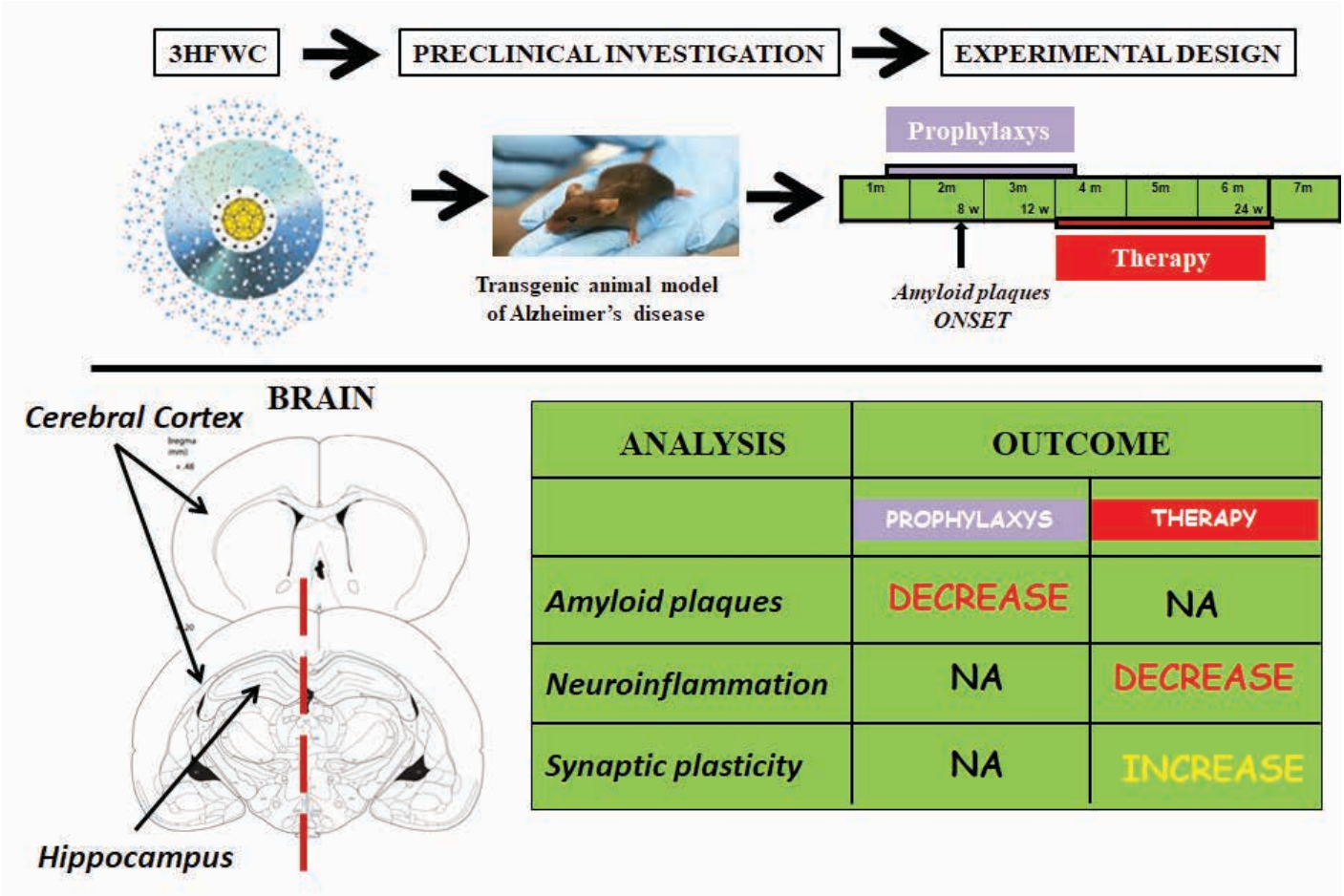


Figure 4. The effect of 3HFWC nano-substance, administered as a prophylaxis or therapy, on amyloid plaque burden, neuroinflammation and synaptic plasticity in 5xFAD transgenic animal AD model.

called *prodromal* phase. Mice have shorter life span and in AD transgenic models the prodromal phase lasts several months, facilitating the evaluation of putative new therapies. With that in mind, the specific study was designed aiming to evaluate and compare the effects of 3HFWC when it is administered in prodromal phase (before the appearance of amyloid plaques), or when animals were already sick. Both groups were treated for 3 months. Interestingly, this study showed that although 3HFWC had beneficial effects on specific aspects of AD pathology in both experimental paradigms, these effects strongly depend on the time when the treatment was given (before the symptoms of a disease were visible or when the disease is fully developed). When approaching such a complex disease as AD, several aspects of brain pathology are taken into account and the effects of the new treatment are evaluated on each of them.

Firstly, the main structural parameter analyzed is the formation of amyloid plaques, an irregular accumulation of missfolded protein aggregates that is the hallmark of AD. A decrease in plaque accumulation or in the presence of its main constituent, the toxic form of amyloid-beta peptide ($A\beta_{42}$) is considered beneficial for the treatment of AD. Secondly, the pathological changes in AD brain such as the formation of plaques and tangles are accompanied with the increased inflammation that can induce further damage to the nervous tissue. Therefore, diminishing the neuroinflammation is always beneficial. Lastly, the proper nerve cells communication is necessary in order to successfully respond to everyday tasks, to solve problems, and to think. This communication is achievable through specific structures called synapses. They are adaptable, dynamic and responsive structures representing the foundation of brain's plasticity, a

unique feature responsible for our adaptive responses to various intrinsic or extrinsic stimuli. The dynamic nature of synapses, i.e. their plasticity, can be measured and used to evaluate the level of pathology or the efficacy of the potential therapy. Importantly, synaptic plasticity is weakened in neurodegenerative disorders, including AD and the treatment is considered beneficial if it induces the increase in synaptic plasticity. The effects of 3HFWC were analyzed in two brain regions that are regularly affected in AD, the cortex and hippocampus, and are responsible for thinking and for the formation of memories.

The effects of 3HFWC in the brain of an animal model of Alzheimer's disease

The analyses of experimental animals (40 mice) after the 3-month-long 3HFWC treatment showed clear and significant differences when compared to control transgenic animals and importantly, showed qualitatively different effects whether 3HFWC was given as a *prophylaxis* or as a therapy. When 3HFWC was given as prophylaxis, i.e. during the prodromal phase, to the animals that are in the early stages of the disease, the number of plaques in the brain was reduced while the neuroinflammation and synaptic plasticity were unaltered. In contrast, when 3HFWC was given as a *therapy* to the already sick animals the effect on amyloid plaques was missing, but neuroinflammation was significantly reduced and synaptic plasticity increased (Figure 4).

The prophylactic effect of 3HFWC on the level of plaque formation is most probably the result of the conformational changes of amyloid-beta affecting its irregular aggregation. The anti-inflammatory effect of the treatment with 3HFWC when the disease is already developed in full and when the plaque growth is in its exponential phase may act as an indirect support of the synaptic health, increase its plasticity, and as a result improving the cognitive functions in general. In this case, the possibility that 3HFWC can be used as an adjuvant to conventional therapies in order to improve patient's mental health or to slow down the progression of disease is exciting. As in the case of prophylactic use the therapeutic potential of 3HFWC warrants more in-depth studies.

Conclusion

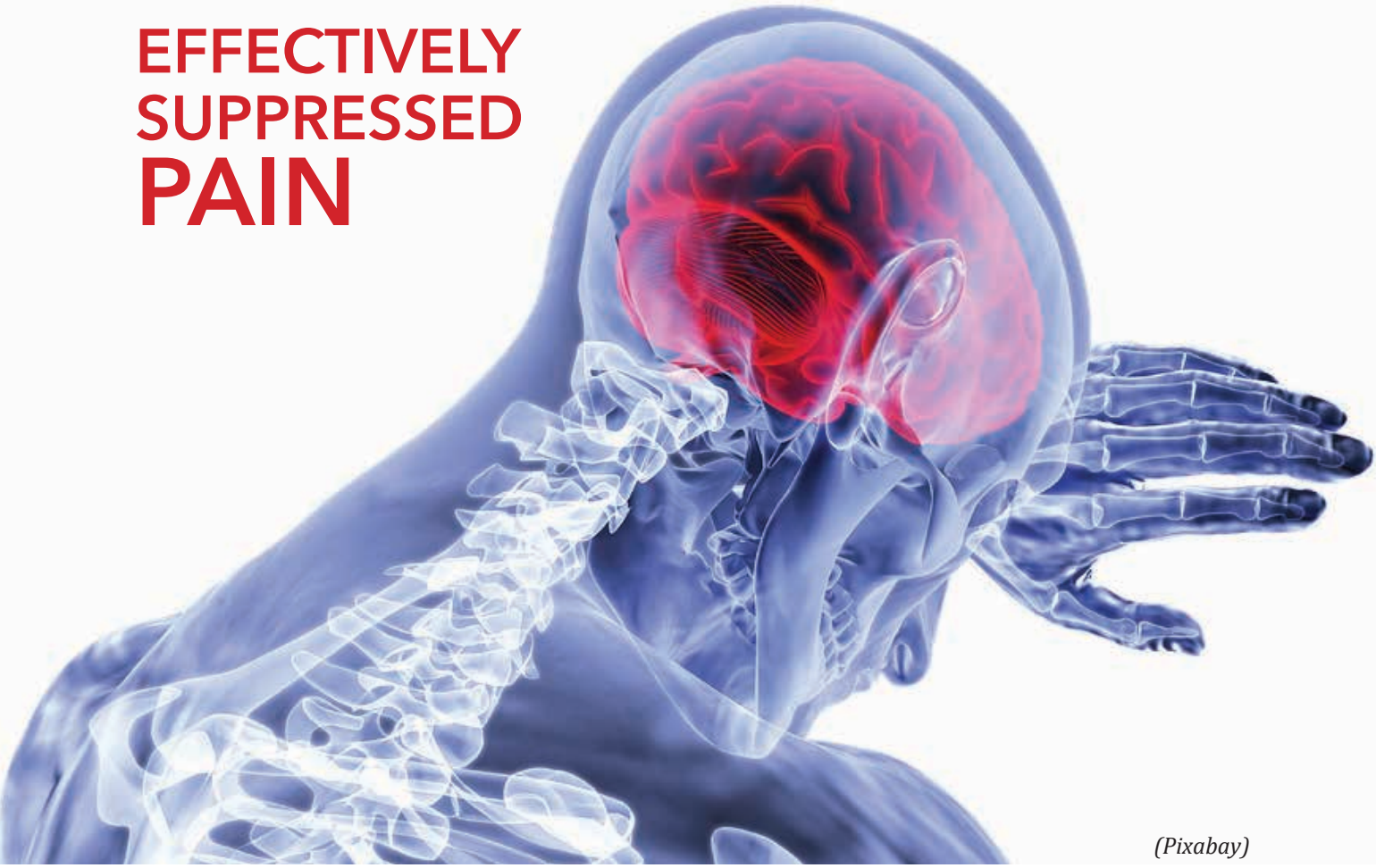
AD belongs to the class of diseases that have extracellular protein aggregates as a common denominator. Specific proteins become structurally abnormal and consequently impair the function of cells, tissues and organs in the body. Such irregular proteins can become toxic or they can lose their normal function. In medicine, these diseases are called *proteinopathies* and they include besides AD, such diseases as Creutzfeldt-Jakob disease and other prion diseases, Parkinson disease, amyloidosis, multiple system atrophy and a wide range of other disorders. The development of effective treatments for many proteinopathies has been difficult as they not only involve different proteins but they arise often from different sources.

The potential of fullerenes to interact with Aβ and to exert an effect on the diseased AD brain in experimental animals is particularly important considering that extracellular irregular protein aggregates are also present in the specific age-related form of neurodegeneration defined as mild cognitive impairment (MCI). The potential of 3HFWC to slow down protein aggregation and decrease the speed of subsequent neurodegeneration is intriguing. These findings substantially broaden the potential therapeutic value of 3HFWC, particularly as a general prophylactic in aging population. However, further studies are necessary to fully understand the effects of this nano particle in ameliorating the consequences of aging. Some of the exciting questions that need answers are - what will be the effect of fullerenes on other proteinopathies in experimental animals; what, if any, are the effects of fullerenes on other organs not primarily affected with the specific disease; can fullerenes be considered as potential adjuvants for the already existing therapies?

White (polychromatic) light and its individual color (monochromatic) components in the wavelength range from 400 to 780 nm have been received by humans for medical purposes for many centuries. This physiotherapy direction has the general name actinotherapy with variations of light therapy, phototherapy, low-intensity laser therapy, color therapy, photobiomodulation.

There are no objections to the empirically established approaches to the treatment of psychoemotional disorders, insomnia, neonatal jaundice, prophylactic and pain-relieving light procedures, etc. [1-6]. The possibilities of light therapy have expanded since the advent of LASERs, which has drawn particular attention to a new kind of light. Laser creates coherent polarized light (monochromatic), the quanta of which propagated in a parallel stream. High-intensity laser light is used for the surgical destruction of pathological foci [7]. Low-intensity laser radiation is successfully used for therapeutic purposes in der-

EFFECTIVELY SUPPRESSED PAIN



(Pixabay)

We revealed that the factors that significantly enhance the analgesic result of PL therapy are the polarization of light and the presence of the long-wavelength part of visible light. Clinical observations of human pain before and after the application of PL revealed dynamics similar to those obtained in animals. Analgesia after 3-day application of red light to AP He-Gu in a patient with post-traumatic pain reached 48.2%. We emphasize the efficacy, simplicity and safety of the PL color clinical application.

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matology, rheumatology, wound treatment, pain relief, etc. in humans and animals [8-10]. Low intensity red laser light has been shown to effectively suppress acute and chronic pain [11-12]. However, lasers have a drawback - a narrow wavelength range and the impossibility of simultaneously using the full palette of sunlight.

Bioptrons, as a separate group of light therapy devices that produce polychromatic polarized light (PL), appeared in the late 80s. last century [13-14], however, their real implementation in medical practice occurred after the merger of the companies Zepter and Bioptron [15-16]. At that time, the main arguments for the effectiveness of Bioptron-light were the hypothetical mechanisms of action of laser light and the practical experience gained in the treatment of several cases of trophic ulcers of the leg [17]. But the first wave of results obtained in the 80-90s of the last century was characterized by heterogeneity in the selection of objects of observation, errors in the methodological base, empirical approaches and, ultimately, incomparability of data. Clinical observations due to the specificity of the human factor have demonstrated only relative evidence of the effectiveness of polychromatic PL.

As for the individual monochromatic spectral ranges of the Bioptron device (quasi-laser light, color therapy), at the beginning of their application, the initial emphasis was shifted to the field of alternative medicine without obtaining an evidence base [18]. As a result, problems arose with the recognition of Bioptron-color therapy as a medical technology. At the same time, this path has already been passed by low-intensity laser medicine using color-PL. Methodological difficulties have also arisen due to the orientation of clinicians exclusively on the data obtained on patients with a specific disease. The implementation of such requirements is laborious and not possible for all diagnoses. Direct experimental results obtained in animals have not been properly accepted. The jealousy of fans of laser medicine towards the young direction at that time is not excluded, which was expressed in ignoring the first results obtained at the level of case reports.

Now one of the first necessary questions is to consider the significance of such a property of Bioptron light as polarization. This question was associated with the abundance of light technology used in physiotherapy, which also causes an analgesic effect, and the lack of clarity in understanding the differences between specific devices. The question of the presence or absence of a similar effect in unpolarized light, or of the exceptional property acquired by light after polarization, could be resolved by setting up a comparative study of the role of these two variants of light, provided they have the same power. This could be identified using different pain models: acute pain (vocalization on the electrode floor) and an artificially created locus of tonic somatic pain (formalin test).

Everyone understands that white light contains electromagnetic waves with different wavelengths and, perhaps, not all of them have the same analgesic effect. However, the evidence base on this topic is still practically absent. Hence, the relevance of the study of the analgesic effect of monochromatic color light ranges is clear.

Our goal was to apply a unified experimental methodological approach that would allow an objective assessment, with a minimum risk of errors, to determine the effectiveness of monochromatic light exposure on pain response. Such evidence cannot be obtained in human beings. It was important for us to obtain direct data and estimate the contribution of the polarization of poly- and monochromatic light. They would serve as the basis for further in-depth study of the differences for each of the polarized color ranges. In particular, to find out the dependence of the analgesic effect on the PL wavelength. At the same time, it was important to find and quantify the ranges with the most noticeable analgesic effects.

Methods
We focused on the assessment of the analgesic response of polarized and unpolarized monochromatic and polychromatic light in different types of pain (tonic and acute) that arose after the application of a chemical or electrical stimulus in animals. The study also used the observation of the dynamics of post-traumatic pain in humans under the influence of polarized light.

Exposure to Polarized light
We used BIOPTRON light: incoherent, low-energy (40 mW / cm2) light (physical name PILER) with a wavelength range of 480-3400 nm in the visible and near infrared spectrum. This light is also called Bioptron® Quantum Hyperlight®. The wavelength range of light could be modified by Colortherapy-Set monochromatic absorption filters (red, orange, yellow, green, cyan, blue, violet). The polarization of light from a halogen lamp was created by reflecting it from a laminated glass located at the Brewster angle (linear polarization). Unpolarized light was obtained in a similar optical system of the BIOPTRON apparatus without a polarizer. Distance from the skin surface 5 cm. Exposure 10 min. The effects obtained with direct application of light to the site of pain (inflammatory response) or distant exposure (response with TA) were evaluated. The beam diameter was 5 mm (in animal experiments) or 5 cm (in human studies).

Experiments on animals
The study was performed on 280 adult white male mice weighing 28-33 g. All experiments were carried out in accordance with the Ethical Guidelines of the International Pain Association. As a model of tonic pain response, we used well described in the literature [22-23] formalin test. The pain was induced by subcutaneous injection of a 5% formalin solution into the dorsum of the foot of the left hind limb. The experimental model was described in detail by us earlier [24]. Immediately after the formalin injection, a 10-minute application with the Bioptron device light to the pain locus or AP E-36 was performed. Each series of experiments consisted of 10 animals, the placebo series (control without light) included 20 animals.

With the help of a computer program, the duration of the painful behavioral reaction was calculated - licking the affected limb; as well as non-painful reactions (duration of sleep, eating, washing and running) for every consecutive 10 mins during the 60 mins observation period. Acute pain was induced by irritating the paws of animals with an electric current. The mouse was placed in a chamber with an electric floor. An unavoidable, gradually increasing electrical painful stimulation was applied and the threshold voltage (V) was recorded when the animal reacted by vocalization. The vocalization threshold was recorded before and after light application.

Research of post-traumatic pain in humans
In a patient diagnosed with a displaced fracture of the fifth metacarpal bone, we studied the effect of the red polarized light of the Bioptron device on the intensity of pain. Under local anesthesia, bone fragments were repositioned and fixed with a titanium plate. Severe pain syndrome was observed after the operation. To relieve it, the patient received 4 days of pharmacological analgesia (dexalgin). Then, instead of a pharmacological analgesic, treatment was performed with red polarized light (Bioptron device with a red absorption filter of glass blowing origin). Since the application of light to the locus of pain was impossible due to the immobilizing dressing, the light was directed to AP GL-4 (HeGu). The patient received a 10-min session of light therapy daily. Using a special computer program, the duration (in secs) of pain sensations was recorded for 30 minutes before the light was applied and for 30 mins after the end of the light therapy session.

Processing of experimental data
Data from animal and human studies were statistically processed. Results are presented as mean and standard error of the mean for each group (M ± m). The significance of the difference between the results before

and after the application of light, as well as between the groups where polarized and unpolarized light or light with different wavelengths were used, was assessed by the Student's test. The difference was considered significant at $P < 0.05$.

3. Results

3.1. Influence of polychromatic PL on pain and non-pain behavior of animals

First of all, it is necessary to consider the correlation of pain and non-pain reactions in animals before and after the use of polarized light against the background of control data. This correlation makes it possible to assess the intensity of pain and, thus, to judge the presence of a biological response to a given type of light and specifically about the possibility of light analgesia.

If to take the duration of all observed behavioral reactions as 100% (full circle), then changes in the relationship between pain and non-pain responses in different groups of animals will become obvious (Fig. 1). Under normal conditions (without any exposure), the animals ate or slept 75% of the time (eating 36%, sleeping 39%), running and washing took them 25% of the time, there was no pain. In the group of animals that received formalin pain, but did not have the PL light application, we observed a decrease in sleep and a complete lack of interest in food. More than half of the time (55%) these animals licked the affected paw (pain locus). In the group that received PL light (10 min) on AP E-36, the total time of licking the painful area significantly decreased (by 2.2 times) in comparison with the group without light application ($P < 0.01$), which indicates pain relief. Sleep duration increased by 1.8 times ($P < 0.05$). Some of the animals (6 out of 10) started eating food, but this was just a trend, like running or washing. We, subsequently, confirmed many times such patterns of behavioral reactions [19, 25-27].

Despite the fact that the above data convinced us of the effectiveness of the PL light, the question arose about the role of polarization in the development of the analgesic effect. The results of experiments carried out according to the method described above against the background of variations in pain syndromes, wavelength ranges and polarization, made it possible to verify the existence of differences in the case of using polarized and unpolarized light.

Comparison of the effects of unpolarized and PL on acute and tonic pain

The effect of polychromatic unpolarized light on analgesic AP did not cause statistically significant changes in the pain threshold (acute pain) to electrical irritation of the soles of the feet (Fig. 2, A). Its fluctuations did not exceed 6-11% of the initial values. Almost in the same range (5-8%), changes in the pain threshold were observed in the group that was not exposed to light (control). Curves of changes in the threshold current values in these two groups practically

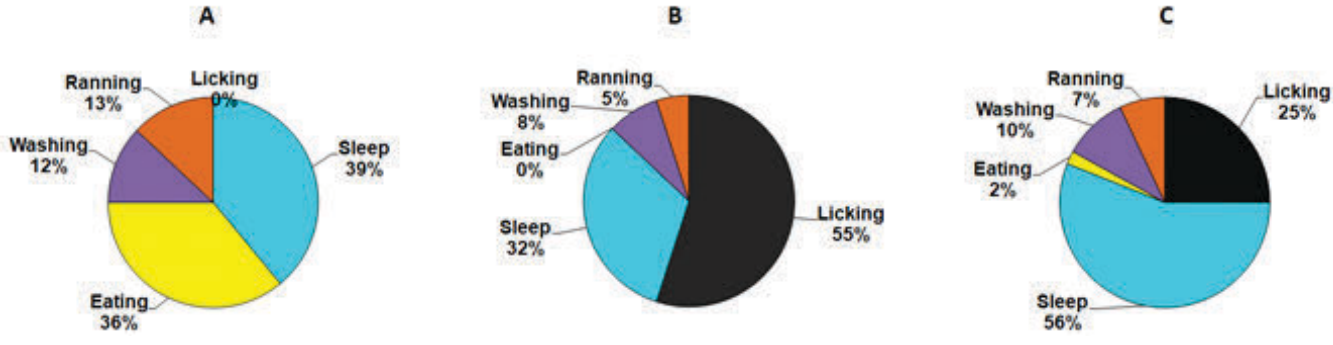

Fig. 1. The structure and duration of behavioral reactions in animals in a calm state (A - control group), in the presence of formalin-induced tonic pain before (B) and after 10-mins application of polychromatic light to AP E-36 (C) [21]: Area of a whole circle was taken as 100%

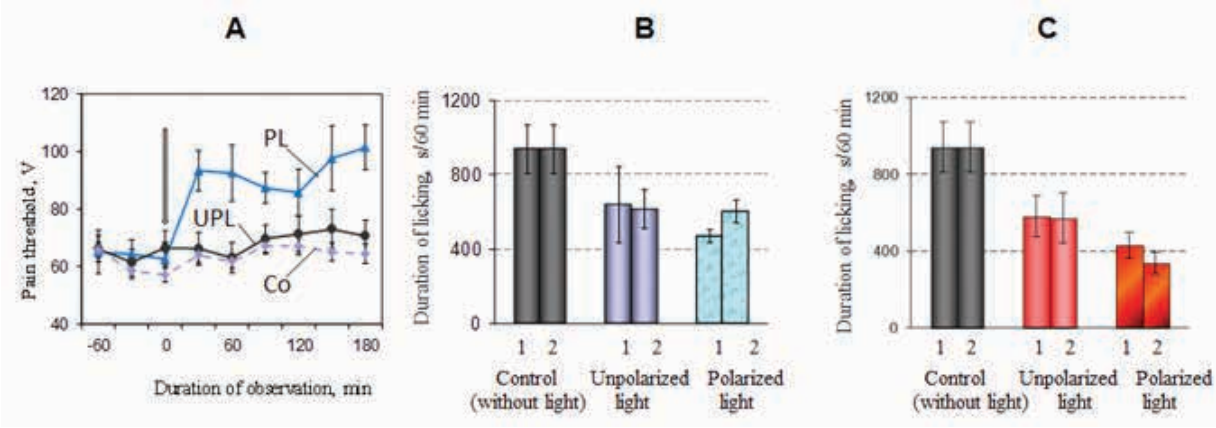

Fig. 2. Influence of unpolarized and PL in polychromatic and monochromatic (red) variants on acute and tonic pain: A - acute pain (polychromatic light, application to AP E-36), the arrow indicates the beginning of exposure to light; B and C - tonic pain (poly- and monochromatic red light when applied to AP (1) or to the pain locus (2), PL - polarized light, UPL - unpolarized light, Co - control group (without light)

coincided. On the other hand, PL caused a noticeable increase in the pain threshold (by 34.2-59.1%). The analgesic effect lasted over 3 hours. These results showed that only PL light had statistical significance of weakening the sensitivity to acute pain.

After illumination of AP E-36 with both polarized and unpolarized white light, tonic pain response (Fig. 2, C) was lower than in placebo (50% and 67.9% of the control value). However, statistical analysis revealed an insignificant difference between the duration of licking the pain locus in the group where unpolarized light was used with the control group. On the other hand, PL light significantly ($P < 0.01$) reduced the duration of the pain response.

If the polychromatic unpolarized light was directed right to the pain locus, then the duration of the pain reaction decreased in almost the same way as after exposure to the PL (65.4% and 64.2% of the control value), but due to the large scatter of individual values, the difference with the control turned out to be statistically insignificant. Only the increase in the duration of sleep compared to the control was significant ($P < 0.05$).

Monochromatic (red) PL, as shown above, reliably suppressed both acute and tonic pain. Since red PL had the greatest analgesic effect of the entire spectrum, it was advisable to compare the effectiveness of the use of unpolarized red and PL.

When studying the effects of monochromatic (red) light on a model of acute pain, an increase in the pain threshold was recorded when the AP E-36 was exposed to not only polarized, but also non-polarized red light. The threshold increased by 25.4% and 22%, respectively, compared with the control group. At the same time, polychromatic unpolarized light increased the pain threshold by a maximum of 11%, which did not differ significantly from the control.

In animals with an artificially created locus of tonic pain, a pronounced reduction in the duration of the pain reaction was observed after application of unpolarized red light to AP E-36 or to the locus of pain. The changes, however, were weaker in comparison with the effect of red PL (Fig. 2, C). This is clearly seen both in the dynamics and when comparing the total (for 60 min of observation) values of pain reactions in different groups.

The nature of the changes in non-pain behavioral reactions is also noteworthy. In the group exposed to unpolarized red light, the duration of sleep and washing was shorter and the running time was longer than in the control animals. This meant that red PL sup-

pressed tonic pain more noticeably than unpolarized red light.

So, comparative studies have shown that tonic and acute pain are most effectively alleviated by the action of PL (both poly- and monochromatic). Unpolarized light does not induce significant changes in sensitivity to acute or tonic pain. These data reconcile with the results of R. Bolton et al. [28], who compared the effects of different polarization values of Bioptron light (95 and 14%) on the growth of macrophages in tissue culture. They found that under the influence of 1- and 2-min exposures, the reaction of macrophage proliferation was noticeable 4 days after application, and its severity (number of cells) was the greatest after exposure to polarized light (95%) for two mins.

Our data showed that when unpolarized light acted on the locus of pain caused by inflammation, a more pronounced weakening of the behavioral pain response was observed than the response from AP E-36. It is known that hemogenic inflammation is characterized by the appearance of many inflammatory mediators, in particular, bradykinin and histamine, which stimulate nociceptive fibers and have a vasodilating effect, the development of edema, an increase in the permeability of the basement membranes of the skin, an increase in the metabolic rate by about one third, a decrease in the pH in the locus to 5.3, an increase in osmotic pressure, an increase in the concentration of K+, Na+, Ca++ ions by about 1.5 times [29-30]. It was found that these and other pathological conditions are accompanied by changes in skin resistance.

Thus, in a rabbit with experimental peritonitis for 7 days, areas with a strongly reduced resistance were noted on the auricles [31]. Skin areas with low resistance also appeared after the creation of an artificial gastric ulcer or upon stimulation of a number of visceral structures and the cerebral cortex [32]. This interesting fact suggests that the area of the skin outside the area of the acupuncture point, altered as a result of hemogenic inflammation, acquires the properties of such a point and the ability to activate endogenous analgesic systems. In the practice of acupuncture, these pathological extra-acupuncture areas are used to effectively suppress pain.

At the same time, when studying changes in the pain threshold in experiments with acute pain, it was found that unpolarized light when applied to an AP is not able to cause a statistically significant suppression of the behavioral pain response, similar to that which occurs after the application of polarized light of the Bioptron device [19]. It is known that in acute pain there is a natural physiological activation of nociceptive fibers, which is not accompanied by the development of local pathological changes in the skin. This fact confirms the conclusion that inflammation mechanisms underlie the increase in the sensitivity of ordinary skin to polarized light.

There is evidence that under the action of PL on the skin of the paw of an anesthetized rat, a prolonged inhibition of the background activity in the afferent fibers of the cutaneous nerve was observed, while under the action of unpolarized light of the same intensity, biphasic changes in excitability occurred [29]. All this convinces us that only polarized light has the property of weakening sensitivity to acute and tonic pain, despite the presence of a general biological response to any light source. It can also be assumed that the best efficiency of red light was due to the absence in its spectrum of neutral and blue components that have antagonistic effects to it.

Influence of monochromatic spectral ranges

Fig. 3 shows that after AP E-36 exposure to polarized light, statistically significant pain relief was provided by both polychromatic and all ranges of colored light. When acting on the pain locus, statistically significant pain relief took place after the application of white light and 5 variants of colored light, with the exception of blue (Fig. 4).

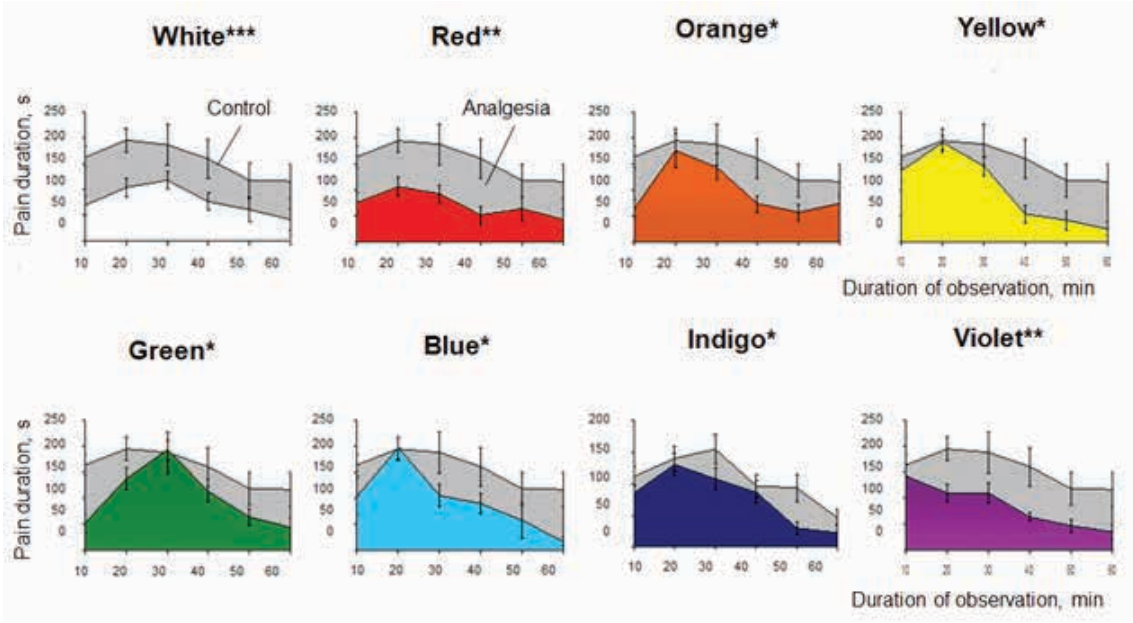

Fig. 3. Dynamics of pain response to tonic pain in animals after 10 minutes of AP E-36 exposure to poly- or monochromatic light of the Bioptron device: The ordinate shows the duration of licking of the affected limb (s). The abscissa shows the observation duration (min).
*Significance of difference with control over 60 min of observation: * - P < 0.05; ** - P < 0.01; *** - P < 0.001.*

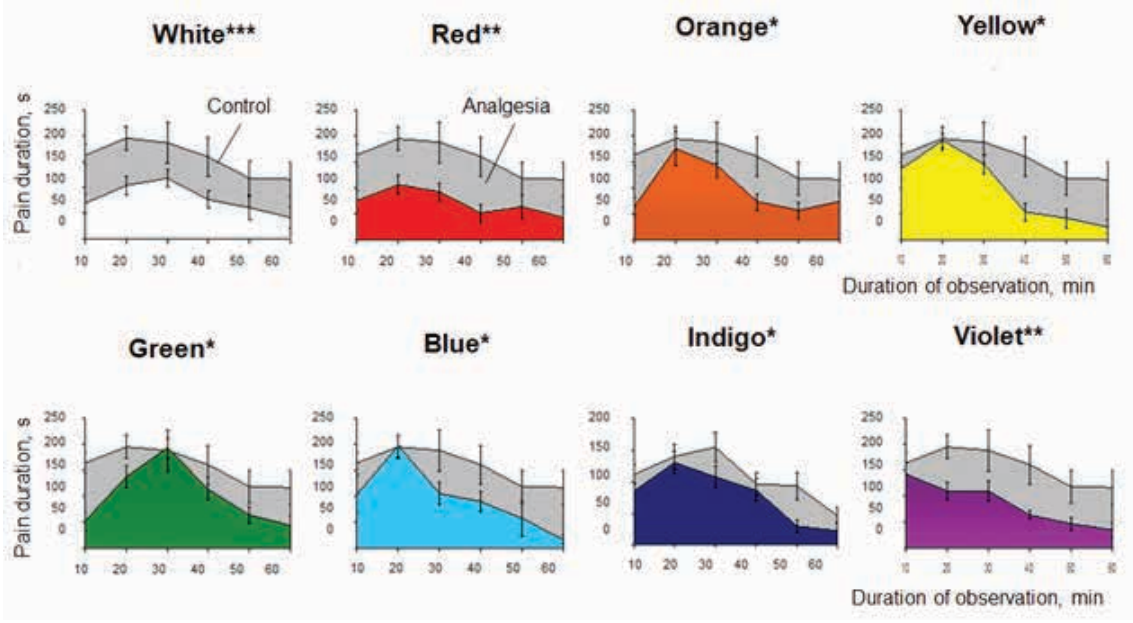

Fig. 4. Dynamics of pain response to tonic pain in animals after 10 minutes of the pain locus exposure to the poly- or monochromatic PL of Bioptron devices: The ordinate shows the duration of licking of the affected limb (s). The abscissa shows the observation duration (min).
*Significance of difference with control over 60 min of observation: * P <0.05; ** P <0.01; *** P <0.001*

Regardless of whether the AP or the pain locus was illuminated, the shortest duration of the pain reaction was observed after the application with red light. The total time of licking the pain locus in these two experimental groups was 45.6–7% and 35.9–6.1% of the like indicator in animals not exposed to PL. Thus, the analgesic effect of the application of red PL to AP E-36 was 54.4%, and to the pain locus - 64.1%. Following the red light in terms of efficiency of AP E-36 illumination come - white light (the duration of the pain reaction was 50% of the control), and when the locus of pain was illuminat-

ed by yellow (44.6%) and by orange (49.9%). After application by the remaining colors of the spectrum, the pain response was 53.7-68.5% of the similar response in animals not exposed to PL of the Bioptron device.

The reduction in the duration of the pain reaction after exposure to colored PL was especially noticeable in the second half hour. This is clearly shown in Fig. 5. The pain reaction of all the groups was more intense in the first 30 mins. However, in the control mice, even in the second half hour, the duration of licking the pain locus remained rather long and was up to 394.8 secs (versus 547.3 secs in the first 30 minutes). In mice that received a session of color therapy, this time was in the range of 86.7-190.2 secs (after irradiation of the pain locus) or 118-256.2 secs (after AP E-36 exposure to PL).

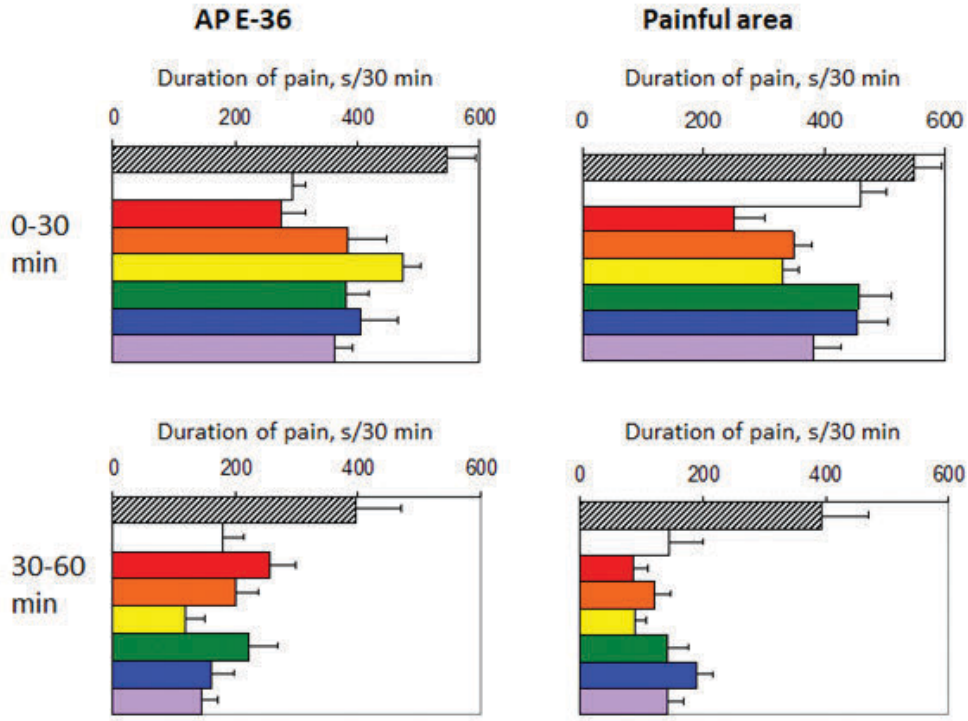

Fig. 5. The duration of the tonic pain reaction in animals in the first half hour and in the second half hour after 10 mins of AP E-36 or the pain locus exposure to monochromatic light with different wavelengths.

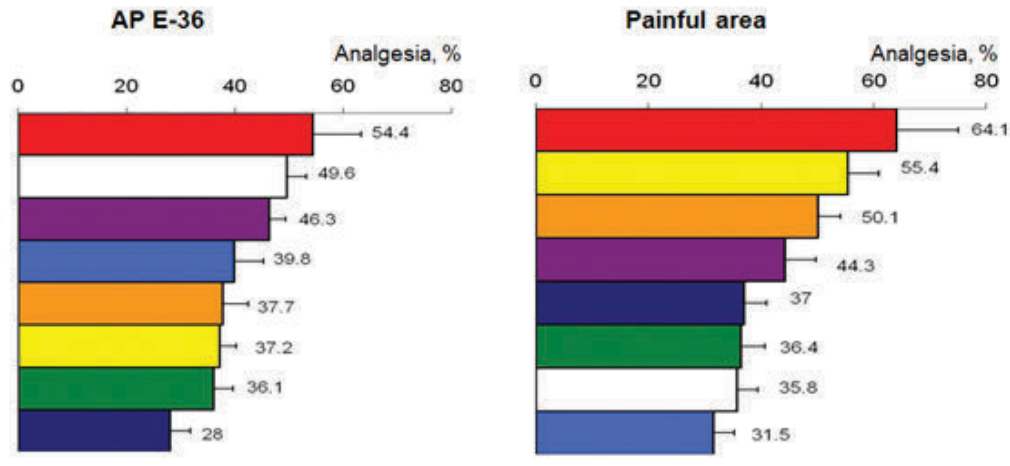

Fig. 6 Dependence of the analgesic/anti-inflammatory effect of polarized light on monochromatic wavelengths of BIOPTRON device [33]. Numbers above the bars - mean analgesia in different groups.

The results of our experiments showed that the monochromatic PL of all investigated wavelength ranges had statistical significance as to weakened pain. When PL was applied to AP E-36, analgesia ranged from 28% to 54.5%, and to the pain locus - from 31.5% to 64.1% (Fig. 6). In both cases, red light produced the most potent analgesic effect: 54.5% and 64.1%, respectively.

It was interesting to find out whether the differences between the most effective red light and other colors of the spectrum had statistical significance. The total (for 60 min of observation) values of the duration of licking of the affected limb (the main indicator of pain in the formalin test) are shown in Fig. 7 and in Table. 1. When the pain locus was exposed to light directly, differences were observed even within the color ranges. They were statistically significant when compresence was between the most effective red light and the three colors of the "cold" part of the spectrum (green, blue, violet). Red light had better statistical significance than polychromatic light. No significant differences were found between red and two other "warm" colors of the spectrum (yellow, orange); their analgesic efficacy was close to red light. They shortened the pain response

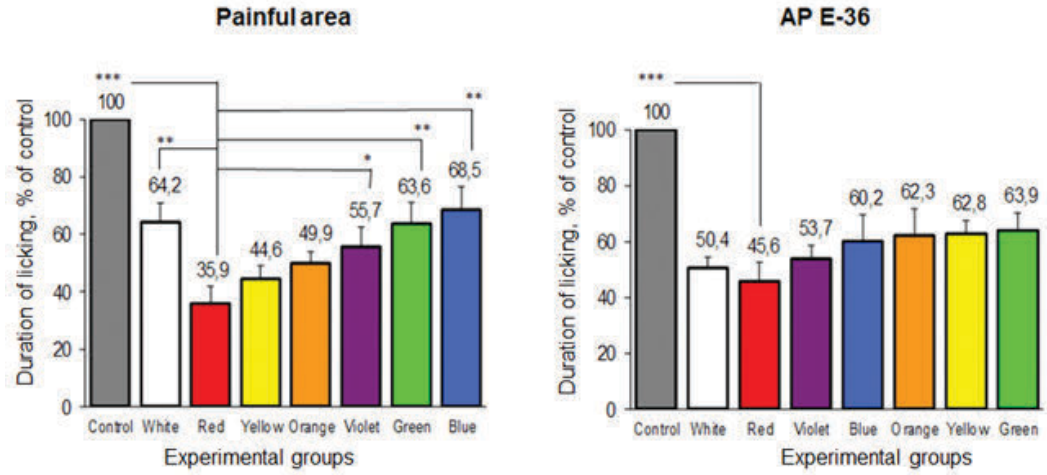

*Fig. 7. Pain reactions in animals after application of different ranges of monochromatic light in comparison with red light: Mean (± SEM) values of licking time (in % of the control value) for 60 min period of observation after exposures of painful area or AP E-36 to light. Significant difference from the red light group: * P <0.05, ** P <0.01, *** P <0.001*

Table 1. Differences between the duration of pain response in the group of mice exposed to the red color and in other experimental groups

Colour	**After 10 minutes application of Bioptron Light**			
	to AP E-36		**to the locus of pain**	
	Licking, s	***t-stud***	***Licking, s***	***t-stud***
Red	429,8±65,8	-	338,2±57,4	-
White	471,3±38,0	0,55	604,7±63,5**	3,11
Orange	587,0±89,6	1,41	470,0±37,4	1,92
Yellow	591,4±44,7	2,03	420,6±41,2	1,17
Green	601,8±60,2	1,93	599,2±70,9**	2,86
Blue	566,9±88,6	1,24	645,1±76,5**	3,21
Violet	549,7±42,7	1,53	524,6±64,2*	2,16

by 50.1-64.1%, while the "cold" colors - only by 31.5-44.3%. These data indicate the leading role of red light in its topical application, and this was confirmed by the clinical experience gained with the use of red light of laser or LED origin.

Statistical significance of the difference between the group where the red light was used and other experimental groups: * - $P < 0.05$; ** - $P < 0.01$.
T-stud - Student test.

Under the influence of colored PL, changes also occurred in non-pain behavioral reactions, in particular, eating behavior and sleep duration (Fig. 8).

Animals that received a 10-minute session of color therapy immediately after creating a locus of pain slept longer than control animals (Fig. 8). If in control animals the duration of sleep averaged 557.3 secs, then in experimental animals it was: after AP E-36 exposure to PL- from 577.9 to 1295.3 secs, and after irradiation of the pain locus - from 757.2 to 1271,2 secs. It should also be noted that their sleep was calmer, without frequent shudders and awakenings, characteristic for the animals of the control group. This indicated a reduction in pain.

Fig. 8 shows that different wavelengths of light significantly altered the feeding behavior of animals. Of the 10 control individuals, only one touched food, and for a very short time. In the experimental groups grew the number of animals taking food (up to 5-7); the duration of their feeding process also increased. The activation of the eating behavior indicated that the pain relieved after the light applications. Let us especially note the role of green color, under the influence of which food consumption increased. This is important for the clinical setting because patients can, through the activation of appetite, more easily compensate the consequences of pathological process.

Discussion

Prior to the beginning of our studies, there was no objective evidence of the effect of colored PL on experimentally induced pain syndromes. The above data are the first to reveal the analgesic effect of the main monochromatic ranges of light, as well as to conduct a comparative quantitative assessment of the effectiveness of polarized light with different wavelengths. In animals that received a single 10-minute exposure to color PL on AP or on the pain locus, according to the data obtained, a decrease in pain response was observed within 10-20 minutes,

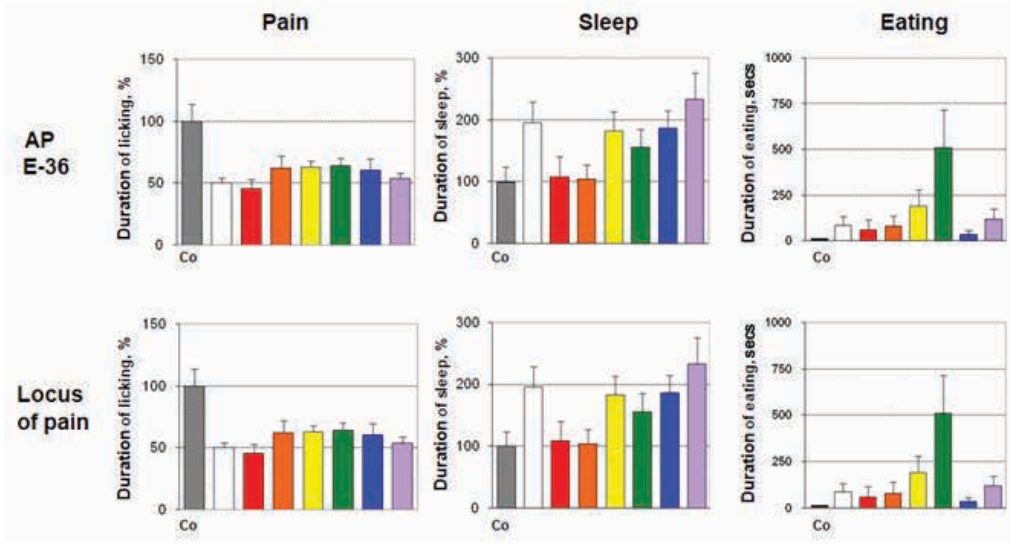

Fig. 8. Comparison of changes in the duration of pain and non-pain behavioral reactions in response to the action of poly- and monochromatic polarized light on the pain locus or AP E-36: Co - data of the control group (pain without light application); The duration of taking food per hour of observation is indicated in secs, the other two reactions are in % of control (taken as 100%).

whereas in the control group, the pain increased during this period of time. In the case of analgesic AP E-36 exposure to all wavelength ranges, we recorded statistical significance of pain relief. If the light was directed right to the locus of pain, a significant analgesic effect was also obtained.

However, for the blue color, despite the shortening of the duration of the pain reaction (up to 645.1±76.5 s), the difference with the control (941.1±130.9 s) did not have statistical significance ($P>0.05$). Perhaps, in this case, the lower power density is of importance, which has arisen due to the attenuating effect of the blue filter. This is confirmed by special measurements: if for most ranges it was recorded within 23.0-51.0 mW/cm2, then for blue, a value of 15.0-16.0 mW/cm2 was obtained.

We drew attention to the fact that when the PL color was applied to the analgesic AP, there were no statistically significant differences between the effects of the use of different wavelength ranges: they all weakened the pain response by 36.1-54.4%. This fact confirms our earlier proposed [34] hypothesis that APs are electromagnetoreceptors. This hypothesis is also supported by experimental data on a high analgesic effect in cases of AP E-36 exposure to PL and in cases of exposure to electromagnetic waves of other frequencies [35-37]. Apparently, AP can be activated by electromagnetic waves of different (including light) ranges, but the final effect is due to the triggering of the brain's own pain-relieving systems, which leads to suppression of the transmission of pain impulses at the neural level. This mechanism has been verified in relation to electroacupuncture [12, 38]. Recent human studies have shown that the PL of the Bioptron device alters the conductivity of AP [39].

If we consider the effect of colored PL on the pain locus, we can see that a statistically significant analgesic effect was obtained for both poly- and for all other monochromatic light variants studied by us, with the exception of blue.

The mechanism of the local analgesic effect of light in the case of its application to the locus of pain differs from the systemic (acupuncture) one. In this case, local changes play the main role. It is known that when applied to the skin, polarized light improves blood and lymph circulation, activates metabolic processes, and accelerates tissue metabolism [40]. This results in an anti-inflammatory effect, which in turn leads to a decrease in tissue edema and pain relief.

On the other hand, recent studies have shown that a decrease in the sensitivity of nerve endings is determined at the locus of exposure to PL [40]. For example, when the skin of the paw of an anesthetized rat was exposed to polarized light, we observed a prolonged inhibition of the background activity in the afferent fibers of the cutaneous nerve, while when this locus was exposed to unpolarized light of the same intensity, biphasic changes occurred [41]. When the synthesis of nitrogen monoxide was blocked, afferent impulses were also suppressed [42].

In our experiments, when PL was exposed directly to the pain locus, warm colors of the spectrum (red, yellow, orange) shortened the pain response by 50.1-64.1%, while cold colors (blue, green, violet) only by 31.5%-44.3%. The differences between the most effective red light and the three colors of the cold spectrum (green, blue, violet) were statistically significant.

Red PL light had more efficient statistical significance than polychromatic PL, although the power density of these two versions of light was the same (45.0 mW/cm2). No significant differences were found between red and two other warm colors of the spectrum (yellow, orange). These data suggest that there are combinations in the skin that provide selective filtering of frequencies in the optical range. It is possible that this selectivity is provided by numerous carotenoids, which have been shown to perform a number of independent biological functions, including spectral filtering [11,43]. Retinylidenes of photoreceptor cells, which

are found not only in the retina of the eye, but also in various tissues, including the skin of animals and humans, can also carry out partial filtering of light waves. Retinylidenes are suggested to include photo signal-driven ion transport, as well as a number of other processes [44].

The greatest analgesic effect of red light is possibly due to the fact that, along with the above mechanisms of action, together with the presence of near infrared radiation, it has a certain warming effect, which increases the blood flow rate, changes the rheological properties (increases fluidity) of blood [45] and creates an additional anti-inflammatory effect. Although the light of the Bioptron device, due to its low (about 40 mW / cm2) intensity, increases the skin temperature at the locus of exposure insignificantly, the thermal effect is undoubtedly present. It is caused by the presence of electromagnetic radiation in polychromatic light with wavelengths corresponding to the red and infrared spectrum.

The results of this work indicate that monochromatic fragments of polarized light have higher therapeutic potential than polychromatic PL [46-47]. This can be explained by the removal of mutual neutralization of the red and blue parts of the spectrum, as a result of which the properties of each isolated range appear more noticeably. This confirms the previously existing empirical experience of using colored light in practical medicine.

Clinical aspect of PL color therapy

Based on the foregoing, the use of specialized treatment regimens (programs) for clinical practice becomes justified. We regard the term "Program" as a specific set of factors, the use of which leads to a clinical outcome. Mandatory use of the main components of the Program supposes: "color + frequency + exposure + localization of the application + number of sessions". Within each Program, variations are created (for example, by color, localization of the application, etc.), specific to the treatment of specific disorders. According to this scheme, we have previously

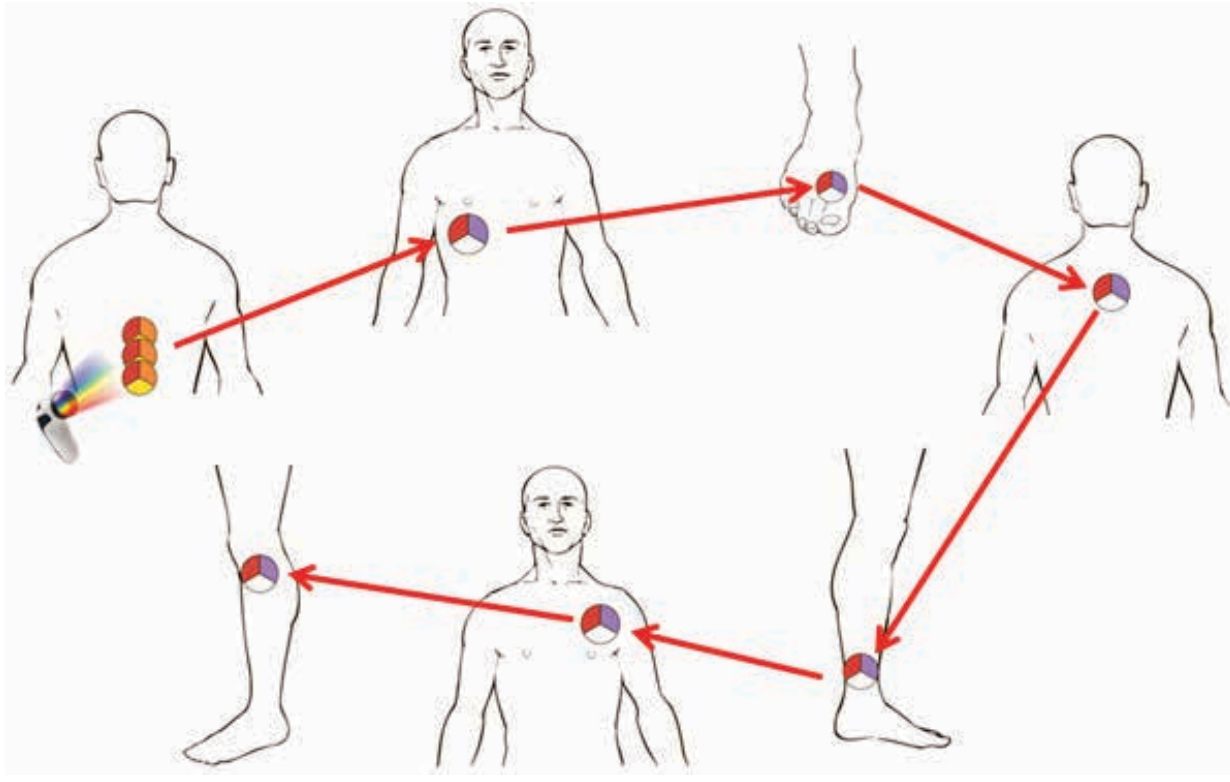

Fig. 9. Treatment scheme for acute intercostal neuralgia [48]: The primary application is aimed at the pain center, the subsequent ones - at the zones of pain irradiation and pain-relieving acupuncture points. One of the indicated colors (red, orange, white, violet) is used, the exposure of each zone is 10 mins. Possible fixation of the effect with drugs containing ethereal oils.

prepared Treatment Programs for the light of the Bioptron, Medolight-Z4L and Medolight-Blu-Doc Z5L-C [48-50] devices. The experience of their application has shown the feasibility of this approach. For doctors working in a narrow specialization, there is considerable scope for professional creativity and accumulation of experience.

Here is one of the schemes according to which clinical experience has been accumulated in relation to Bioptron devices (Fig. 9).

Clinical experience shows that it is problematic to obtain objective data on the severity of pain or the effectiveness of an analgesic factor in humans. The visual analogue scale (VAS pain) is often used [51], although everyone understands that subjective data inherent in a particular patient will be obtained.

Here is a case report on the result of analgesic treatment for a patient with a diagnosis "Shrapnel fracture of the fifth metacarpal bone with displacement." Under local anesthesia, reduction of bone fragments and their fixation with a titanium plate was done. After the operation severe pain syndrome was observed. To relieve pain, the patient received pharmacological analgesia for the first 4 days (dexalgin). Then, instead of a pharmacological analgesic, treatment with red PL (Bioptron device with a red absorption filter of a glass blower origin). The application of light to the locus of pain was impossible due to the immobilizing dressing. Each day, the patient received one 10-minute session of red PL on AP Gl-4 (KheGu). The duration of pain was measured using special computer program, which made it possible to assess pain quantitatively (in seconds for 30 minutes of registration). For 3 days of observation, pain decreased by 48.2% in relation to the control data, as well as a progressive reduction of pain during the first 3 days of color therapy (Fig. 10).

The arsenal of a specialist in physical rehabilitation (physiotherapist) has increased due to the expansion of variations in physical factors (color of light, their frequency and exposure), combined into targeted treatment programs. The creation of such programs, taking into account the diagnoses and the duration of the courses, is a separate large task. However, now we can already predict that the indications for color therapy may include pain syndromes, inflammatory skin disorders, skin manifestations of allergic conditions, cosmetic defects, inflammatory joint disorders, consequences of musculoskeletal system injuries, inflammatory

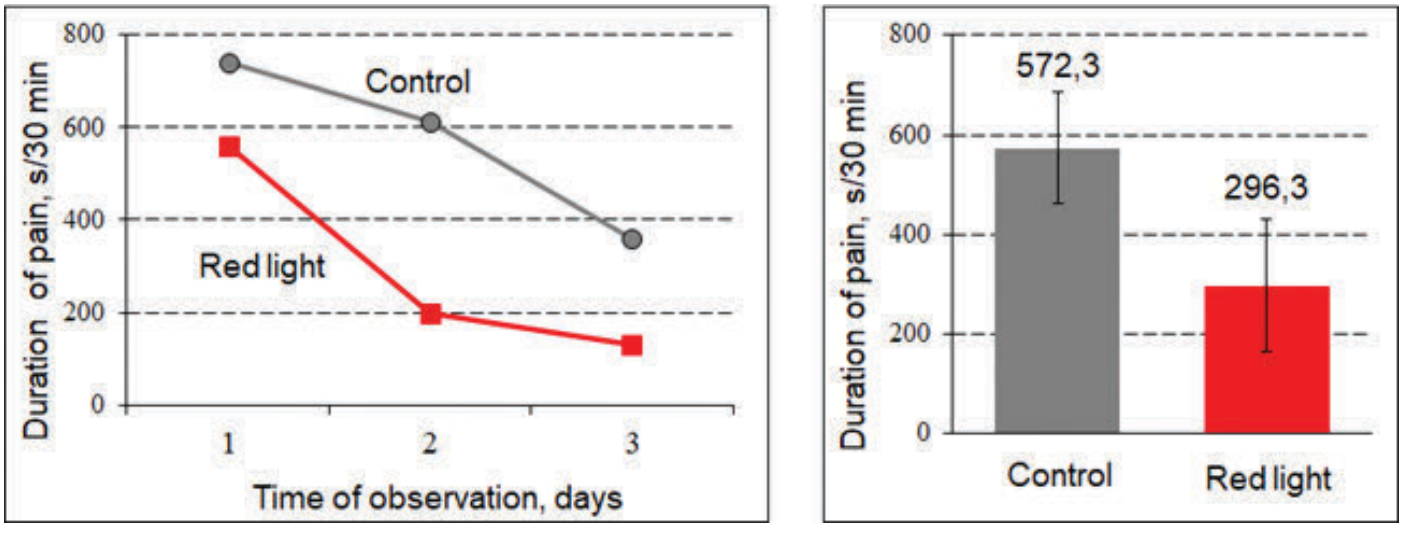

Fig. 10 Influence of red polarized light of the Bioptron device (10-minute application on AP HeGy) on postoperative pain syndrome in patient T .: A - dynamics of the pain process; B - the average values of the duration of pain before and after the session of light therapy.

diseases of the nose, throat, ear and mouth, glaucoma, inflammatory and degenerative eye diseases, stress and depressive conditions, neonatal jaundice, disorders that are traditionally corrected by the polychromatic light of Bioptron devices (wound treatment, immunocorrection, etc.).

Opportunities have appeared for the targeted use of the full palette of PL wavelengths to activate multifunctional zones in order to obtain effects at the level of the whole organism. On the other hand, approaches for the prevention of acute respiratory diseases, including COVID-19, have become popular by using the bactericidal effects of shortwave (blue) and polychromatic ranges of polarized or LED light [50, 52-54]. It is important for clinicians to understand the possibility of using local applications, activating biologically active zones and points (acupuncture), transcutaneous blood photomodification and combinations of these approaches to achieve the optimal therapeutic effect [55].

Conclusions

1. It has been experimentally verified that when using polychromatic PL pain weakened, statistically significant, due to local reactions from the locus of pain and systemic processes triggered through the analgesic APs.
2. We revealed that the factors that significantly enhance the analgesic result of PL therapy are the polarization of light and the presence of the long-wavelength part of visible light.
3. When applying different PL wavelengths to AP E-36, it was noted that all seven colors of the spectrum, as well as polychromatic PL, effectively suppressed pain; analgesia was 36.1-54.4%, and no statistically significant differences were found between the reactions.
4. It has been experimentally proven that APs can respond to each of the main monochromatic ranges of sunlight and receive reactions that can be used for medicinal purposes.
5. When PL is applied to the pain locus in the long-wavelength range (red, yellow, orange), the pain response was shortened by 50.1-64.1%, while the other colors (blue, green, purple) weakened pain only by 31.5-44.3%. The differences between them and the most effective red light are statistically significant. Red light was also more effective than polychromatic PL, and no significant differences were found between red, orange and yellow colors.
6. Clinical observations of human pain before and after the application of PL revealed dynamics similar to those obtained in animals. Analgesia after 3-day application of red light to AP He-Gu in a patient with post-traumatic pain reached 48.2%. We emphasize the efficacy, simplicity and safety of the PL color clinical application.

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Our investigation on melanoma cell lines isolated from the less or highly invasive primary melanomas, as well as from the lung metastases showed that cells are likely to be reprogrammed by hyperpolarized light and the 3HWC substance (hyper-harmonized hydroxylated fullerene), the newly patented fullerene derivative.

Sanja Mijatović, Danijela Maksimović-Ivanić, Đuro Koruga

Mallignant cell REPROGRAMMING

All biological processes, from basic communications at the molecular level to the most complex functions in the body, possess a dual nature. Coherence and inseparability of the phenomena of decomposition and creation, mutually opposed but unbreakable manifestations of cell physiology, are the best illustration of the duality principle. Every day, in our body a number of cells die, and a certain number are born. Perfect coordination of these events makes us healthy, which represents proper interactions within us and between us and the environment. The diseases that are the most difficult to deal with are those resulting from the loss of this balance and are often related to uncontrolled division or uncontrolled death of cells. The most striking example of the former is malignant tumors.

Due to an intensive, uncontrolled cell division that progressively disturbs tissue architecture, and consequently, its function, tumor tissue acquires chaotic behavior, implicating a lack of any strategy in progression. In line with this, the starting points in the treatment of malignant diseases were set up in accordance with the idea of a tumor mass as a random, rather than organized group of highly dividing transformed cells, not taking into account the complexity of intercellular communication in the tumor tissue. In summary, all processes involved in the initiation, development, progression,

and dissemination used to be characterized as random.Abnormal tissue and blood vessel architecture at the later stages of the disease were often used as a proof of this hypothesis.

Starting from the middle of the previous century, a wide spectrum of naturally occurring or synthesized chemotherapeutic agents have been used, whose anti-tumor activity is realized through blockage of cell division and/or activation of programmed cell death as an intrinsic software present in the genome of each cell in the body. The most common form of the programmed cell death they provoke is apoptosis. Since its discovery, apoptosis has been investigated as a main route of elimination of abnormal, intoxicated, or sufficient cells.

What has been overlooked, though, is how dying cells balance events in their environment, transmitting information (signals) crucial for maintaining the tissue homeostasis, and thus the entire organism. In a cascade of biochemical and biophysical events that lead to the disruption of the cell nucleus and cytoplasm, the cell in which this program has been launched activates a number of molecules whose role is more complex than it was believed before. They are not involved in the realization of the death signal only – an apoptotic cell organizes its own removal and takes care of all the consequences that its death will bring to the tissue it belongs to, thus showing altruistic behavior, contrary to its prior egoistic one. Immediately upon the activation of the death program, a cell first organizes both the cleaning of its own residues in advance, and the production of protective molecules preventing further destruction of the surrounding tissue.

Then, owing to the activity of the same enzyme crucial for the last steps in the degradation of genetic material, a dying cell initiates cell division of the neighboring cells to compensate for the loss and to maintain the tissue balance. All these aspects of a cell's social life and its commitment to the whole entity as opposed to its egoistic behavior, were completely neglected when the induction of apoptosis became a key criterion for the selection of effective chemotherapy. The cause of poor efficacy of regular chemotherapeutic protocols in aggressive tumor treatment lies in this cell behavior. While in less aggressive forms the goal of the therapy is to cure, in highly invasive tumors the aim of the treatment is to turn the disease into a chronic state, therefore prolonging life. In these cases, healing, if it occurs at all, is a personal achievement.

What distinguishes invasive/metastatic clones from less aggressive ones, making them resistant to killing-based therapies? It was long believed that genetic changes alone are the cause of malignant transformations and disease progression drivers. Today we know that the presence of genetic abnormalities makes these cells visible to our immune system. The problem arises from the fact that transformed cells look and behave like their healthy equivalents, rendering impossible their recognition as dangerous. This allows their uninterrupted and even supported existence in the tissue, organs, and organism of the host.

With regard to the scientific and technological development in the field of molecular biology, altered cell specificity and its malignant potential can be described using several parameters, ranging from cell morphology to intracellular protein and gene signature. The most fascinating fact connected to the malignant alteration is that this process presents a reverse pathway that the cells passed through in the process of embryonic development, which can be described as particular regression (figure 1).

As far as the cell is altered in its morphology and function typical of the tissue to which it belongs and closer to its embryonic form, its plasticity and freedom in shape, intracellular features, and communication become higher, resulting in an increased power of transformation and the more aggressive phenotype. As the cell maturation from the embryonic to adult tissue is deter-

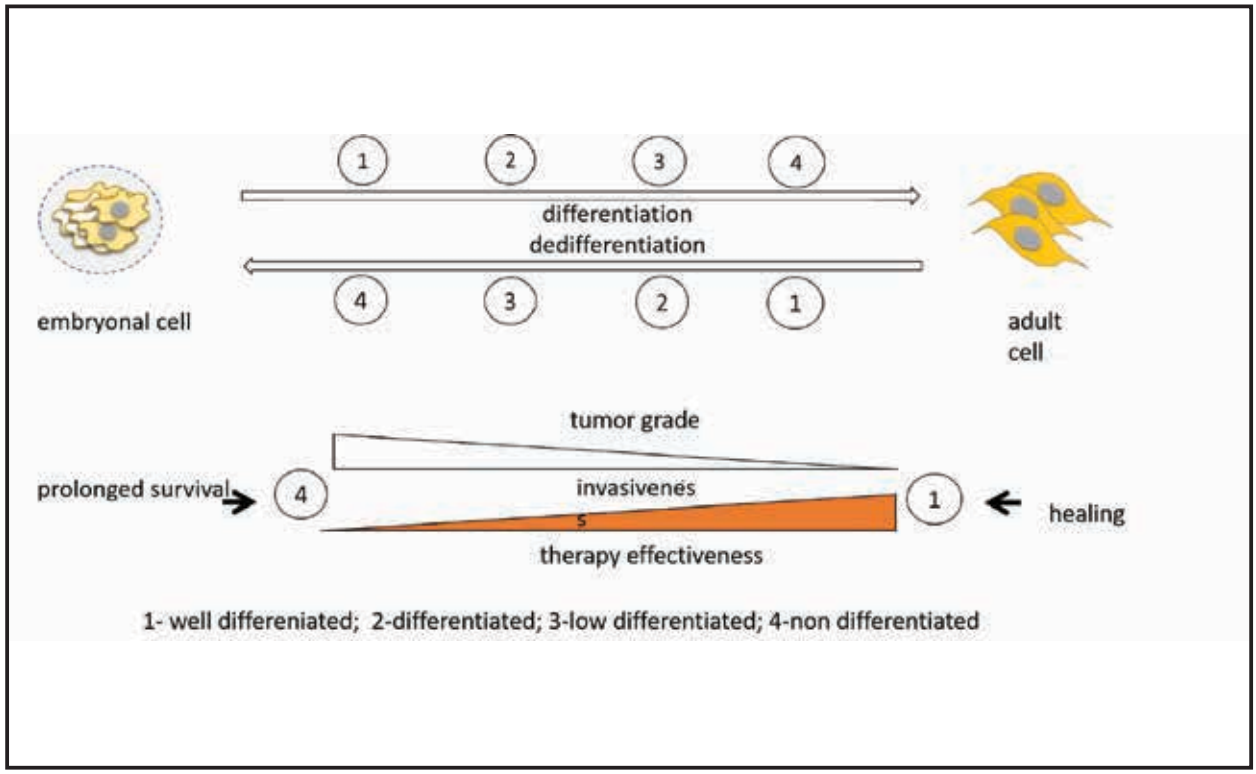


Figure 1

mined by differentiation, the process of malignant transformation is marked as dedifferentiation and serves as a scale for defining the so-called tumor grade in the diagnosis. On that scale, tumors of the lowest grade contain cells that have made minor progress in the process of dedifferentiation and still possess the characteristics of the tissue to which they belong. Their response to therapy is good, and the goal of the treatment is healing. Conversely, high-grade tumors possess undifferentiated cell fraction. These cells are similar to their embryonic ancestors and their morphology and characteristics are far more different from those typical of their home tissue. The presence of low/nondifferentiated cells in the tumor is considered a bad prognostic sign, and the therapy in these cases is tailored with an aim to extend and improve the quality of life, but without healing.

Limited effects of therapy in malignant diseases of highly invasive and metastatic character are still attributed to the initial or acquired resistance of cancer cells to the toxic effects of therapeutics, but also to the fact that the use of these drugs multiply diminish the body power, affecting the healthy cells vitality. Causes of drug resistance are determined by a number of signals and mechanisms developed by the transformed cell to block death pathways, amplify division, and/or remove the drug from the intracellular compartment. To overcome this, protocols that include the combination of drugs with different modes of actions have been established.

Malignant cells have shown a remarkable capacity to overcome such an attack, but not only at an individual level as previously believed, but rather at a collective level, acting as a self-governing multicellular entity with a heterogeneous cell structure, complex intercellular interactions, and indisputably "intelligent" communication with the host organism using their skills for self-progression. More than 40 years ago, scientists noticed a "paradoxical" pattern – radiotherapy potentates the division of cancer cells after a short-term improvement (Figure 2).

Analyses of high-grade tumor tissue samples showed that the presence of cells in apoptosis correlated with a worse outcome. This

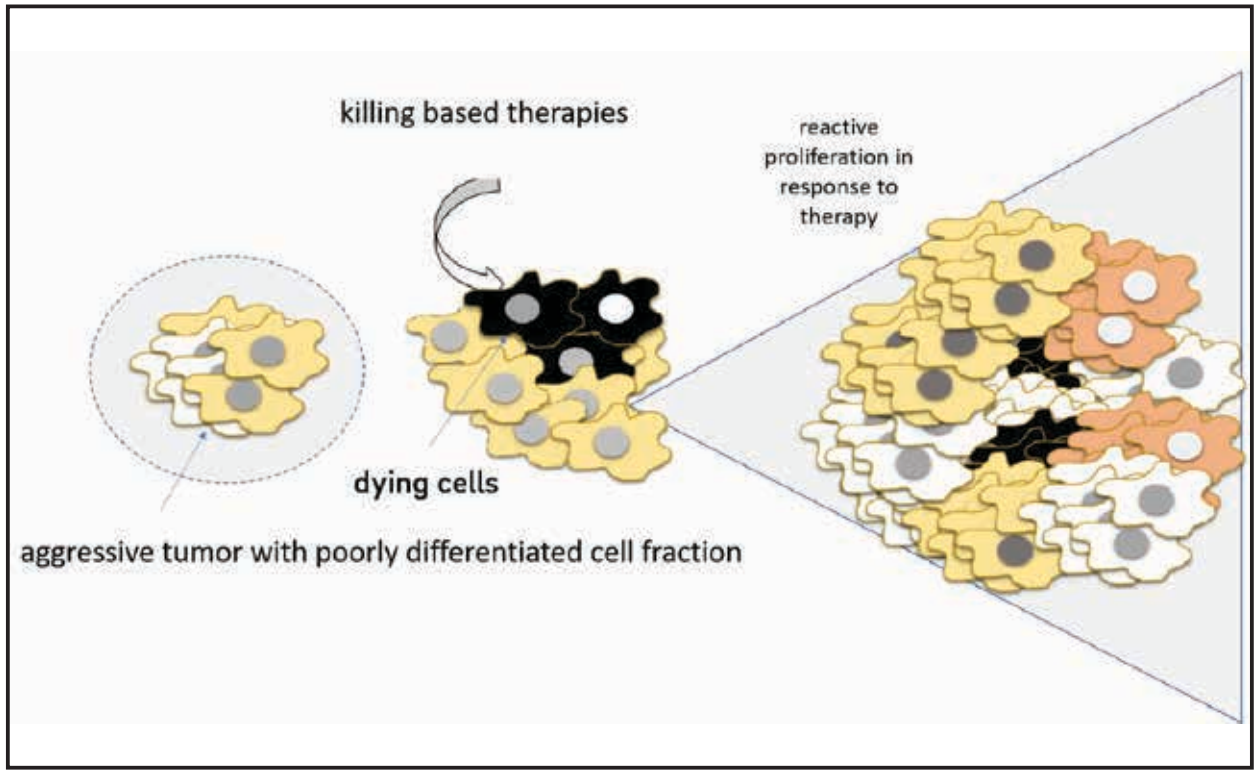


Figure 2

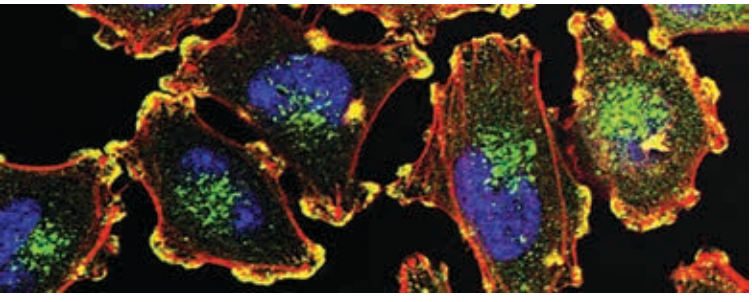
observation opposes the claim that the cause of tumor resistance to therapy lies in immortal cell phenotype. Another almost absurd finding of better survival among patients whose tumors key death program executor molecule caspase 3 didn't express unequivocally points to the fact that aggressive therapy based on cell death induction can initiate more aggressive division of cancer cells and tumor expansion.

This is precisely because of the fact that a malignant tumor is not a simple cluster of clones of transformed cells, but a complex multi-cellular community consisting of heterogeneous cells with clearly defined roles, fascinating plasticity, and complex communication within the commune and, most probably, with distant sites in the body as well, enabling not only their survival, but also dissemination. The intensive cell division often happens upon the exposure to chemo- or radiotherapy and is ascribed to the resistance of the tumor cells to death signals, leaving them to divide unhindered. However, there is a growing amount of data showing that tumor expansion upon therapy represents a reactive response of the tumor tissue to the signals released from the damage site caused by the treatment. It is precisely the aspect that distinguishes high-grade tumors from less aggressive forms, while understanding this distinction should serve as the starting point in setting up a platform that should offer a solution to limiting tumor growth without killing the cells.

How to change the malignant character of the cell? Not by conflict! Aggressiveness almost always promotes more aggression, especially having in mind the fact that the malignant transformation arises from the previously compromised function of certain cells in the tissue. Can we remind these cells about their lineage by forcing them to enter a more mature state similar to that they achieved by embryogenesis? Such reprogramming was seen many times in experimental practice and has been used as an approach in the treatment of some hematological malignancies since the 1980s, yielding remarkable results. The treatment of patients suffering from a therapy resistant form of acute promyelocytic leukemia with cis-retinoic acid led to a complete remission in 95.8% of patients.

A similar approach of inducing cancer cell phenotype conversion into a more differentiated state in the treatment of solid tumors is still disputable. There are sporadic examples of a successful reprogramming of liposarcoma and anaplastic thyroid tumors into less aggressive forms in clinical practice. In preclinical investigations, however, there are numerous examples of inducing cell differentiation in extremely aggressive tumors, such as neuroblastoma, glioma, melanoma, as well as breast, colon, pancreas, and lung cancers upon exposure to naturally occurring or synthetic compounds.

Our investigation on melanoma cell lines isolated from the less or highly invasive primary melanomas, as well as from the lung metastases showed that cells are likely to be reprogrammed by hyperpolarized light and the 3HWC substance (hyper-harmonized hydroxylated fullerene), the newly patented fullerene derivative.
Fullerene is the third pure crystal form of carbon, alongside graphite and diamond.
All three forms belong to the point symmetry crystals, with graphite and diamond crystallizing in 32 crystallographic groups (basic crystallographic aspects replicate into crystal formations of different sizes), and fullerene crystallizes into the icosahedral symmetry formation (a molecular crystal that has only one size). Whereas in graphite and diamond, as in all other crystals in nature, the products of symmetrical elements and their own energies are integers ...-2, -1, 0, 1, 2..., in fullerene (molecule C_{60}), in addition to the integers, there are also non-integer values, like ±1/2(1+Ö5) = ± 1.61803.... ±1/2(1-Ö5) = ± 0.61803. Fullerene was discovered by chance in 1985 by Harold Croto, Robert Kerl, and Richard Smally when they attempted to simulate cosmic dust around carbon-rich red giant stars using laser. They won the Nobel Prize for this discovery in 1996.



Melanoma metastasis (NIC)

The structure of the most famous fullerene, C_{60}, is an icosahedron consisting of 20 hexagons and 12 pentagonal rings joined into a spherical soccer ball-like shape. The number of pentagons is always constant, 12, while the number of hexagons can vary. Thus, the fullerene family consists of different molecules: C_{60}, C_{70}, C_{82} etc.

Accordingly, its structure is always spherical, resembling a cage.

Despite its extraordinary stability, the C_{60} molecule is very reactive, so there are numerous derivatives of this molecule. Functionalization of fullerenes increased their solubility and improved different chemical and physical properties, allowing their application in the treatment of numerous pathological conditions (Figure 3).

To improve solubility, multiple chemical modifications of fullerene have been created, and one of them is based on hydroxyl group addition. This modification results in the formation of water-soluble fullerols. Biological properties of fullerene and fullerol were initially tested jointly by physicists, chemists, biologists, physicians, and biomedical engineering experts more than 15 years ago.

Back in 1993, Wudl and coworkers showed that water-soluble derivatives of fullerene inhibit the activity of HIV protease, an enzyme necessary for the formation of an infective viral particle. Although the mechanism has not been fully clarified, it is speculated that fullerols block HIV protease activity through interaction with an enzyme-binding site.

Another important property of fullerene and its derivatives is the capacity to pre-

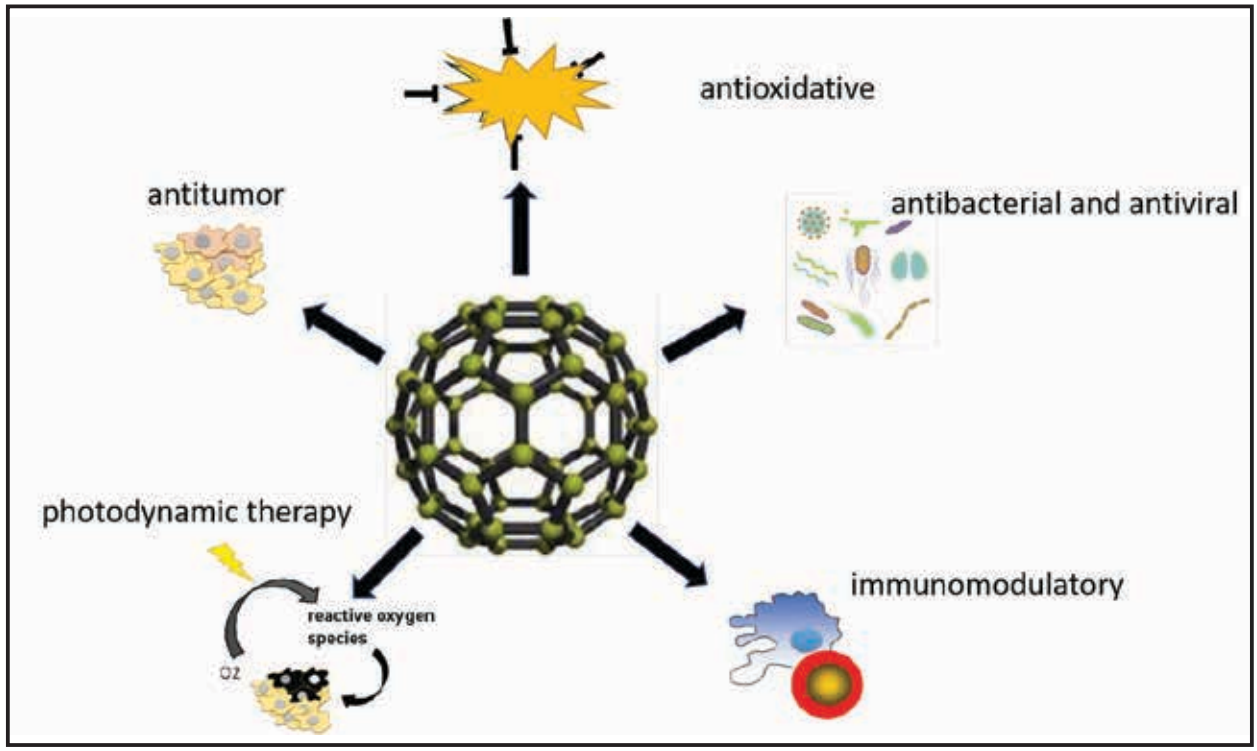


Figure 3

vent the bacteria-host cells contact through interaction with adhesive molecules. There are also a lot of data about their interplay with the immune system and cancer cells. It was found that these nanostructures can suppress the growth of a certain type of cancer cells in experimental conditions, as well as modulate cytotoxic drugs activity even.

Perhaps the most important characteristic of fullerene derivatives is their antioxidant potential. They act as sponges that scavenge free radicals, and consequently protect cells from their toxic effects. Conversely, there are also data showing high levels of oxygen radicals produced by fullerenes after their exposure to light of different wavelengths. In that case, liberated reactive molecules damage the cell membrane, interacting with lipids and proteins. This property serves as the basis in photodynamic therapy, in which fullerene derivatives are used as sensitive substances.

Our research, conducted at the request of the Scientific Board of ZEPTER INTERNATIONAL, led by Prof. Ljubiša Rakić, PhD, full member of Serbian Academy of Sciences and Arts, showed that modified fullerol (3H-WC substance) in interaction with hyperpolarized light (whose angular photon organization is icosahedral symmetry) suppresses the growth of melanoma cells (malignant skin cancer) in laboratory conditions (Figure 4).

Most importantly, the administered treatment was equally effective in cell lines originating from primary tumors of different grades as well as in those originating from metastases. The reduced number of melanoma cells in the culture was not caused by the induction of cell death. In fact, the treatment provokes cell differentiation accompanied by the downregulation of dividing potential and increased production of the pigment melanin. Ultra-structural analyses confirmed the increased number of melanosomes – organelles which produce melanin – but they also revealed a series of changes that indicated a substantial alteration in the cell's metabolic status. Accordingly, a certain number of cells were brought into a state of senescence, or cellular dormancy. Senescent cells remain vital but do not re-

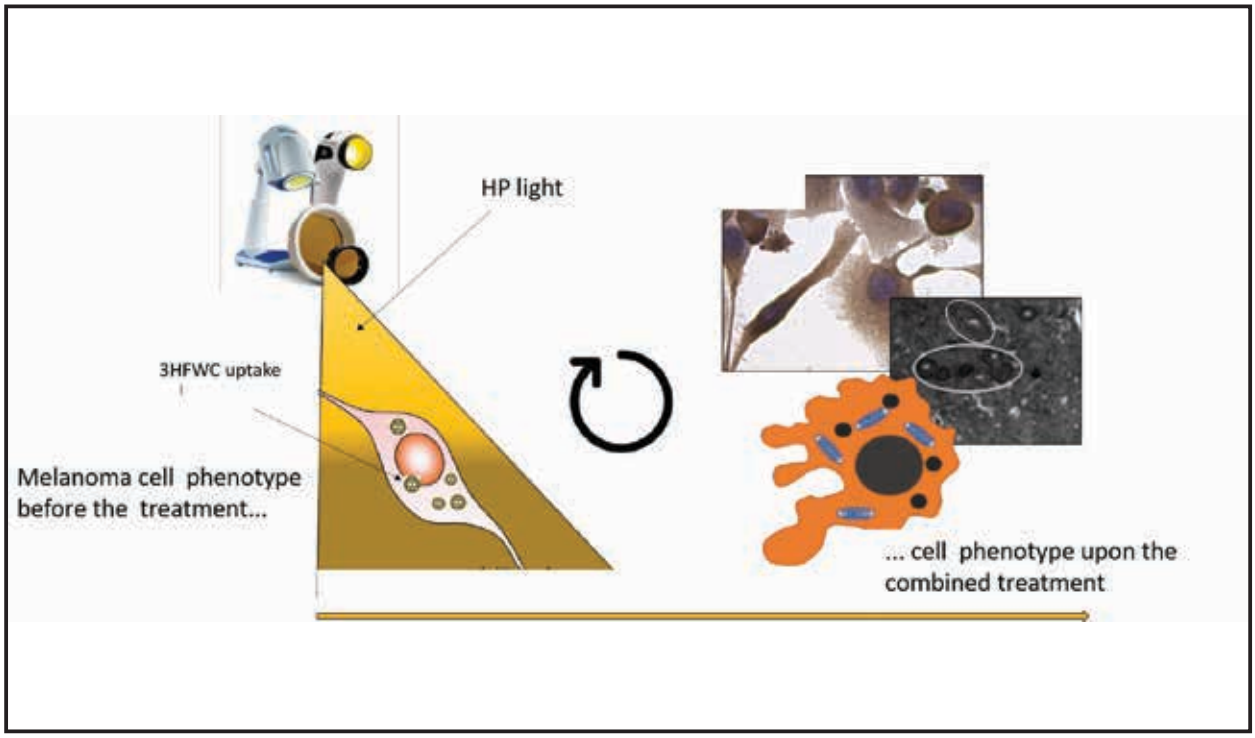
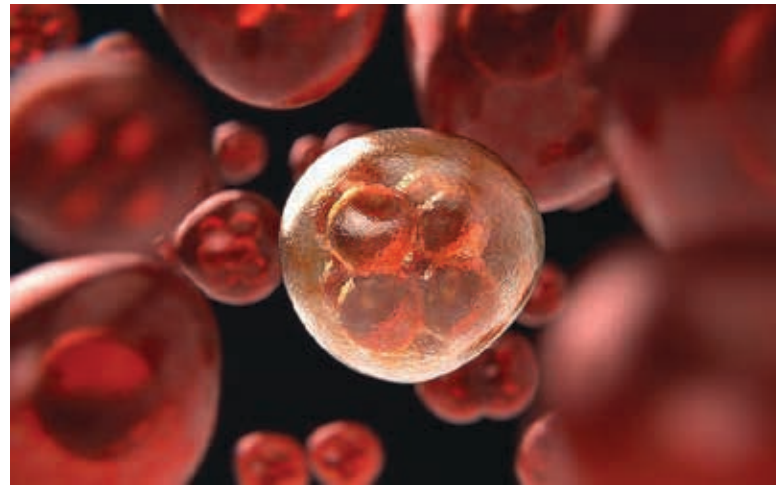


Figure 4

spond to growth and death stimuli and often spontaneously involve. Each of these effects represents a non-aggressive way to abrogate tumor progression, avoiding tumor repopulation in response to the damage triggered by standard treatments. Classical photodynamic therapy is based on photoexcitation of fullerene substances and consequential production of reactive oxygen species leading to cell toxicity. The application of hyperpolarized light in our research presumably favored the antioxidant potential of the 3HWC substance as yet unknown mechanisms of cell reprogram induction and establishment of phenotype close of healthy melanocyte. Quantum hyperpolarized light shows that the order of photons matches the energy structures of our tissue. Hyper-harmonized hydroxylated fullerene tends to harmonize biological processes. Following one of the basic postulates of quantum medicine that a harmonized structure conveys its energy/information to the structure of the broken record, can we expect that the exposure to hyperpolarized light together with hyper-harmonized hydroxylated fullerene could induce the malignant cells reprogramming?

This hypothesis has already a strong anchorage in the preliminary results of our research. According to the basic principle of "theory guides, experiment decides", introduced into science by Faraday, further experiments will continue. They will bring us closer to the secret of the black holes of this disease and to a better understanding of the rules and causes of its destructive potential. However, these are just the first steps on the path ahead of us, which will show whether it is possible to treat a tumor with a non-toxic approach.

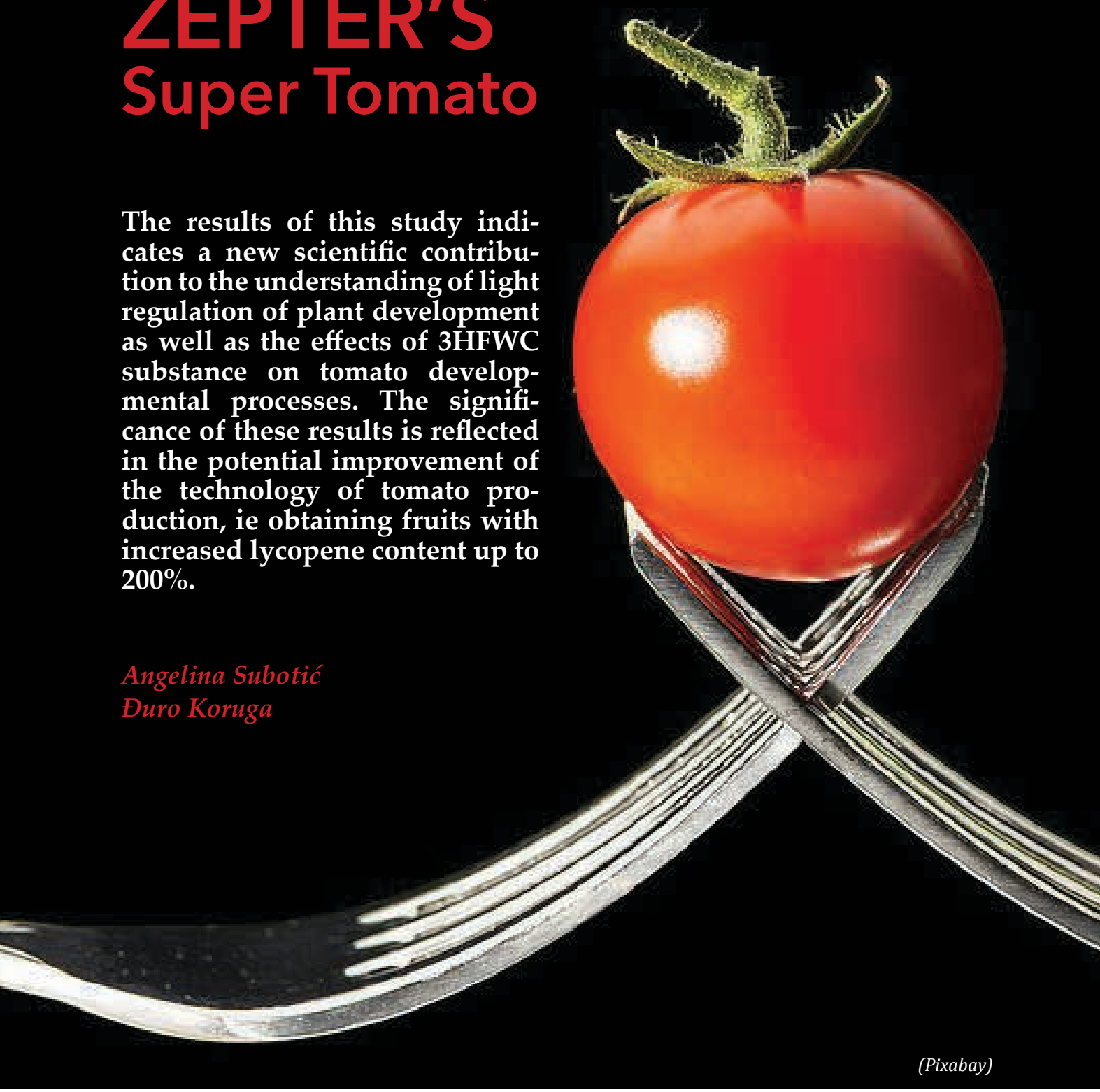


Mallignant cells (Pixabay CC0 1.0)

ZEPTER'S Super Tomato

The results of this study indicates a new scientific contribution to the understanding of light regulation of plant development as well as the effects of 3HFWC substance on tomato developmental processes. The significance of these results is reflected in the potential improvement of the technology of tomato production, ie obtaining fruits with increased lycopene content up to 200%.

Angelina Subotić
Đuro Koruga



(Pixabay)

Nanotechnology and biotechnology are the two most promising scientific fields of this century. Biotechnology studies metabolic and physiological processes of biological systems. These two scientific fields are closely related and play a vital role in the development and application of many useful "tools" in the research of biological systems. Nanotechnology is a modern branch of science and economics that studies the creation, manipulation, and use of small molecule materials. The first postulates of nanotechnology were presented by Richard Feynman back in 1959, who presented the idea of the possibilities to manipulate individual mol-

ecules and atoms. The term nanotechnology was first defined by Professor Norio Taniguchi of Tokyo Science University as "a production technology to get the extra high accuracy and ultrafine dimensions, i.e. the preciseness and fineness on the order of 1 nm (10^{-9} m)."

Since then, the term has been constantly evolving, and it denotes everything from the science of atom and molecule manipulation to the synthesis of new life forms. This branch of science can provide classical, quantum and advanced nanomaterials. The benefits of nanotechnology are connected with the advances in medicine and pharmacology, with the development of new energy and water purification systems, with the development of information technologies, and with food production. Nanotechnology is a relatively new scientific field, and an extensive research is needed to extract from it as much useful knowledge as possible for the benefit of humankind.

Many countries around the world are aware of the potential of nanotechnology in the agricultural sector and are developing programs that would reduce crop production costs and increase yields, protect the environment from overuse of herbicides and/or pesticides, and produce functional foods. The application of nanotechnology in agriculture is very promising, but there is still a huge time distance between discoveries and end products that have commercial significance. One of the most interesting areas of application of nanotechnology in agriculture is the production of nutritionally advanced plants with the improved properties of edible parts. Properties such as the composition of fruits or seeds, their taste, durability, or freshness, constitute output or consumer properties, which are a very interesting and economically important ground for modern nanotechnological manipulations. Nanotechnology, like all other modern technologies, carries many potential risks, problems, controversies, and unknowns.

With regard to biological systems, new insights that nanotechnology offers are expected to cause a shift in relation to the classical approaches to research, primarily in elucidating the phenomena manifested by biomolecules. During evolution, a large number of biological systems, compounds, and processes that function at the molecular and nanometer levels have developed, and their properties still cannot be surpassed by synthetic technologies. Therefore, nanotechnology needs to "learn from nature," that is, to understand the structures and functions of biological systems in order to develop useful nano-quantum-systems ("biomimicry").

Manipulation of matter at the atomic level is an inevitable consequence of continuous progress in the field of research in physics, chemistry, and biology. Biologists are well acquainted with similar mechanisms described by molecular nanotechnology, such as programmed and self-replicating processes, which enable construction with atomic precision. Biology is a definite proof of the existence of nanotechnology, because biological systems, even when macroscopic, are basically nano systems, because the diameter of the basic DNA strand in human chromosomes is only 2 nm. In recent decades, a great deal of research has been devoted to the interaction of plants with nanomaterials (created atom-by-atom) and nanoparticles (shredding existing macroscopic material to nano levels or creating a "bunch of atoms" of the same or different atoms), as well as to the development of a new discipline – phytonanotechnology.

Priorities in this research include the development of intelligent systems that would enable controlled absorption, transport, and accumulation of nanomaterials and/or nanoparticles, an increase in their efficiency in modulating plant growth, development, and metabolism, as well as a reduction of the effects of phytotoxicity. The effects of a large number of nanomaterials and nanoparticles on the development processes in different plant species has been a subject of numerous investigations. Scientific studies have tried to shed light on the ways and pathways of assimilation of nanomaterials and/or nanoparticles, their impact on cell structure, and plant physiology (Figure 1).

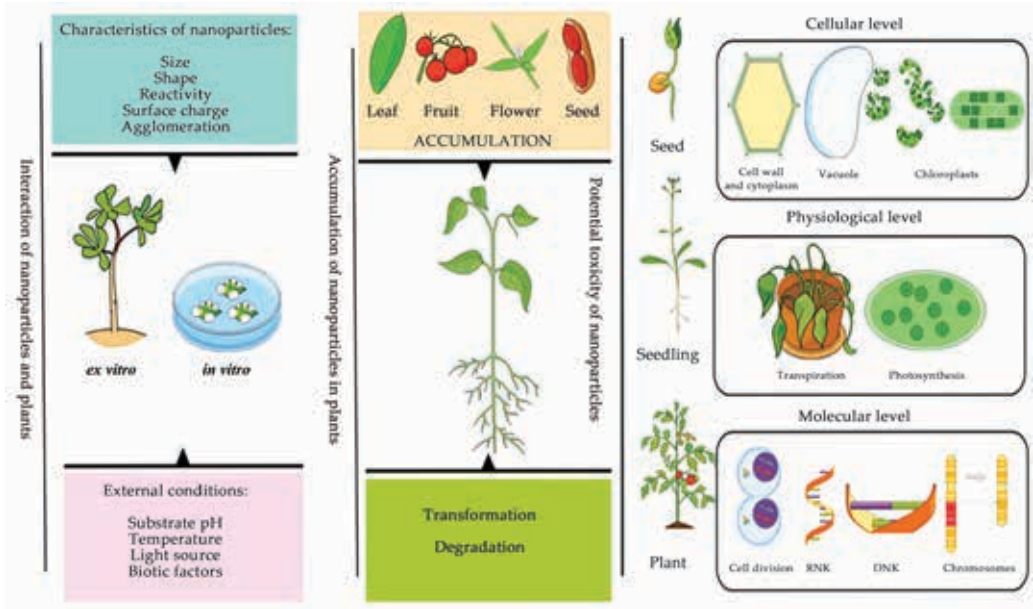


Figure 1. Interaction of nanomaterial (NM) and plant.

A plant cell has a cell wall – a specific barrier that regulates the entry of nanoparticles into the plant organism. This mechanism has not yet been elucidated, but it is known that the entry of nanoparticles into plant cells depends on their physicochemical characteristics, size, shape, and surface charge. A plant can absorb nanoparticles through the root system or through the leaves. Their transport to other plant organs is based on very complex mechanisms that require the formation of complexes with transport proteins of the cell wall or membrane, cytoplasm, and nucleus.

Nanoparticles in the plant organism increase the growth parameters in all stages of plant development. These changes take place at the cellular, physiological, and molecular levels through changes in cell structure, plant transpiration, increased photosynthetic activity, and the production of specific biologically active substances. Plant seeds have built-in instructions in their genetic material for manipulating atoms and molecules. Based on the DNA data, ribosomes are involved in protein production and energy collection, collecting atoms from the local environment, and possibly making more proteins.

A lot of research is focused on the development of "intelligent synthesis", which should enable the positioning of atoms in the right places, thus enabling the creation of biologically active substances with improved properties. We should be cautious about the use of nanoparticles in plant breeding, because if nanoparticles are not compatible with and complementary to biomolecules, i.e. safe to use, then the possibility of side effects increases, which can affect the yield and quality of plant products.

Fullerenes are the third allotrope of carbon, the other two being graphite and diamond, and they belong to the family of carbon clusters. They are made of five- and six-membered carbon rings, with 12 pentagons closing the structure. Their general formula is C_{20} + 2m, where m represents an arbitrary number of hexagons. Fullerene molecules differ in size, i.e., in the number of carbon atoms.

The most famous is certainly the C_{60} molecule, whose structure is composed of 20 hexagons and 12 pentagons with the shape of a truncated polyhedron. This unique molecule, which is built of only one chemical element in the form of a spherical cage, shows the duality of behavior of waves and particles, i.e., it has the properties of both an electromagnetic wave and a particle. Due to its stability and ability to bind and release electrons easily, as well as to its optical properties, it is widely used in various scientific disciplines.

Of the newer nanomaterials, it is important to mention fullerols, polyhydroxylated soluble

derivatives of fullerene, that have antioxidant, catalytic, toxic, and antitoxic properties. These molecules are very interesting for scientists because of their photoactivity. Fullerols are known as powerful antioxidants due to their ability to "scavenge" free radicals. In the last decade, there have been a number of scientific studies describing the effects of fullerols on the processes of plant growth and development. Some of these studies have shown both negative and positive effects on plant development. In onion plants, fullerol caused cell damage, but in Arabidopsis it stimulated the growth of seedlings by as much as 40%. It is assumed that its beneficial effect on the increase of biomass and metabolites in plants is related to the antioxidant properties of this molecule. There are data that fullerols have a positive effect on the germination of tomato seeds because they stimulate faster water absorption and accelerate the transport of nutrients, which results in an increase in plant biomass. There are currently no data on the possible mechanisms of the influence of water-soluble fullerol on physiological and biochemical processes in plants.

The tomato (*Solanum lycopersicum L.*) is one of the most widespread vegetable crops that is consumed around the world both fresh and processed. This plant species is of great importance in human nutrition and is believed to have positive effects on health. Tomato fruit is rich in dietary fibers, which are mostly found in the epidermal cell walls and include indigestible carbohydrates and lignin. Dietary fibers can be water-soluble, such as pectins, β-glucans and galactomannans; indigestible oligosaccharides, such as inulin; or water-insoluble, such as cellulose, hemicellulose and lignin. All these fibers have different roles in disease prevention.

Insoluble fibers regulate bowel function and water absorption. Soluble fibers, which form solutions, can influence the regulation of blood glucose levels after eating by reducing digestibility and absorption of carbohydrates with a high glycemic index. In addition, soluble fibers have the effect of reducing the levels of total and LDL cholesterol in the blood. Therefore, dietary fibers can reduce the risk of many chronic diseases, including cardiovascular disease, obesity, diabetes, and various types of cancer. Dietary fibers are carriers of other biologically active substances as well, such as vitamins, carotenoids, and polyphenols. Fibers isolated from the tomato skin are rich in antioxidants, of which lycopene is dominant, as well as minerals, such as potassium, magnesium, and calcium, while having a low content of sodium, iron, and zinc. This sodium-to-potassium ratio makes tomato a very important food that has a protective effect in preventing cardiovascular diseases.

Fresh fruits, as well as tomato-based foods are rich in vitamins A, C, and E. In addition to the nutrients mentioned above, the tomato also contains various molecules of primary and secondary metabolism, carotenoids, and phenolic compounds, which are effective natural antioxidants. Lycopene is a plant pigment that gives fruits and vegetables a red color. The most important sources of lycopene are the tomato and watermelon. Since lycopene is a lipophilic compound, a higher percentage of lycopene is found in tomatoes thermally processed in oil (ketchup, tomato sauce) than in fresh fruits. The strong red color of lycopene protects tomatoes from aggressive UV rays. The recommended daily intake of lycopene has not yet been precisely established, but many studies recommend at least 3–6 mg per day in order to achieve optimal positive effects on human health.

It is very difficult, however, for the body to get the required amount of lycopene from food. In modern living conditions, most people do not consume enough fresh fruits and vegetables, so their body lacks necessary antioxidants. Because of this, people who do not take enough lycopene through their diet are recommended to increase their daily intake with dietary products that contain lycopene. Today, there are many clinical studies that have proven that high daily intake of lycopene provides protection against various types of diseases. Due to its lipophilic character, lycopene tends to settle in tissues, primarily in the prostate, liver, and adrenal glands. By increasing lycopene levels in tissues, oxidative damage to biolog-

ical systems is reduced, including damage to cell membranes and other structures, such as DNA molecules, lipids, and proteins. Free radicals damage these cellular structures and molecules.

Free radicals originate from various pollutants, solar and ionizing radiation, some drugs, tobacco smoke, stress, and/or big physical effort. Also, the body itself produces free radicals in the metabolism of fatty substances, as well as part of the normal immune response. Lycopene and other antioxidants bind free radicals and neutralize their harmful effects, preventing tissue damage. Many studies indicate that lycopene is the most powerful "scavenger" of free radicals among carotenoids. Increased levels of lycopene in adipose tissue cells contribute to the improvement of the overall antioxidant status of the whole body, which is very important for reducing the risk of heart attack, cancer, and other diseases.

Lycopene greatly reduces the harmful effects of UV radiation on the skin because it helps protect the skin from both short-term harmful effects (redness, erythema) and long-term ones (skin cancer). Beta-carotene is often used in combination with lycopene as an oral sunscreen. Vitamins E and C, in synergy with lycopene and beta-carotene, contribute to preserving the vitality, elasticity and natural freshness of the skin. There is a growing body of research worldwide that shows that a diet rich in vegetables, or an increased intake of plant antioxidants, such as carotenoids, reduces many risks of cardiovascular disease, cancer, and other disorders related to aging.

Antioxidants are molecules that can successfully remove prooxidants while creating products that are non-toxic and non-damaging to the cells. Antioxidants protect the body from prooxidative action in several ways: by inhibiting the formation of free radicals, reducing the oxidative capacity of prooxidants, and inhibiting oxidative enzymes. Therefore, the function of antioxidants is to neutralize free radicals and protect cells from their toxic effects, thus preventing the appearance and development of diseases related to oxidative stress. Antioxidants are produced in the cell or are taken into the body through food or supplements. They work by preventing the formation of new free radicals in the body, destroying the radicals already created in the body (as "scavengers"), or repairing damage to the cell caused by their action.

According to their composition, antioxidants are divided into enzymes that repair DNA and protein molecules, proteins (ferritin, albumin, transferrin, lactoferrin), or small molecules (vitamin E, carotenoids, vitamin C, glutathione, alpha-lipoic acid, ubiquinone, flavonoids) damaged by free radicals. According to their mode of action, antioxidants can be divided into primary, secondary, and tertiary antioxidants. Primary antioxidants are also preventive, because they prevent the formation of free radicals (albumin, transferrin). Secondary antioxidants (scavengers) remove the free radicals that have already been formed (superoxide dismutase, catalase, glutathione peroxidase, glutathione, vitamin C, vitamin E, carotenoids, flavonoids). Tertiary antioxidants (enzymes) repair the damage or remove the biomolecules damaged by radicals before their accumulation causes new damage (phospholipases, proteases, peptidases, DNA polymerases).

Antioxidant activity depends on many factors, the most important of which are bioavailability, oxidative potential, the rate of reaction with free radicals, stability, and low reactivity of the resulting antioxidant/free radical derivative. Antioxidants from food are defined as molecules that can "cleanse" free radicals and stop the chain reactions they cause. Due to the fact that the antioxidant components of some plant species are used in human nutrition, there is a growing trend all over the world to produce functional foods. Functional food is any whole, enhanced, enriched, or improved food that, in addition to satisfying energy needs and the intake of necessary nutrients (for example, vitamins and minerals), provides prevention from nutrition-related diseases, also improving physical fitness and mental health of individuals. Given that lycopene is the main ingredient of the tomato fruit that has a functional effect, it would be significant to improve

its synthesis by applying modern methods of nanobiotechnology.

Researchers from the Institute for Biological Research had a great pleasure to conduct a scientific study funded by the "ZEPTER INTERNATIONAL LLC" company with the aim of investigating the effects that three types of light in combination with 3HFWC substance based on furellol and aqueous layers strong hydrogens bonds (patent PCT/EP2019/083307) exert on the growth and development of tomato plants (Figure 2).

The results of this study indicate a new scientific contribution to the understanding of light regulation in plant development, as well as the effects of 3HFWC substance on the tomato developmental processes. The significance of these results involves a potential improvement of the tomato production technology, i.e., in obtaining fruits with increased lycopene content up to 200%. The results of our study have shown that the exposure of tomato plants to sources of polarized and hyperpolarized light, individually or in interaction with the 3HFWC substance, led to significant changes in their growth, development, and metabolism.

The responses of tomato plants to these treatments differed depending on the ontogenetic phase of the development. In the seedling development phase, biomass increase is successfully stimulated by polarized and hyperpolarized light sources in the presence of 3HFWC substance. There were also physiological changes in seedlings, which included the increase in the synthesis of the photosynthetic pigment chlorophyll. A significant increase in biomass production was achieved by controlled exposure of tomato plants to sources of polarized and hyperpolarized light, either individually or in the presence of 3HFWC substance.

The applied treatments were equally effective in stimulating flower formation. The greatest contribution of this study is that it indicates that the use of hyper-harmonized light and 3HFWC substance can induce an increase in lycopene synthesis in fruits. These results undoubtedly confirm the enormous potential of the newly synthesized 3HFWC nanosubstance produced at TFT Nano Center (ZEPTER GROUP) for improving the nutritional value of tomato fruits and creating a new functional food product.

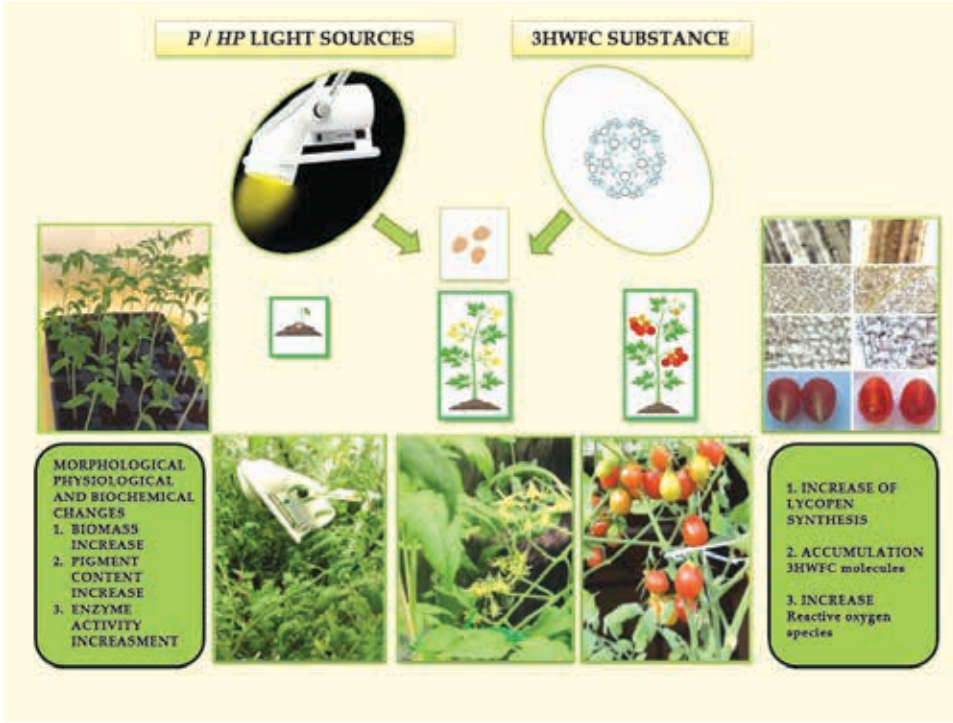


Figure 2. Effects of three types of light and 3HFWC substance on the tomato growth (38 - 71 %) and fruit development (120-200%)

QUANTUM COSMETICS
Revolution in skin care

(Pixabay)

The point of view of quantum cosmetics approaches beauty by respecting the classical and adding a new dimension to it – a sublime experience. Quantum cosmetic harmonizes the condition of the skin with the essence of existence, the quantum states of our body. Quantum products act on the nano-quantum level on the skin, not only energetically, in the classical way, but also energetically-informationally, in the quantum way.

Zorana Jović

Conventional medicine, as well as modern methods of care and preservation of health and beauty, focus on treating the symptoms of the disease, i.e., they treat the consequences of changes at the level of organs and organ systems. Such an approach often does not give satisfactory results, because it does not affect the cause of changes, since the cause is mostly unknown and invisible for modern medicine and cosmetology because the phenomenon of life is still a "wrapped entanglement" for us. From ancient times to the present day, we have looked at beauty only in the classical way. It is observed from the angle of visual experience of an object or a work of art. Cosmetic products were in the function of visual beauty of the face or body and the products served primarily to alleviate damage, cover up imperfections or highlight parts of the body to look more beautiful.

We know for sure that the changes that can grow into diseases occur in cells or molecules and that they should be the goal when it comes to care, rejuvenation, and treatment of the body. The quantum states of the basic elements of our organism and their connection with the classical states is a "wrapped entanglement" that we must first unpack and only then can we engage in it. When it comes to the human body, the epidermis of the skin is the "wrapper" and the basement membrane is both a classical and quantum entity. That is why the skin is a biophysical and spiritual mirror of the organism, just as water is a mirror of the sky and earth. The point of view of quantum cosmetics, designed and produced by the Zepter company, approaches beauty by respecting the classical and adding a new dimension to it – a sublime experience. Quantum cosmetic harmonizes the condition of the skin with the essence of existence, the quantum states of our body. Quantum products act on the nano-quantum level on the skin, not only energetically, in the classical way, but also energetically-informationally, in the quantum way. This phenomenon of a synergistic effect of classical and quantum is called the fractal effect and it is established in the body during embryogenesis.

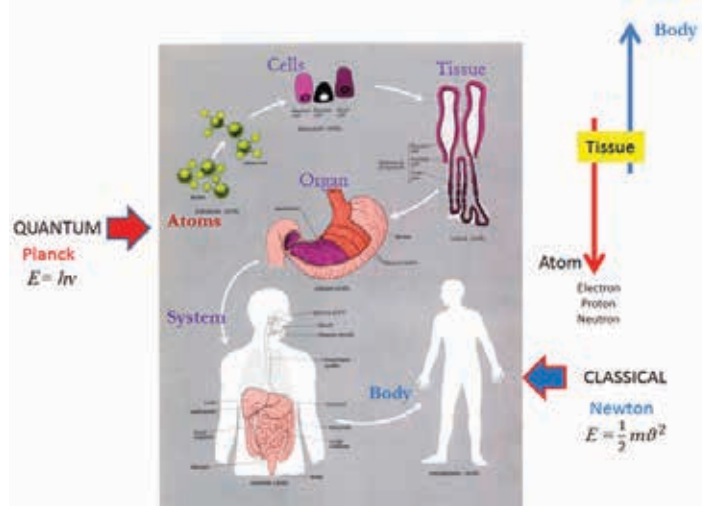


Figure 1: Today's vision of the human body as a classical and quantum system. However, it is a quantum-classical system with a dominant quantum core (atoms and molecules), quantum-classical (cells and tissues) and classical (organs and body)(Adapt from Tortora, G.T., and Anagnostakos, N. P., Principles of Anatomy and Physiology, Harper & Row Pub., Cambridge, 1981)

Why is skin so important? The answer is surprisingly simple but the principle of action is extremely powerful. Our body is formed from one fertilized egg, which is the basic quantum and classical information entity. It divides by creating new cells so that the informational genetic content remains in the nucleus of each cell (the principle of self-identity), and the cytoplasm and membranes specialize in building each tissue of which organs are composed. This process, known as embryogenesis, is multifractal – one of the three keys that unlock the door that leads to the secret functioning of the body ("wrapped entanglements") and our experience of the beautiful and the sublime. The second key is the quantum-classical information process of our body. As mentioned, the human body, like all matter in the environment, is made up of atoms and molecules that are predominantly quantum in nature. Tissues and organs, such as skin, are made up of water, biomolecules, and cells in which quantum effects are dominant and classical are secondary. The third key is awareness that the skin has a dual character according to its embryological origin,

its epidermis originates from the ectoderm (from which the brain or neurons originate – primarily information structures), and the dermis originates from the mesoderm (from which smooth muscle tissue is formed – primarily energy structures). All organs that have epithelial tissues, especially the skin, have synergistic classical-quantum properties. The skin has another special role in relation to the epithelial tissues of internal organs: it protects the organism from harmful effects of the environment and represents the boundary layer between the organism and the environment.

It is believed that life is built from carbon (about 24%), which allows numerous combinations of molecules, that hydrogen and oxygen make up about 74% of our body, and all other elements (nitrogen, phosphorus, sulfur, etc.) make up 2%. The origin of these two elements, hydrogen and oxygen, is different: hydrogen is the result of the state and action of the entire Universe, while oxygen is created locally in the stars. In other words, we as beings are cosmic and stellar from the quantum aspect, and earthly from the classical aspect. Since the water molecule is made up of two hydrogen atoms and one oxygen atom, and makes up about 70% of our body, we can say that Thales (an ancient philosopher, who lived 500 years BC) was right when he said that water (its principle) is the basis of everything that exists (everything originated from the vacuum of the Universe, as hydrogen and helium and later in the development of the Universe from atoms formed in the stars).

One of the most important components of the skin, as well as the whole organism, which enables the normal course of metabolic processes, functioning of the barrier and the preservation of the youthful appearance of the skin, is water. Water is an exception in nature, because it is characterized by properties different from most matter; therefore, we say that it has about 40 "anomalies". For example, while most matter shrinks when cooled, water expands, and so on.

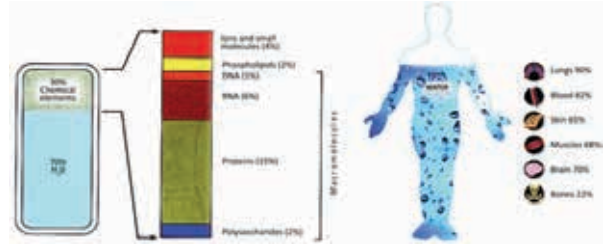


Figure 2: Percentage of water in the cell and individual tissues of the human body (Adapted from Pollak, G. H., et al., Water and Cell, Springer, Dodercht, 2006)

The reason for this is molecular reorganization in water, whereby the main structural network is formed by non-covalent hydrogen bonds. The power of reorganization of hydrogen bonds is best manifested by water pipes bursting in the winter. In the human body, 40 percent of water is in free state, and 60 percent is bound to biomolecules. The water in our body is different from water in the external environment. In the biological environment, where there are intense and strong electrical discharges and the temperature is around 37°C, water changes from liquid state to a slightly viscoelastic state, i.e. it is in the form of a liquid crystal. Thanks to the presence of non-covalent hydrogen bonds, water molecules undergo a process of self-ionization and self-organization into stable, short-lived water clusters.

Water is not only an environment in which biochemical and biophysical processes take place, but it actively participates in them: its elements (atoms, ions, molecules) have paramagnetic or diamagnetic properties. A molecule of water in vacuum is diamagnetic, but one mole of water can be paramagnetic at one moment and diamagnetic at the next. It depends on the interaction and organization of water into clusters, i.e. on the number of paired and unpaired electrons. The change of states between paramagnetic and diamagnetic ones occurs at 14s and 28s, although the time of interaction between free water molecules is 50 fs. In other words, water "breathes": the shift frequency of paramagnetism/diamagnetism occurs at 14 and 28 seconds, when organized into clusters. These clusters are very similar to the layers of water that surround biomolecules in

living organisms. Aqueous layers transmit vibrations to surrounding molecules and affect the conformational state of proteins, lipid layers of the corneal layer and other structures. Like light, water has a wave property and can therefore, under certain conditions, cause the soliton effect. A soliton is a wave that, under certain conditions, is formed as a result of dispersion (propagation of waves of different wavelengths at different speeds) and non-linearity (change in amplitude intensity) creating constant localized shapes, which move at a constant speed. This phenomenon allows information to be stored for a long period of time and to be transmitted over long distances. The soliton effect occurs on some rivers, in the depths of the sea or in the atmosphere, and it can be used to explain signal transmission in neurons.

Nobel laureate Linus Pauling (1901–1994) noticed the importance of hydrogen bonds for proper functioning of biological systems in 1939. According to two-time Nobel Prize winner Linus Pauling, the hydrogen bonds and the network they form are the basis for the functioning of a living organism, more important even than individual organs such as the heart, brain, lungs, etc. Hydrogen bonds participate in maintaining the conformational structure of biomolecules (spatial arrangement of molecules), which enables the functioning of molecules such as water, proteins, DNA and others. Any change in the strength of the bond or its termination causes a change that can be an integral part of the regulatory mechanism, i.e., if the bond breakage is abrupt, a breach of the functionality of molecules and disorders of metabolic processes occurs.

The specific three-dimensional structure of molecules enables access to receptors, binding water and enzymes and other processes necessary for its normal functioning, and thus, for the organism as a whole. When the basic conformational structure is disrupted, receptors are not available and cannot be found by signaling molecules, enzymes or water, so the biomolecule loses its function and becomes inactive, and often a ballast that the body must release. How do these structures return to their original, normal state? Aid comes from structural or energy oscillators that generate oscillatory processes of hydrogen bonds, which constantly and correctly oscillate and thus transmit signals (information and energy) to the molecule they act on and gradually force it to return to its original state. Constant jiggling and wiggling of oxygen and hydrogen atoms, i.e. nitrogen and hydrogen that create this bond, performs gradual, fine conformational corrections of the structure, enables the process of biomolecule regeneration and establishes harmonized relations in the environment.

Until 1999, it was considered that the hydrogen bond was only of the Coulomb type (classical), but 20 years ago it was experimentally proven that the hydrogen bond has both classical and quantum properties. However, it has been shown experimentally that the anisotropy of the charge and the momentum of the electron agree better with the experiment when the process is described by the quantum Schrödinger equation than by the classical Coulomb equation. The experiment showed that the quantum state of the hydrogen bond, at the same time, has two dominant values, 0.161nm and 0.272nm in length, around which the oscillatory process takes place. How is that possible? In the classical situation it is impossible, but in quantum reality it is one of the basic properties. Similar to the ace in the game of Tablanet – it is both "1" and "11" at the same time, and which value of these two will it really have will depend on the conditions (which cards are still on the table): the value that suits best at a given moment will be chosen. Such is the case with the whole quantum nature of our reality!

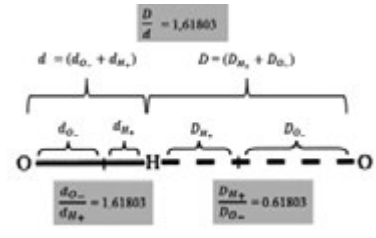


Figure 3: Harmonized ratio of oxygen and hydrogen charges in covalent (solid line) and non-covalent (dashed line) hydrogen bonds (Koruga, Hyperpolarized light, Zepter Book World, Belgrade, 2018)

The redistribution of charges in the O ... H bond and between donor atoms (O and/or N) leads to this phenomenon: a pair of pairs occurs (logical square), the basis of quantum superposition, and the Fibonacci relation is realized as ± 1.618 and ± 0.618. Namely, in hydrogen bonds, both Fibonacci values exist at the same time: if the action (product: forces, displacements and time of action) is equal to or close to the Planck constant ($h=6.626\times10^{-34}$ Js), then the Fibonacci process is quantum in nature. If we denote the distance O ... H of the noncovalent bond with x, and the distance of the covalent bond O-H between the oxygen and hydrogen atoms by 1 (unit value, whatever it may be), then due to the dynamics of the charge the system oscillates and the hydrogen non-covalent bond on a covalent hydrogen bond oscillates according to Fibonacci law.

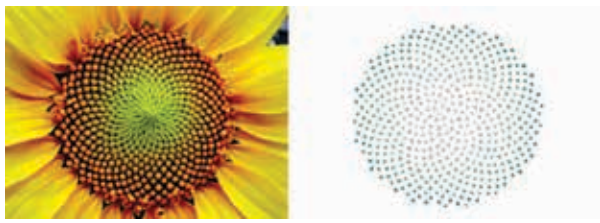


Figure 4: Organization of a sunflower according to Fibonacci law (above) and the law of the oscillatory process of water molecules under the influence of an oscillatory magnetic field which generates hyperpolarized light (Koruga, Hyperpolarized light, Zepter Book World, Belgrade, 2018)

We still do not perceive the mentioned changes and processes in biological organisms in the right way. Although they are the basis for the occurrence of deformities and diseases, modern medicine, care and health prevention are still only based on the treatment of consequences at the level of organs or tissues. Knowing the real cause is still far from us, but new devices and methods are gradually being introduced that enable access and insight into the state of the body at the level of interaction of atoms and molecules, which gives the possibility for appropriate treatment. However, in order to influence these basic processes, which can cause changes and eliminate the disease, we must have the appropriate means to act. And there is room for new solutions. Such means exist in nature, they just need to be discovered and adapted to our needs, and some are created in laboratories. Before their application in the field of medicine and cosmetology, detailed safety and efficacy tests are performed and the optimal doses are estimated.

The C_{60} molecule – fullerene – is found in nature, but is very rare. It is assumed to originate from some stars and can be found in cosmic dust, some rocks, and even in the flame of a candle. Fullerene is the largest object in nature, measuring 1 nm (billionth of a meter, 10^{-9}), which still has a dual property: the classical-quantum property. This molecule rotates a billion times per second and has 46 different vibrational states, making it an ideal candidate for jiggling and wiggling of atoms. The C_{60} fullerene (the Buckminster fullerene, or buckyball) exhibits both classical and quantum properties, which was experimentally confirmed in 1999 by the Vienna Research Group led by Prof. Zeilinger, which allow it to behave both as a De Broglie wave and as a particle. It acts on the skin in two ways: the classical way, by transferring energy (bringing the process into equilibrium) and quantum, through the wave function, energy-informational (bringing the constituents of the process into a harmonized state). In the human body, quantum properties dominate at the level of atoms, molecules and tissues (about 90%, 80%, or 60%, respectively), and classical properties dominate at the level of organs (skin) and the whole organism (about 60%, or 90 %). Due to the incredibly fast rotation of C_{60} molecules ($\sim18\times10^{9}s^{-1}$), the 12 pentagons and 20 hexagons of which it is composed change position in space producing four quantum superimposed paramagnetic and diamagnetic states. Four quantum states in a large number of molecules give a multitude of combinations for interaction in the cellular and extracellular space. This structure is one of the most perfect forms found in nature, and it has special energy properties. In an aquatic environment, in biological systems, the Buckminsterfullerene indirectly acts on

distant molecules through this soliton effect. The collagen molecule returns to its original equilibrium state, and then through hydrogen bonds, with the help of soliton, it harmonizes the intercellular space and sends a signal to fibroblasts to synthesize more collagen, if this molecule is not present in sufficient quantities at a given time and in a certain space.

Thanks to its unique structure and special energy properties, fullerene finds various applications in medicine. Due to the insolubility in water and polar solvents, which limit its application, the so-called functionalized fullerenes, formed by the addition of hydroxyl groups (OH) to the surface of the sphere. These modifications increase the solubility and give significantly improved toxicological characteristics. They are tested for use in drugs, diagnostic agents, antioxidants, etc. Its use in cosmetics is especially interesting, due to its anti-aging effect, cellulite control, hydration and sun protection. Using water molecules and oscillatory energy, according to Fibonacci law, an aqueous mantle is created around the molecules of fullerene, and thus an NHS-nano-harmonizing substance is formed, [C_{60}(OH)24•2016H2O]Φ/ϕ (Koruga, US Patent 8,058,483 B2, 2011). The fullerene-water complex is patented as a material obtained by functionalization of the C_{60} molecules with OH groups (C_{60}(OHx) and addition of OH groups in water layers C_{60}(OH)×@(H_2O)y. These water layers – liquid water (H_2O)n, which surrounds the solid phase – nanostructure C_{60}(OH)× – are bound by hydrogen bonds and have properties similar to liquid crystals. Aqueous layers protect the complex C_{60}(OH)× from environmental influences, allow proper transmission of icosahedral vibrations to the environment, while preventing toxic effects of C_{60} on biomolecules. Said compact structure has a diameter of 5–15nm and dissolves in water, representing an amphiphilic molecule that can be used for various purposes. One of the main ones in cosmetics is the influence on oscillatory Amide-I processes, hydrogen bonds and soliton signal transport.

By further functionalization of C_{60} molecules with hydroxyl (OH) groups and addition of OH groups from aqueous layers surrounding the spherical structure of Buckminster fullerene, the substance Fullerene Water Complex 3HFWC – "quantum cosmetic substance" was obtained - (3H–hydroxylated, harmonized and, F–fullerene base, W– water, C–complex), which is produced from water of high purity (18.2 MΩ) and 99.95% pure fullerol $C_{60}(OH)_{36}$, by the effect of a strong oscillatory magnetic field, the following structures: $C_{60}(OH)_{36\pm12}@(H_2O)_{252\text{-}2016}$. (Koruga, Int, App. No. PCT/EP2019083307)

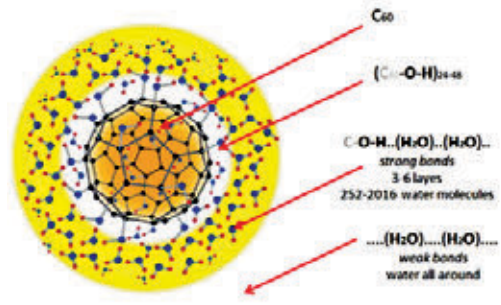


Figure 5: Organization of nano-quantum 3HFWC substance (Koruga, Đ. Int, App. No. PCT / EP2019083307, 2019)

The fullerene "cage" acts as a nanogenerator of paramagnetic and diamagnetic fields, and thanks to that, hydrogen bonds and the state of the liquid crystal in the water layers around it are established. The layers of such organized water, in addition to protecting C_{60} from various environmental influences, and biomolecules from potential side effects of the C_{60} molecule itself (when one or more double bonds are broken, C=C) also generate oscillatory processes, according to Fibonacci law. This whole structure (Figure 5) is 8–15 nanometers (nm) in size and is a significant active ingredient and stabilizer of cosmetic products, which according to the so-called INCI-nomenclature (International Nomenclature of Cosmetic Ingredients), is called water (and) hydroxylated fullerene. Studies of $C_{60}(OH)_{36\pm12}$ on human dermis fibroblasts (HDF) and liver cancer cells (HepG2) showed no toxic effects. In order to examine the effects of fullerenes i.e., structures such as the 3HFWC on the skin, it is necessary to

change the point of view and use special devices that can register changes on the level of atomic interactions and conformational changes of molecules.

If we look at our body from a quantum aspect, we will notice that the function of biomolecules is based on the mutual unity of structure, energy and information. The structural symmetry of biomolecules determines the electronic states and vibrational-rotational energies that are crucial for sending signals from one molecule to another through water (covalent and non-covalent hydrogen bonds). Signals are necessary for the proper functioning of biological systems, from conception to the process of regeneration of biomolecules, tissues and organs. 3HFWC, modified fullerene and water have the property of paramagnetism/diamagnetism, i.e., the ability to establish the optimal physiological organization of biomolecules through vibrations according to the rule of icosahedral symmetry (golden ratio). When a paramagnetic material is present in the skin, it will, under the influence of the Earth's magnetic field, amplify the paramagnetic field of the skin and thus stimulate the orderliness of charged molecules – dipoles, such as water and protein molecules. By arranging biological molecules, their optimal function is reestablished, which is reflected in the quality and appearance of the skin. The tissue gets better dynamic properties and faster signal transmission and thanks to that it reacts better to changes in the tissue and the environment and it regenerates faster.

The Buckminsterfullerene and its modified derivatives, such as 3HFWC, act on the basic elements of every living thing – atoms and molecules. The energy and information that 3HFWC transmits to the biomolecules in its environment, cause short and fast movements, or oscillations of atoms, which thus cause changes in the structure of biomolecules (conformation) in the body. This is a biophysical process, which involves the transfer of energy directly or through hydrogen bonds and water molecules. There are no chemical reactions in this process, and biomolecules do not change so as to create new chemical structures and undesirable products, but they biophysically harmonize, i.e., they return to their original, optimal state. In order to transfer this information efficiently, it is necessary that the charge-to-oxygen ratio in the non-covalent hydrogen bond is 0.61803, which is a "small" Fibonacci number. Their ratio in the covalent hydrogen bond, as well as the ratio of the covalent and non-covalent hydrogen bonds themselves, represents the "large" Fibonacci number, i.e. 1.61803. These interrelationships are not constant and their changes represent oscillatory processes of hydrogen bonds (Figure 3). If the balance of the hydrogen bond is disturbed, the whole system is disturbed and disorders/diseases occur.

It has been experimentally established that fullerol, although having a diameter of only 1.4 nm, cannot pass through the lipid bilayers in the corneal layer. However, it can affect the collagen and elastin molecules located in the deeper layer – the dermis of the skin, even when there is no direct contact with the biomolecule. The ubiquitous water molecules and the hydrogen bonds that surround biomolecules are responsible for transmitting energy and information. They transfer energy and information by a natural, biophysical process from 3HFWC molecules with a domino effect, transferring oscillations from one water molecule to another via hydrogen bonds. (Figure 6-4)

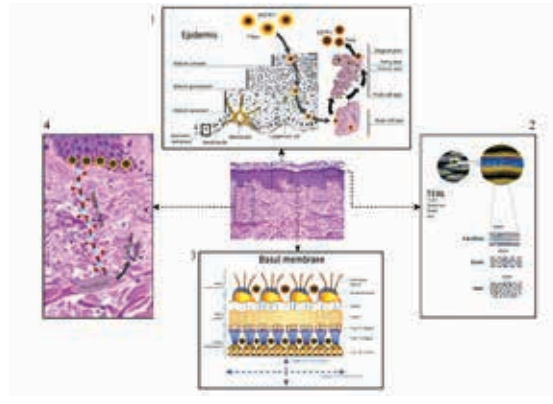


Figure 6: Schematic representation of the effect of 3HFWC substance in the epidermis (1 and 2) on the basement membrane (3) and in the dermis, from the basal, via water, to collagen and fibroblasts (4).

Collagen is one of the most abundant proteins in the human body and, compared to all others, it makes up 40% of the total mass. In the skin, that percentage is much higher, almost 75%. The three main amino acids that participate in its formation are glycine, proline and lysine. Depending on the order of amino acids, there are about 28 different types of collagen. It is extremely important for the quality and beautiful appearance of the skin, because it is a support network that allows the skin to return to its original position after being deformed by movement. With age, as the amount of collagen fibers in the skin decreases, and due to the effects of UV and high-energy photons of the sun, pollution, age and so on, the quality changes significantly, constant movement from and back to the same place on the skin leads to changes called – wrinkles.

When amino acids form any protein, even collagen, two neighboring amino acids in the biochemical process form a peptide plane and synthesize two water molecules that form metabolic water (about 10% of the total daily amount in the body). The peptide plane becomes a biophysical entity, and the group of R atoms (bound to carbon C) from the amino acid that is not part of the α peptide plane, performs biochemical (achieves covalent bonds with other molecules), or biophysical (ion-ion, ion-dipole, dipole-dipole and other) function. The oscillatory modes of the peptide planes must be harmonized in order to preserve the quality and function of collagen in the skin and this is achieved because of 3HFWC. Peptide planes of collagen fibers located just below the basement membrane must oscillate harmoniously, to ensure their function and preserve the "finely wave" (like egg carton) structure of the basement membrane, because it provides better nutrition of the cells of the basal layer of the epidermis and skin tightness.

If the basement membrane is flattened, the cells feed less, which is why the epidermis regenerates much more slowly. On the other hand, the improved collagen structure contributes to better signal transmission and stimulates the activity of fibroblasts to synthesize larger amounts of collagen and elastin fibers, which gives the skin fullness, alleviates the depth of wrinkles and achieves a beautiful appearance. 3HFWC establishes harmonization of the oscillatory process of peptide planes and forces molecules to oscillate in a natural way, i.e. corrects deformations of molecules. The secondary structure of collagen is α-helix, with three chains of hydrogen bonds (O… H), through which coordination of oscillatory processes of peptide planes is achieved. The collagen molecule is 280-300nm long, with a diameter of 1-2nm, and is packaged in a more complex structure of collagen fibrils with a gap of 64 nm between the molecules (similar to the gap at the junction of railway tracks). This packaging enables unhindered oscillatory dilatations (otherwise there would be a deformation of the collagen structure) due to the oscillatory processes of the peptide planes and the molecule itself.

More collagen fibrils (diameter about 100 nm) form a collagen fiber (1-20 micrometers, μm), which form a primary bundle of collagen fibers (20-70μm), then the secondary bundle of fibers (70-140μm), tertiary bundle of fibers (140-200μm) and, finally, collagen fibrils (~500μm). The packaging of "fibrils", "fibers" and "bundles" of collagen can be twofold: (a) spatial-pentagonal and (b) linear-planar. Both processes are reversible and represent two different functions of collagen. One function is energy-structural, supporting (linear-plane), and the other is energy-informational for signal transmission (spatial-pentagonal).

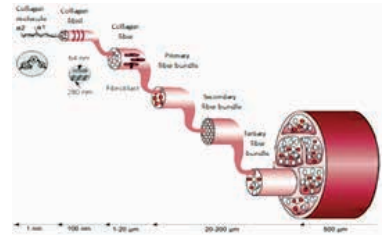


Figure 7: Complex organization of collagen: from molecules 2 nm in diameter to fibers 0.5 mm (Adapt from Tortora, G. T., and Anagnostakos, N. P., Principles of Anatomy and Physiology, Harper &Row Pub., Cambridge, 1981)

Thus, for example, the organization of collagen I and III in the basement membrane is of type (b), linear-planar (hexagonal packaging), because it forms the basis for the basement membrane. When the signal should be transmitted, in interaction with collagens IV and VII, i.e., to establish the correct configuration of the basement membrane, then all four types of collagen transition into a combined pentagonal-hexagonal organizational structure. The pentagons (dodecahedral structure) are dual with icosahedral structures and will oscillate based on the law of common symmetry (symmetry underlies the structure of nature). If the oscillations occur in one direction (1D), the law of oscillation will be spiral. If the oscillation is in the plane (2D), then the system has a left and right orientation, and the oscillatory structures must be perpendicular (at right angles, $\perp$), which is the case with collagen types [I, III] and [IV, VII] in the basement membranes (sunflower principle).

If the process of collagen oscillation [I, III] $\perp$ [IV, VII] is disturbed, then a 3D structure with icosahedral symmetry is implemented in or near that space, and it is repaired directly or through water and returned to its natural state. The oscillatory process in the protein chain or any higher hierarchical collagen structure is observed in the ordered trio, i.e., three adjacent elements are observed (previous-current-forthcoming) (Figure 8). If we observe the oscillation of the peptide planes of collagen, then the first peptide plane (named Gibbson after the American scientist of statistical thermodynamics Josiah Willard Gibbs and has condensate properties – several atoms behave oscillatory like a monolith), oscillates at $865\times10^{11}s^{-1}$, the second with $658\times10^{11}s^{-1}$, and the third $533\times10^{11}s^{-1}$ with . If we divide all three values with the third value, we get the ratio 1.6/1.2/1. However, when the signal travels through the collagen structure, at the end of the collagen molecule, oscillations will obtain the ratio of 2.7/1.6/1. In other words, the signal was transmitted from the beginning to the end of the collagen molecule according to the law of „*-e*", the basis of the natural logarithm. But when a disturbance occurs or the process is to be accelerated, then this can be remedied, by bringing a structure with dodecahedral/icosahedral molecular symmetry.

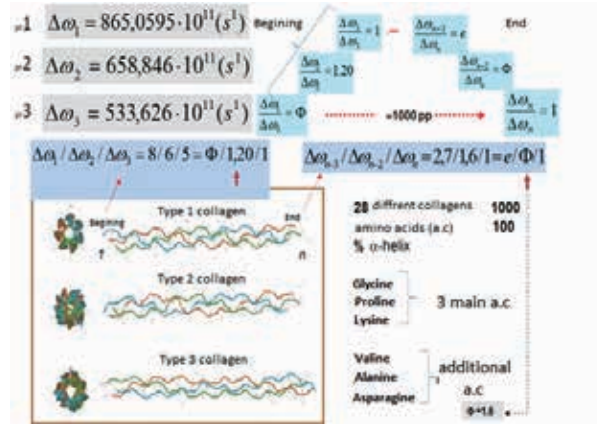


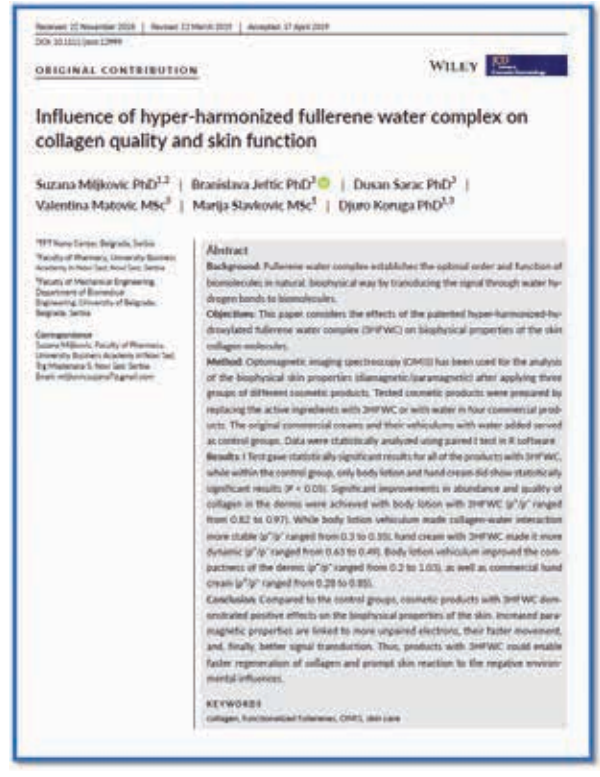
Figure 8: The oscillatory process in the protein chain, the collagen structure, is observed in the ordered triple, i.e. the three adjacent elements (previous-current-forthcoming) are observed (Koruga, Hyperpolarized light, Zepter Book World, Belgrade, 2018)

A significant role in this process is played by hydrogen bonds in collagen, i.e., the chain of covalent and hydrogen bonds $—C_\alpha—N—H...O—C_\alpha—N—$.The amide part (covalent) in the chain oscillates at 6.05μm and the hydrogen bond oscillates at 43.27nm. The energy and even the frequency of the amide part in the chain is about seven (7 ± 0.15) times higher than the energy of the hydrogen bond. The harmonization of this oscillatory process is done through a phenomenon known in science as soliton. The length of the covalent hydrogen bond O-H or N-H is about 0.099 nm (with small oscillatory changes), and the length of the non-covalent hydrogen bond O… H or N… H is about 0.161 nm (also with small oscillatory changes). If we take the length of the covalent hydrogen bond as a unit $l = 1 \pm 0.05$ (in relation to it, all other bonds between the atoms in the molecule and between the molecules are compared and synchronized), then the length of the noncovalent hydrogen bond is $l = 1.61 \pm 0.08$. Their ratio is Φ (Fibonacci number), which is the basis for harmonizing

the ratio of quantities and proportions of action and process.
In the dynamics of charge exchange in a set of noncovalent hydrogen bonds (O… H, i.e. N… H), vertical (V) and horizontal (H) collagen, two main oscillatory charge situations arise: (f_1) charge oscillations are paired , and (f_2) the charge oscillations are unpaired .

As many hydrogen bonds participate and as electrons are quantum entities, these two possible oscillatory states of charge are superimposed, which results in four oscillatory situations: [1] – neither paired nor unpaired, [2] – both paired and unpaired, [3] – neither paired nor unpaired and [4] – both paired and unpaired. Thus, the harmonization of the disturbed oscillatory process of collagen type [I, III], oscillating horizontally and collagen type [IV, VII], oscillating vertically in the basement membrane can be achieved if these structures are acted upon by means that have a perpendicular (⊥) oscillatory process generated by laws of icosahedral or dodecahedral symmetries in the range 5.5–7.05μm.

The 3HFWC substance acts on biological structures that are arranged according to the same laws of symmetry (collagen, clathrin, microtubules, centrioles, flagella and processes based on Gibbs free energy); it harmonizes them and brings them into a natural functional state. Due to its icosahedral structure, it has appropriate vibrational-rotational states that enable it to harmonize the entire body. 3HFWC stimulates the formation of linearly bound water molecules in accordance with icosahedral (Fibonacci) properties (a), the conformational structure of biomolecules and the influence of water/hydrogen bonds on the establishment of the original, optimal state (b), signal transmission via non-covalent hydrogen bonds in the α-helix via peptide planes (c), creates a liquid crystal structure in a cosmetic product applied to the skin (d), creates a water cluster with icosahedral symmetry, which together with water organized in linear chains, creates a network of water with properties of icosahedral symmetry (e).
The quantum effects of the 3HFWC substance is manifested by appropriate vibrational-rotational states that return the oscillatory processes of collagen to an equilibrium and harmonized relationship. Such collagen is again in its basic regulated state and can efficiently transmit information, which leads to the renewal of already present collagen in the skin, as well as the creation of new one. A larger amount of collagen provides greater resistance to deformation and thus prevents/slows down the formation of wrinkles. 3HFWC creates an oscillatory paramagnetic/diamagnetic field that dipole molecules, such as water or proteins, organize in the direction of signal propagation, according to the law of the golden ratio. Under the influence of vibration and signal transmission with 3HFWC, irregular structures of biomolecules are corrected and normal function is established, with an increase in moisture content and better regeneration of biomolecules. The research team of TFT NanoCenter published the results of the 3HFWC complex effects in the Journal of Cosmetics Dermatology, in 2019 and 2021.



ORIGINAL CONTRIBUTION

WILEY

Influence of hyper-harmonized fullerene water complex on collagen quality and skin function

Suzana Miljkovic PhD[1,2] | Branislava Jeftic PhD[3] | Dusan Sarac PhD[3] | Valentina Matovic MSc[3] | Marija Stavkovic MSc[3] | Djuro Koruga PhD[1,3]

Abstract

ORIGINAL CONTRIBUTION

WILEY

Mechanisms of skin moisturization with hyperharmonized hydroxyl modified fullerene substance

Suzana Miljkovic PhD[1,2] | Branislava Jeftic PhD[3] | Ivana Stankovic MSc[2] | Nikola Stojiljkovic PhD[3] | Djuro Koruga PhD[1,3]

Abstract

Background: Hyper Harmonized Hydroxyl Modified Fullerene Substance (3HFWC®) establishes hydrogen bonds with the surrounding water molecules and organizes them in clusters with the liquid crystalline state, similar to the properties of water surrounding the biomolecules.

Aims: To investigate the moisturizing properties of hyperharmonized fullerenol–3HFWC® as an emulsion O/W ingredient on the skin.

Patients/Methods: We have analyzed the reflexion of the blue light from the skin, in vivo, with different levels of moisturization and compared the influence of three groups of cosmetic products (with various active ingredients, 3HFWC® or water in same percentage in the "vehiculum") on skin moisturization by measuring paramagnetic/diamagnetic properties by Optomagnetic Imaging Spectroscopy.

Results: Regenerating Cream and Body Lotion have shown statistically significant increase of diamagnetic features predominantly in all 3 types of creams, while the Hand Cream formulations have not shown statistically significant results after 4 weeks of treatment. Anti-aging cream with 3HFWC® demonstrated statistically significant increase of paramagnetic properties of the skin (χ''/χ' from 0.90 to 0.62) and showed beneficial effects on information transfer and water content in stratum corneum.

Conclusion: Although it does not act as a classical moisturizing agent on the skin, 3HFWC® can increase moisturization as a result of hydrogen bonds established among 3HFWC® and water or biomolecules, liquid crystalline state of water in 3HFWC® resembling the properties of water surrounding the biomolecules, and finally, liquid crystalline state of water in the products.

KEYWORDS

The mechanisms that lead to an increase in skin moisture are:

- Hydrogen bonds formed between 3HFWC and water molecules keep water clusters stable and protect the proper conformation and function of biomolecules. Water organized in clusters has different properties from free water, but it has almost the same properties of water that surrounds biomolecules. The optimal organization of water molecules is a polyhedral structure of water clusters, with a network of hydrogen bonds, and they are compatible with the code system of the genetic code (DNA and proteins).
- These hydrogen bonds also increase the hydration of the biomolecules themselves.
- The liquid crystal water that makes up the aqueous layers of 3HFWC is very similar to the properties of the water that surrounds the biomolecules, allowing them to be recognized and utilized.
- The liquid crystal water that makes up the aqueous layers of 3HFWC is very similar to the properties of the water that surrounds the biomolecules, allowing them to be recognized and utilized

Products with 3HFWC slow down the aging process of the skin:

- Reorganize biomolecules and establish their optimal conformational structure;
Increase the water content in the epidermis by regulating the optimal supply of water from the dermis
- Prevent the effects of ultraviolet radiation (UV), blue light, pollution, electromagnetic smog and other harmful effects from the environment;
- Prevent the appearance of hyperpigmented surfaces (freckles and spots);
- Slow down the development of cellulite and alleviate existing changes;
- They enable accelerated healing of wounds without scars;
- Improve skin texture by acting on collagen in the basement membrane.
- Improve skin elasticity by repairing existing collagen and elastin and stimulating synthesis of new ones.

These effects were confirmed by a study conducted from 2018 to 2020. Ninety volunteers used products with or without 3HFWC for 2 to 6 weeks. The changes were monitored by opto-magnetic imaging spectroscopy (OMIS). Compared to four commercial cosmetic products that contained different active ingredients, and products that contained water instead of them, products that had 3HFWC instead of active ingredients, showed better effects by 12–32%. However, what has been shown to be very significant are the effects with the substance 3HFWC; excellent effects are obtained after the first week, as well as after two weeks of application in the dermis, while the cream without this substance, and with the same other composition, showed effects with a time delay of 1-2 weeks. Initial research was also done during 2019–2020 and it was shown that this substance has antibacterial and antiviral effects. The substance has a beneficial effect on the skin microbiome as an antioxidant and effective agent in protection against ultraviolet (UV) radiation and high-energy blue light.

Within the Zepter International company, testing of cosmetic products with the quantum substance 3HFWC based on the double derivative of C_{60} molecules (TFT Nano

Center, Belgrade) was conducted, because we wanted to research the synergistic effects of C_{60} and gold nanoparticles. Studies have confirmed that 3HFWC increases the moisture content and stimulates the regeneration of biomolecules. In comparison with four commercial cosmetic products, 3HFWC-based cosmetics showed better effects by 12–32% (Journal of Cosmetological Dermatolology, 19; 494-501, 2019). Nanoparticles usually have different physical, catalytic or biological properties from larger materials with the same chemical composition. The key to achieving better nanoparticle performance is increasing the surface to volume ratio of the material, due to reduction to nanometer dimensions. The large and reactive interface is responsible for the catalytic, antimicrobial and many electronic properties that give nanoparticles a significant advantage over macromaterials. The most important difference between basic materials and nanoparticles is that nanoparticles have a large number of atoms on a small outer surface, which leads to high surface energy and high reactivity. Ease of production and functionalization has resulted in various applications in many fields of biomedicine, such as in nano-sensors, targeted drug delivery, medical imaging, but also in the cosmetics industry.

Of the many nanoparticles, nanogold attracted special attention. The perception of gold as an inert material was altered by the discovery that nano-sized gold particles are chemically reactive. Their properties can be adapted to certain applications by controlling the size and atomic structure on the surface of the nanoparticle. The high optical absorption of gold nanoparticles, their scattering properties and low or complete lack of toxicity have made them a promising class of materials in cosmetics. Previous research has shown that the main properties of nanogold in beauty care are accelerating blood circulation, anti-inflammatory properties, antiseptic properties, increasing the firmness and elasticity of the skin, improving metabolism, and thus slowing down the aging process. An overview on application of nanoparticles in cosmetics can be found in Asian Journal of Pharmaceutical Sciences and Clinical Research, Vol. 1, Issue 2, 40-55, 2011. To see whether there is a synergistic effect of nano gold particles GNP (Zlatarna Celje, Slovenia) and the substance 3HFWC (TFT NanoCenter, Belgrade), we conducted a study during which we examined the effect of a cream containing gold nanoparticles and a cream containing 3HFWC substance in addition to gold. The study lasted six weeks during which we monitored changes in the forearms of the subjects (women) in two places every seven days. The study involved 33 respondents (women), with an average age of 37, with the oldest being 66 and the youngest 21 years old. Biophysical skin properties (diamagnetic/paramagnetic) were measured using opto-magnetic imaging spectroscopy (OMIS), an innovative diagnostic method, which is patented (Patent US 10,085,643 B2) by professor Dr. Đuro Koruga and his associates, and awarded the WIPO (World Intellectual Property Organization) as the best patent in 2018.

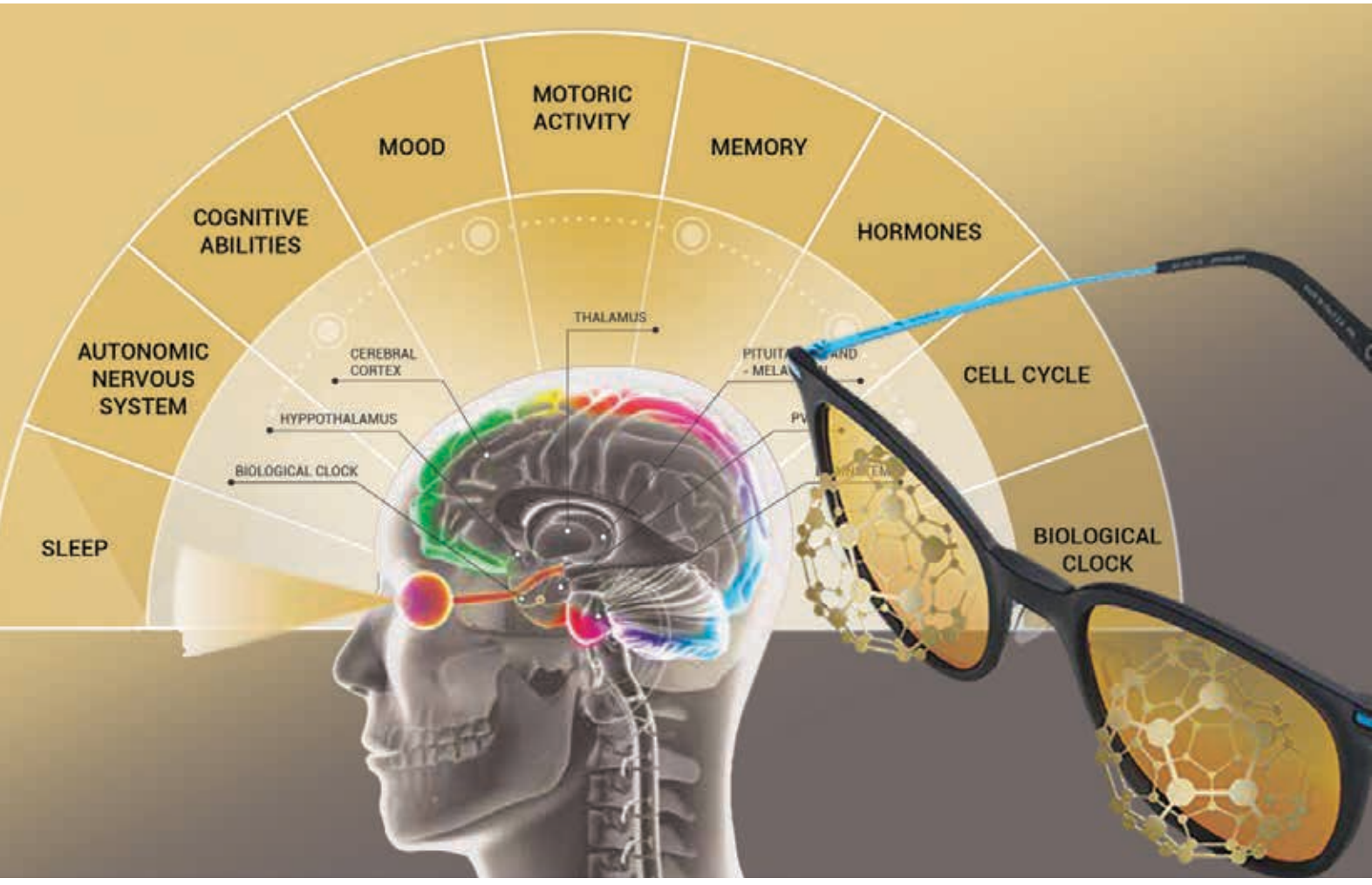
Due to the high water content in the skin (65-70%), and the absorption spectrum of water being 100 to 1,000 times higher for red and infrared light than for blue, blue light penetrates very shallowly into the tissue, about 5–10 μm. Green penetrates deeper, to the base membrane (120–180 μm), red penetrates deep into the dermis, at 800–1,600 μm, and infrared at up to 5–20 mm. Wanting to see how the creams with nano-gold (group III) and with the added 3HFWC (group IV) affect collagen, we observed the red light because it penetrates to the depths where collagen is formed. Table 1 shows the results of the research for red light depending on the difference in wavelength (nm), intensity (n. a. u.), surface ratio (p+/p-) and fractal dimensions. The fractal dimension of the graph for the first week of the third group is $D_f = 1.417$, while for the sixth week $D_f = 1.5$, which indicates that there has been a change in the dermis. The change is different with the fourth group, since the fractal dimension for the first week is $D_f = 1.346$, and for the sixth $D_f = 1.235$. When other parameters

are taken into consideration, such as the ratio of unpaired and paired electrons (p+/p-), then we see that for group III, for the first week the result equals -95.38, and for the sixth week -96.67, which indicates that the cream with GNP did not significantly affect fibroblasts and collagen synthesis, which is in accordance with the increase in fractal dimension by 6.3% in group III subjects. In group IV, which for the first week had approximately the same value (p+/p-) = -95.65 as in group III (-95.38), while in the sixth week there was a significant change in collagen synthesis in group IV subjects. The value (p+/p-) increased significantly for group IV, the change in the sixth week compared to the first was even 73.7% better. This is in accordance with the change in the fractal dimension of the signal obtained from the dermis, because the fractal dimension of the signal spectrum decreased by 8.6% due to the balanced dynamics of oscillatory processes in the depth of the dermis, where collagen is dominant.

Bearing in mind that in previous studies with a cream containing only the 3HFWC substance we had an improvement in effect by 28% compared to a cream that had the same base, but classic bioactive ingredients. When we combine gold nanoparticles with 3HFWC, we have improved effects by 73.7% (a difference of 45.7%), which is an obvious beneficial effect of the new cream, which is a combination of nano-quantum substance and gold nanoparticles (3HFWCGNP). New studies of La Danza-Hyperlight fusion Anti-Aging essential complex application are in progress and the results will be processed and presented by the end of the year.

Table 1 – Survey results of groups III and IV of subjects who used the cream with gold nanoparticles (GNP) and the cream with 3HFWC substance and gold nanoparticles (3HFWC^{GNP})

Light	**week**	**Unit of measure**	**GROUP III (nano gold)**		**GROUP IV (nano gold + 3HFWC)**	
			Diamagnetism	Paramagnetism	Diamagnetism	Paramagnetism
R (red)	1	Int (n.a.u)	-41.36	29.36	-48.32	3.95
		WLD (nm)	129.66	106.51	28.37	106.51
		(p+/p-)	-95.38		-95.65	
		D_f	1.41		1.34	
	6	Int (n.a.u)	-42.75	12.10	-52.89	0.0
		WLD (nm)	110.34	106.51	129.66	100.0
		(p+/p-)	-96.67		-55.06	
		D_f	1.50		1.23	



TESLA EYEWEAR

instead of pharmacological drugs

If light has the power to influence our brain, does fullerene filtered light have the super-power to unleash our cognitive abilities? Are we going to be better at decision making? Can we improve our cognitive functions such as memory and learning?

Jelena Zinnanti

We are evolutionary coded to synchronize our body and mind with light. Like soothing music light can trigger wide range of emotions depending on its spectral composition.

Can light influence our mood and behavior? This is one of the very fundamental questions we are tackling. Light is everywhere around us. Through the visual stimuli, it constantly activates our brain, even when we sleep. The eye lids are protecting us from bright light, yet they are transparent enough to pass through some light. This helps our brain detect sunrise and prepare our body for the start of the day. With dusk, the light spectrum (colors of the light) is used to tell our brain it is time to sleep. The light has the key role in adjusting many of the physiological processes in our body according to the day night cycle, known as circadian rhythm. This seem to be just part of the powers light

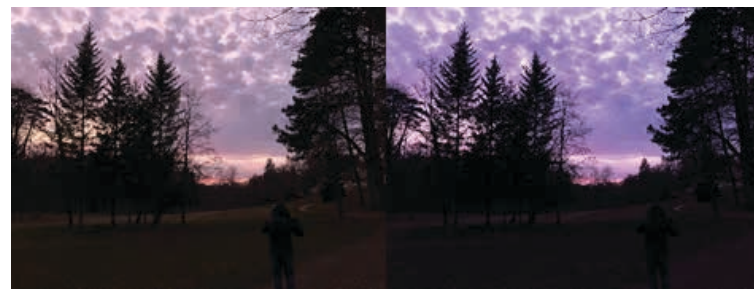
has. Just like soothing musing, light can have instant influence on our mood. How many times you admired or enjoyed something beautiful or magnificent, and immediately felt excited?

There is more than eyes can see, is certainly through when it comes to explanation of emotional reaction associated with visual stimuli. In fact, vision is not the only sense associated with emotional response. It seems that all five of our senses have stronger or weaker emotions associated with them. Every time we enjoy tasty meal or drink, our pleasure centers in the brain become strongly activated and we feel satisfaction. Listening to favorite music can instantly positively affect our mood. Senses such as touch and hearing can elicit variety of emotions from positive to negative. In extreme cases, loud sounds not only trigger emotional response, but reflex responses as well. From an evolutionary perspective this is advantageous, as it can facilitate immediate protective measures.

From sensory stimuli to our emotional part of the brain

When exposed to sudden loud noise, we'll startle or jump without thinking. This is because emotional responses are processed by our subconscious (primitive) brain. They are processed rapidly, before our conscious brain can analyze and rationalize the situation. This prompt response, is not always the best. We experienced situations where we had to think on the fly or under pressure and we made wrong decisions. This is because in a stressful situation our emotional brain will take over our rational brain, and force fast decision making. Highly experienced professionals facing a stressful situation due to the nature of their job, such as fighter pilots, field operatives, paramedics, fire fighters, are trained to remain calm in order to avoid triggering emotional brain, and will make best decision using conscious brain. Similar to loud sound, sudden bright light can immediately trigger a strong aversion response, where immediate „eye blink" is the protective reflex.

To protect our eyes from strong sun light, we wear sunglasses, making exposure to bright light more pleasurable. Similar to the music it can cause wide range of emotions. Majority will feel more joyful and energetic during bright sunny days, while slightly melancholic and blue during rainy days, where gray colors dominate. This can even be extended to geographic variation of personality traits among cordial southern and more reserved northern nations. It appears that not just light intensities, but differences in spectral composition (light colors) can differentially affect our brain. Before we continue to look deeper, we need basic understanding of how light can influence our subconscious and conscious brain, apart from regions involved in image formation.



Light filters change how we perceive colors of environment. What colors we found pleasant can tell a lot about our personality, but even more so about our stress levels. We are learning that fullerene filtered light can help us combat negative emotions we experience associated with anxiety and stress.

The third class of retinal photoreceptors: the missing link between the light and subconscious brain

For imaging forming purposes, eyes are equipped with two types of specialized neuronal cells, part of the retina, called rods and cones. Rods are contributing to night vision, while cones are responsible for color vision and processing of information necessary for image formation. These cells can sense light directly due to photopigments (proteins capable of light detection). For detecting full range of colors, it is necessary to detect blue, green and red, while other colors are perceived through combination of these three. During the night our color perception is poor. This is because

our rods have photopigment, rhodopsin, with one peak absorption around 500 nm, insufficient for detailed color information.

Other animals, such as rodents are better adapted for night vision, since their cones and rods have different photoreceptors sensitive to UV light as well. Regardless, the visual pathway is preserved among species, and it is well established that retinal ganglion cells terminate in primary visual cortex, giving rise to image formation. It was not until it was discovered that even blind persons have the ability to adjust to patterns of day and night (photoentrainment). It became obvious that additional photoreceptors would be necessary to explain photoentrainment. In 1999 initial evidence started to point to the existence of third type of retinal cells (*Science*, 284:1999), intrinsically photosensitive retinal ganglion cells (ipRGCs). It is now established, ipRGCs contribute to light sensing that is not related to image formation. The third class of retinal ganglion cells is expressing photo pigment termed melanopsin.

Compared to other photopigments, melanopsin's peak absorption is at 479 nm, making it selectively sensitive to blue light. When blue light activates melanopsin, ipRGCs become activated, and their activation is involved in inhibition of melatonin release from the pineal gland. Lack of melatonin release prevents transition to sleep and rest. This simplified mechanism, explains why blue light is keeping us awake at night. There is yet more to the story, as ipRGCs receive input from cones and rods, indicating that blue light is not solely activator of these cells. We are yet to discover their additional functions, associated with connections to other brain areas. So far it is known that ipRGCs are involved in control of the pupillary reflex, and photophobia, an aversion involving emotional reaction to very bright light.

Our physiology is evolutionary programmed to be in sync with diurnal cycle. Modulation of light through its spectrum, intensity and duration can have long lasting impact on our well-being

Thanks to ipRGCs we can differentiate dusk, the transition of daylight into the night. The role of these cells is to prepare our body to sleep time, and to regulate our circadian rhythm. Without this synchrony, physiological processes during day and night would interleave, leading to inadequate sleep and rest. An inadequate sleep can have long term consequences on our cognitive abilities such as attention, decision making, problem solving and memory. It is less intuitive that changes in circadian rhythm can lead to chronic stress and anxiety. If we recall, emotions are evolutionary shaped to be primarily protective senses, due to lack of sleep our subconscious brain gets in high alert mode. An anxiety is defined by the state of constant fear of what is about to happen.

Existing evidence based on functional MRI imaging indicates activation of limbic brain area called amygdala to be activated in response to stress. This is no surprise since amygdala is the main brain area processing emotions including fear. There is also evidence that some nerve terminals of ipRGCs are connected to amygdala are raising the possibility for its direct activation by light. One sleepless night can render us in the bad mood the next day, but many sleepless nights will re-wire our brain to be in the constant flight-or-fight mode. This subconscious feeling of fear is triggering a cascade of processes involving secretion of cortisone, a main stress hormone that is preparing our body for danger.

Escape from modern lifestyle and back to nature. Can fullerene filtered light help us combat stress and anxiety?

In contrast, to our ancestors, having to defend themselves from predators, modern age came with its own stressors, the lifestyle itself. The chronic misalignment of lifestyle with circadian rhythm is associated with increased risk factor for various diseases. With introduction of artificial light, our brain is confused with day/night cycle impacting the overall health and wellbeing. We are now fighting the very own problem we created. If we consider the source of perturbation,

the artificial light, we can trace its action to cognitive and emotional centers of the brain. From the birth of universe, tons of cosmic dust had been released, containing fullerene molecules among others.Fullerene is basically another form of carbon, where carbon atoms arrange in caged structure resembling a soccer ball. The biggest difference between fullerene and other forms of carbon such as graphite and diamond, is the connection of carbon atom with only three neighboring carbons, instead of four such as in diamond and graphite. This unsaturated nature of carbon bonds, gives fullerene ability to accept free radicals, with potent antioxidant properties. The pristine fullerene (C_{60}) solution is purple, while colors can range depending on fullerene derivatives. Larger clusters of C_{70} fullerene (micron size particles) have found to naturally absorb light in range between 380-500 nm, therefore leaving the spectrum attenuated in purple, blue and somewhat green region. Can fullerene filtered light, low in blue content, help us combat stressors of modern age?

To help us answer this questions we involved researchers of Vienna Biocenter Core Facilities in Austria. To look at differences in brain activity in response to fullerene filtered light, state of the art, ultra-high field MRI scanner (magnetic field 15.2T) was used, alongside with behavioral testing. As one step further, we investigated differences in brain activity in response to hydroxylated fullerene water complex (3HFWC) introduced through the drinking water. Fullerene molecules are not water soluble, and require hydroxylation (addition of –OH group) to be dissolvable in water. With discovery of hydroxylated fullerenes, its widespread biomedical application begin. They have been used as anti-inflammatory, anti-aging, anti-bacterial agents, etc. Present study is original work on how 3HFWC can influence resting state brain activity.

Experimental design

To be able to determine influence of fullerene filtered light and 3HFWC on brain activation and behavior, it was necessary to form control group and three experimental groups. All groups spent daily two hours either under the halogen lamp, or fullerene filtered light from halogen lamp.

The additional difference in experimental groups was hydroxylated fullerene water complex (3HFWC) supplemented in drinking water. The control group was given regular water and was placed under halogen lamp. The first experimental group was placed under fullerene filtered light, and was given regular water. The third experimental group was placed under halogen lamp, and was given 3HFWC in drinking water. The fourth group received, „dual treatment", fullerene filtered light and 3HFWC in drinking water. During 4 weeks duration of these treatments, body weight, body temperature, blood pressure and ECG were measured. The highest gain in weight had mice exposed to fullerene filtered light, while this was not significantly different with other groups. There were no differences in body temperature, blood pressure or ECG among different treatment groups and controls. After four weeks of treatment resting state fMRI was done on all mice, followed by behavioral testing.

Resting state functional magnetic resonance imaging, a powerful tool to study brain activation at rest

To investigate changes in brain activity, and its consequences on behavior, resting state functional magnetic resonance imaging (rs-fMRI) alongside behavioral testing was used. Magnetic resonance imaging (MRI) is non-invasive imaging modality, where radio-frequency waves similar to waves we hear when listening to radio are used to reconstruct images of our body. In contrast to Roentgen and computed tomography scanners (CT) there are no harmful X- or gamma-rays. MRI is widely used in clinical diagnostics thanks to excellent soft tissue contrast, facilitating visualization of many pathological changes. The main signal in MRI comes from water molecules, or to be more precise protons of hydrogen nuclei. This is why changes associated with

water content, or differences in water content of the tissue can alter MRI signal. For functional MRI (fMRI), differences in blood oxygenation level are particularly important. The red blood cells, our oxygen carriers, have protein called hemoglobin that binds oxygen.

The hemoglobin does this true reaction that involves iron. Because of iron, hemoglobin without bound oxygen is paramagnetic, while once the oxygen is bound it becomes diamagnetic. These changes in magnetic properties of hemoglobin are sufficient enough to be detected using MRI. The higher MRI signal detected with oxyhemoglobin is the basis for functional magnetic resonance imaging (fMRI) and blood oxygen level dependent (BOLD) contrast. Today, fMRI is widely accepted non-invasive method to investigate brain function in response to stimulus. It is established that following brain activation, oxygenated blood is quickly delivered to activated region to replenish increased demand for oxygen.

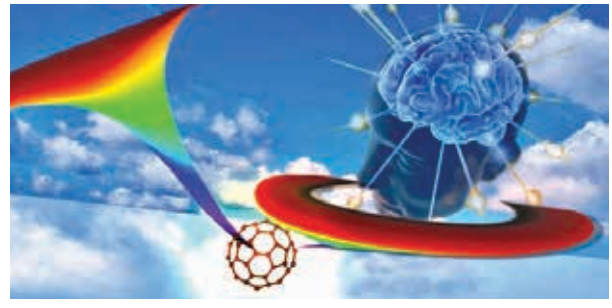
Therefore, activated brain areas can be detected indirectly by measuring increase in MRI signal that indicates increase in oxygenated blood. When brain is at rest, different brain regions receive different oxygen supply, however, it appears that level of oxygen supply is synchronized throughout the brain. This level of synchrony can be disrupted in response to stress, diet, environment, psychiatric patients, drugs etc. In contrast to functional MRI, where task is performed during MRI scan, resting state fMRI measures changes in brain activity at rest. Resting state fMRI is thus very powerful method to detect changes that impact baseline brain activity, and therefore our wellbeing.

Behavioral testing, a sensitive indicator of wellbeing

Behavioral testing has been traditionally used as gold standard to measure changes associated with cognition and emotional response. This study focused on emotional response, while cognitive functions (such as memory and attention) have not been tested. Mice are nocturnal animals, mostly active at night, accordingly their preference is to be in the secluded places. When placed in the open box, they prefer corners, rather than center. Extensive time spent in the corners, and very little time spent in the center can indicate anxiety. When placed on the elevated platform (elevated plus maze) they prefer open rather than closed arms. The amount of time spent in the open arms, and latency to enter open arms can be correlated with anxiety as well. Naturally, mice are good nest builders, and enjoy nest building activities. When depressed, their interest to build nests goes down. Unfinished nests could indicate depression. Mice are good swimmers, and unless depressed will prefer to swim rather than float. Reduced swimming time and early onset of floating can be sign of depression and reduced wellness.

Fullerene filtered light led to reduced activity of region promoting anxiety and increased activity of regions involved in sleep regulation

Treatment with fullerene filtered light lead to significantly reduced activation of brain region involved in processing of negative emotions such as fear and anxiety, the right amygdala. The amygdala, is well established center for processing emotions. As response to chronic stress, amygdala is activated especially in rodents. Reduced activation of this brain region, suggests beneficial influence of fullerene filtered light the wellbeing, and perhaps higher on resilience toward stress and anxiety. Behavioral tests, revealed this group of mice had shortest amount of time needed to enter open arms of maze.



Intriguing potential of fullerene filtered light to directly influence emotional brain processing, through its temporal-spectral characteristics.

This finding suggests decrease anxiety, since mice are naturally scared of open and elevated spaces. It appears after exposure to fullerene filtered light they combated fear more easily. The swimming test showed this group to have longest duration of swimming, before giving up and beginning to float. This is another indication of reduced stress and anxiety. The brain region involved in sleep regulation, the reticular nucleus, was significantly activated in this group. Since the comparison is made where control group is exposed to halogen light, it can be concluded that better sleep regulation is achieved in response to fullerene filtered light. Taken together these results suggest overall improvement in well-being, with reduced stress and anxiety.

Fullerene water complex led to increased sensitivity in response to hot plate

Addition of 3HFWC into the water lead to faster reaction to hot plate in this group of mice. Increased activation of the periaqueductal gray brain region (involved in pain modulation and analgesia) found on functional MRI, could be potentially explain this increased sensitivity. There were no specific signs of anxiety, or stress in this group of mice, alongside with significantly decreased activation of bilateral amygdala found on resting state fMRI. Interestingly, with combined treatment, e.i. addition of fullerene filtered light, pain sensitivity was restored to normal level, implicating fullerene filtered light in pain therapy.

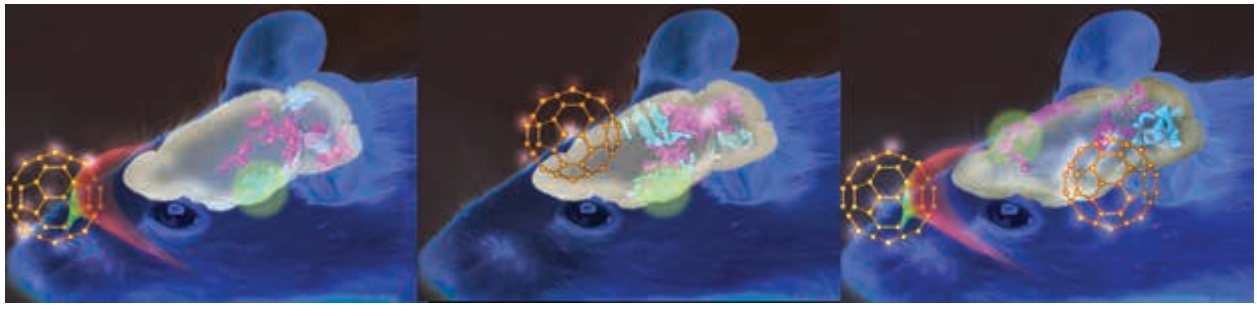
The best at building nests, fullerene filtered light in combination with 3HFWC

The brain centers responsible for memory and attention, hippocampus, retrosplenial/prefrontal cortex, were found to be significantly activated in response to dual treatment, fullerene filtered light and 3HFWC. Increased activation of hippocampus could be interpreted as potential for improvement in short-term memory. The retrosplenial cortex, together with hippocampus is involved in memory formation, as well as in processing visual cues for spatial orientation. It is likely that these mice were best at nest building, due to increased activation of these two brain areas. While cognitive functions have not been tested more specifically, resting state fMRI findings could not be correlated more specifically. No significant indications of increased anxiety were found with performed behavioral testing.

Concluding remarks

Our findings suggest intriguing possibility that fullerene filtered light, through its spectrum, can directly influence our emotional brain processing. We are just starting to uncover potential of fullerene light. Will use of Tesla eyewear help us combat the anxiety instead of pharmacological drugs? For many professions, where rapid decision-making is essential, suppression of emotional processing could be crucial. If light has the power to influence our brain, does fullerene filtered light have the super-power to unleash our cognitive abilities. Are we going to be better at decision making? Can we improve our cognitive functions such as memory and learning? It seem conceivable. It seems simple. We can put Tesla eyewear and discover ourselves.

(Illustrations Zepter International).

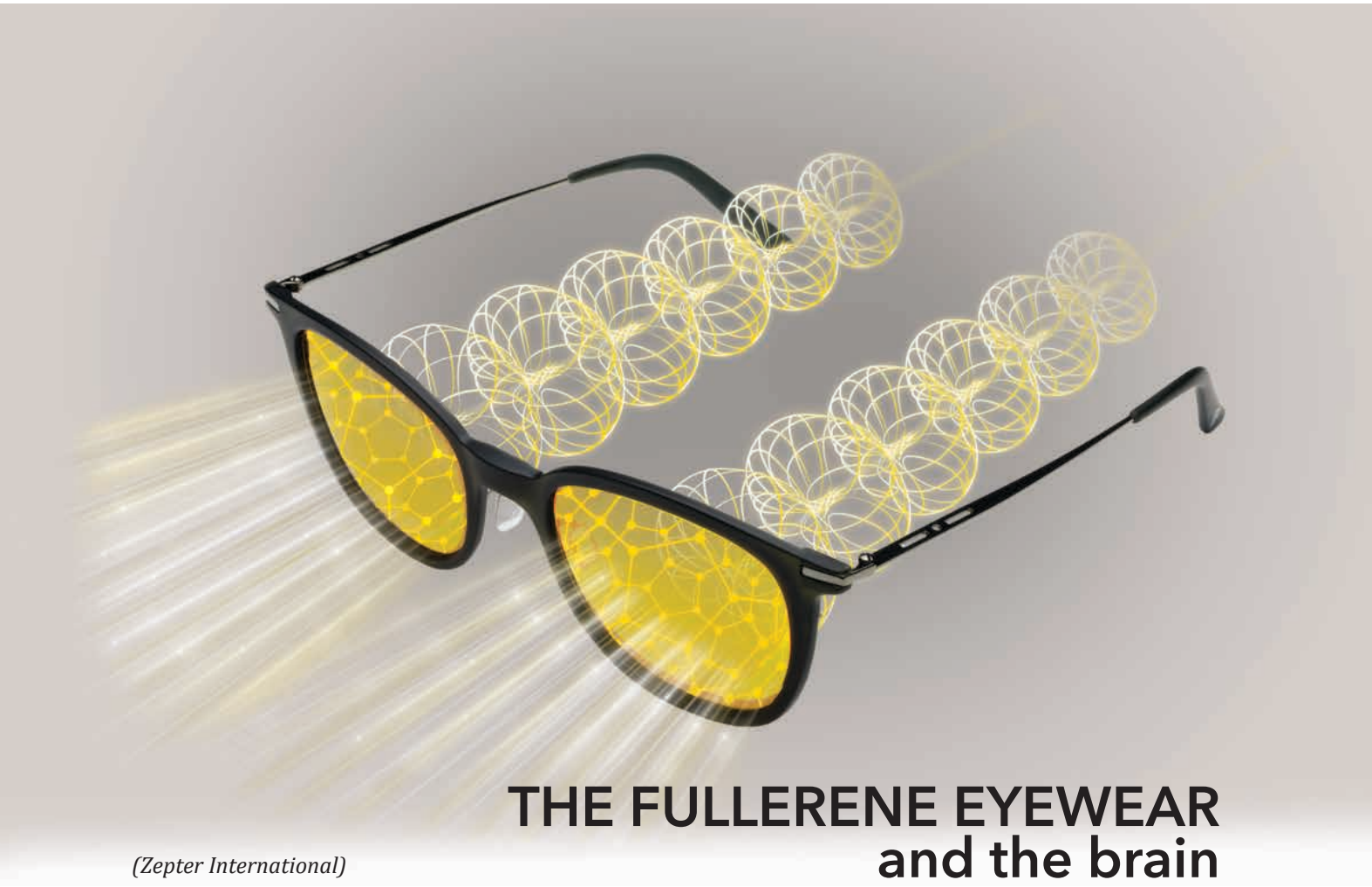


Different patterns of brain activation in response to fullerene filtered light (left), hydroxylated fullerene water complex (middle), and combination of both (right). Increased activation is pseudo colored pink, and decreased activation is pseudo colored blue. Highlighted areas show amygdala (in left and middle) and prefrontal cortex in right.

The effect of light on the mental functions of humans

Daily dosed exposure to sunlight has a positive effect on mental health and the human body in general. The negative effects of sunlight are reflected in the uncontrolled exposure to UV rays, as well as high-energy blue and infrared radiation.

One of the proven positive effects of light is the positive effect on the mood. After exposure to light, serotonin levels increase. Serotonin is a neurotransmitter that is projected into wide regions of the entire brain (basal ganglia, limbic system, hypothalamus and cerebellum). This claim is supported by the fact that the level of serotonin is higher during the summer months. Its influence on the limbic system plays a role in shaping mood, anxiety and aggression, as well as in pain regulation. Increased serotonin activity is associated with improved mood and sleep but also with shaping sexual activity. Decreased activity is associated with poor impulse control, depression and decreased sleep. In the northern parts of the globe, where there are fewer sunny days in the winter and where daylight is other-



(Zepter International)

THE FULLERENE EYEWEAR and the brain

Analyzing the obtained results, we noticed that there is an improvement in most of the respondents by individual scale items. A significant difference was observed in the sphere of somatization of anxiety disorder, depressive and anxiety mood, as well as a positive effect on the sleep.

Jelena Boljanović, Marija Miljković, Branislava Jeftić

wise reduced, a more frequent occurrence of depression has been described, which is called seasonal depression. This depression is characterized by an increased need for carbohydrate intake, increased sleep and a significant increase in body weight. It seems that this is a disorder of the so-called biological clock, which is "reset" by the appearance of the sun, i.e., the summer. It has been determined that melatonin, a hormone of the pineal gland, the production of which is affected by the Sun, could play a significant role in the development of this type depression. Therefore, light therapy has been introduced, during which the subject is exposed to strong artificial lighting (as close to the Sun's spectrum as possible) for three hours, which improves mood and reduces depression.

Also, it has been proven that light exposure reduces stress and has a positive effect on sleep. By definition, sleep is a periodic and temporary interruption of wakefulness in which motor inactivation is almost complete, awareness of the external environment is maximally reduced, while the threshold of reactivity and reflex irritability is raised. Sleep defined in this way implies that it is a part of a complete, circadian (whole-day) rhythm of wakefulness and sleep that lasts about 24 and a half hours (Marić, 2005). The founder of modern chronobiology F. Halberg introduced the term circadian rhythm which is actually an endogenous rhythm because it exists in constant conditions of continuous darkness or light. The circadian rhythm is triggered by a "biological clock" that acts endogenously, independently of the environment and in the absence of external stimuli. The purpose of the circadian rhythm is to maintain the internal activity of the organism, harmonized and harmonious with the outside world.

Sun exposure during the day affects the amount of melatonin produced by our pineal gland. Concentrations of this hormone are lower in the evening when it is time to sleep. During the summer months, the day is longer, so the later going to sleep is more likely. Melatonin participates in the regulation of important physiological and pathological processes. As a hormone, it has a central role in the regulation of biological circadian and seasonal rhythms, which is why it is considered the "primary harmonizer" in the human body. It is very important as a regulator of the mother-fetus relationship as well as other physiological and pathological conditions: sleep induction, mood swings, modulation of the cellular and humoral immune response, maintenance of body weight, reproduction, etc. It is considered a very strong antioxidant and a powerful anti-aging agent.

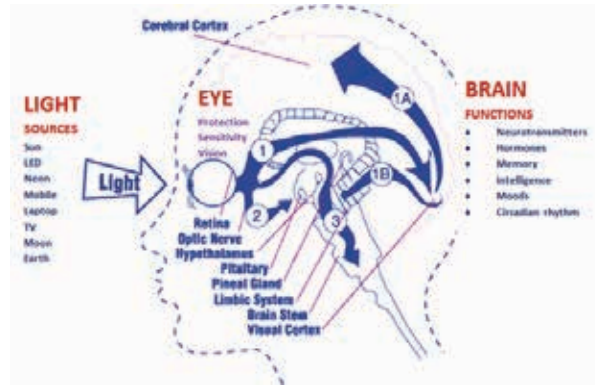


Figure 1: Eye protection and brain activity will depend on the type of incoming light (Sun, LED, etc.). Light through the brain is known to affect the immune and endocrine systems. However, light modulates both human mental states and the waking-sleeping relationship (Source: Koruga, Đ., Hyperpolarized light, ZEPTER BOOK WORLD, Belgrade, 2018)

Biological effect of visual spectrum light on the organism (study I)

In everyday life, we encounter natural sunlight which, if direct, is diffuse, and if it is reflected then it can be diffused and polarized (objects from the environment that randomly reflect at Brewster's angle, like snow, river, lakes, sea, etc.). In its spectrum, the ratio of photons with blue, green and red properties is represented in such a proportion that it gives out white light. However, sunlight contains UV, high-energy blue light as well as infrared light, which can be harmful if exceeding a certain intensity and

duration. Therefore, it is necessary to provide adequate protection in order to protect the damage to the eye structures, but also to prevent the impact on the inadequate secretion of neuro-substances. In addition, artificial lighting based on halogen, neon and LED bulbs is increasingly present in everyday life. The spectra of these artificial lights are completely different from natural sunlight.

In order to overcome the problem of light, the research team ZEPTER GROUP has developed nanophotonic lenses based on C_{60} molecules, which when any of these lights passes through their lens, acquires new properties that are adapted to biomolecules and tissues (not to damage them) but also to regulatory mechanisms of the neuro-endocrine-immune system. This new light takes on the properties of hyperpolarization and hyperharmonization.

The initial study on the impact of hyperpolarized (HPL) and hyperharmonized (HPH) light on the human body was done in 2018, under the guidance of professor Branislav Filipović from the Faculty of Medicine in Belgrade. The study involved 24 respondents who underwent psychiatric exploration before and after Bioptron therapy and the use of Tesla HyperLight Eyewear. All respondents were introduced with the details of the study and all signed a informed consent form to participate in the monitoring of therapeutic effects.

Respondents were of both genders, ranging in age from 31 to 69. They were divided into four groups. Members of the first group wore the nano-photonic eyewear, members of the second group wore the eyewear and were treated with Bioptron, in the third group the respondents were exposed to Bioptron with eyes closed and in the fourth group respondents were exposed to Bioptron but with eyes open. In the first group, there were 6 respondents who wore eyewear for two hours a day and four days a week. Eight respondents in the second group wore the eyewear two hours a day four days a week and were exposed to Bioptron for 10 minutes three days a week with their eyes closed. Six patients of the third group were exposed to Bioptron for 10 minutes three days a week with their eyes closed during treatment. Four respondents in the fourth group were exposed to Bioptron for 10 minutes three days a week with their eyes open during treatment.

Each respondent underwent a structured psychiatric interview. Psychiatric exploration consisted of the Hamilton Depression Test (17 items) and the Hamilton Anxiety Test (14 items). After the examination, the respondents were divided into groups according to the score on the tests.

The laboratory part of the study includes analyses of saliva and a 24-hour urine sample. Melatonin was analyzed from four samples, two in the morning (between 6 a.m. and 8 a.m.) and two in the evening (between 10 p.m. and 12 p.m.). All respondents received detailed instructions on diet, oral hygiene, and sample collection procedures. Serotonin was analyzed from urine collected over 24 hours.

Study results:
Respondents from the second group who wore the eyewear and were exposed to Bioptron had a lower mean serotonin value (Figure 2). Mean serotonin levels differed before and after treatment also in the third group of respondents who were exposed to Bioptron with their eyes closed.

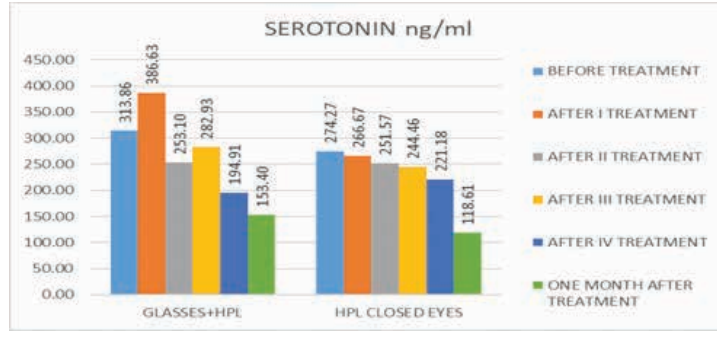


Figure 2: Mean serotonin before, after each treatment and after completion of treatment.

The mean value of melatonin (Figure 3) differed significantly before and after treatment in the second group of respondents. Morning melatonin values were significantly lower while evening values were significantly higher after treatment compared to before in the second group of respondents.

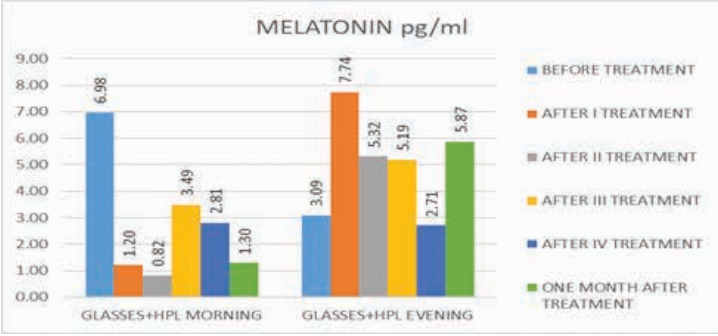


Figure 3: Mean melatonin levels before, after each treatment and after completion of treatment.

Regarding the psychiatric part of the study, although due to the small number of respondents, no statistically significant difference was found, after the exposure to Bioptron, the number of people with anxiety among the respondents decreased. Hamilton anxiety rating scale (HARS) revealed significant improvement in HARS total scores: 7.82 ± 1.61 before and 4.4 ± 0.65, after the treatment with nanophotonic light based on the C_{60} fullerene. Significance has been confirmed by Students' t-test: t = 2.18, Df = 62, p = 0.033. HARS outlined two separated items, as significantly improved after the treatment with C_{60} fullerene: feel of tension (chi square = 10.12, df = 3, p <0.03) and autonomic system correlates of anxiety

Evaluation results by special items: The biggest difference was noticed in the first item, which refers to the presence of anxiety, where according to the Hamilton test, there is a noticeable drop in the anxiety score. After the treatment, the tension was also reduced and sleep was improved. A statistically significant difference was found on the items of muscle numbness and other sensory symptoms (wheezing and ringing in the ears). Significant improvement was found in the area of somatization of anxiety disorder (cardiovascular, respiratory and digestive symptoms were reduced). Partial reduction also exists in neurovegetative disorders (sweating of the face and hands, dry mouth and redness of the face).

Based on the analyzed results, it can be concluded that the level of anxiety after treatment is significantly lower compared to the period before exposure to HPL and HPH ca C_{60} nanophotonic lenses. The level of serotonin concentration after the first week of treatment indicates a positive effect of HPL and HPH on mood. The full effect of melatonin was shown after a month of treatment in respondents who wore the eyeglasses and were exposed to Bioptron.

Testing the effect of Tesla Hyperlight Eyewear on the psychological state of the brain (study II)

In order to consider the influence of nanophotonic eyewear, a study was designed so that three types of lenses were made and eyewear were made that had all three of them. The first type of eyewear had both lenses (left and right) without C_{60} molecules, but the color of the lens (visible part of the spectrum was the same) was made so that it did not differ from the color of the lens with C_{60} molecule. (these eyeglasses with both false lenses we marked "XX"). The lenses marked "X" contain C_{60} molecules and, in addition to the visible spectrum, they also generate an exciton to give polariton light (polariton = photon + exciton), so we have three groups:

1. XX eyewear – both false lenses
2. XY eyewear – one false lens, the other fullerene (C_{60})
3. YY eyewear – both fullerene lenses (C_{60})

In each group, there were 6 respondents (a total of 18) who were distributed according to the principle of stratified random sampling and all respondents signed a written informed consent form to participate in the study. So far, a second psychiatric examination has been performed for six examinees per group, and the study is being continued, where there will be 10 examin-

ees in each group (30 in total). The results presented in this paper refer to 18 respondents.

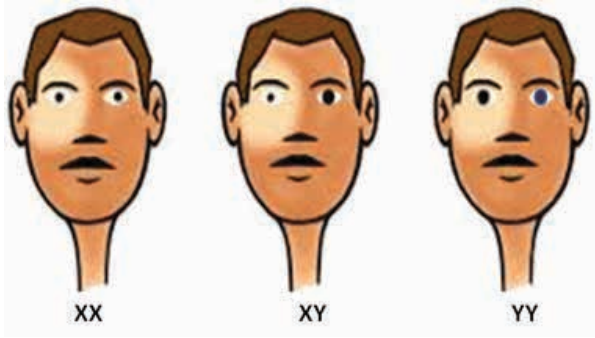


Figure 4: Three types of respondents: XX– both false lenses, XY– one false lens, the other fullerene (C_{60}) and YY– one false lens, the other fullerene (C_{60})

All (30) respondents underwent the first examination before wearing eyeglasses, which included taking personal and family history, measuring body weight and height, measuring blood pressure and the heart rate. Considering that based on the previous research it was hypothesized that Zepter eyewear with fullerene lenses improved *concentration, attention and memory*, increased *productivity* and *efficacy*, reduced *tension* and positively affected the *mood*, at the first psychiatric exam all respondents underwent the Hamilton anxiety and depression scale (HADS) test. In this study, the same psychological methodology was used as in the previous initial examination conducted under the guidance of professor Branislav Filipović, PhD, to whom we dedicate this article. The Hamilton Depression Scale consisting of 17 items and the Hamilton Anxiety Scale consisting of 14 items were used and both tests allow the assessment of mental functions with high accuracy. The questions refer to the *quality of sleep, mood, work and activity, concentration and attention, anxiety, general physical symptoms, loss of body weight*, etc.

The respondents wore eyewear daily for one to three months, after which a second psychiatric examination was performed, and the following results were obtained:

Group XX (both lenses false)

The average value of scores on the **depression** test before wearing eyewear was 4.33 and after wearing eyewear it was 2.50, whereat the standard deviation before and after wearing eyewear was 2.58 and 1.87, respectively. In five out of six respondents, the value of the score decreased. The average value of scores on the **anxiety** test before wearing eyewear was 4.83 and after wearing eyewear it was 2.33, where the standard deviation before and after wearing eyewear was 2.40 and 2.73, respectively. In five out of six respondents, the value of the score decreased, whereas the change in the score of 100% was recorded in three respondents.

Group XY (one false lens, other, fullerene lens)

The average value of scores on the depression scale before and after wearing eyewear was 5.33 and 3.33, respectively, whereas the standard deviation being 3.50 and 2.42, respectively. In five of six respondents, there was a decrease of the scores after wearing eyewear, while in one respondent, the value remained the same.

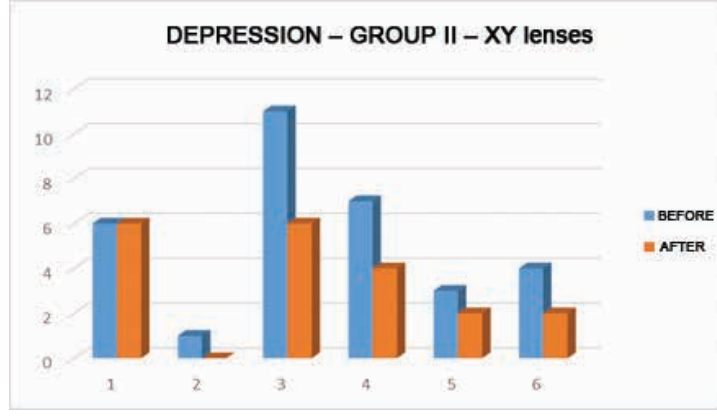


Figure 5: Display of total scores on the depression scale before and after wearing eyewear for each respondent (1 to 6)

The average value of the scores on the anxiety test before and after wearing eyewear was 5.17 and 2.33, respectively, while the standard deviation was 3.31 and 2.16, respec-

tively. The scores were decreased among all respondents.

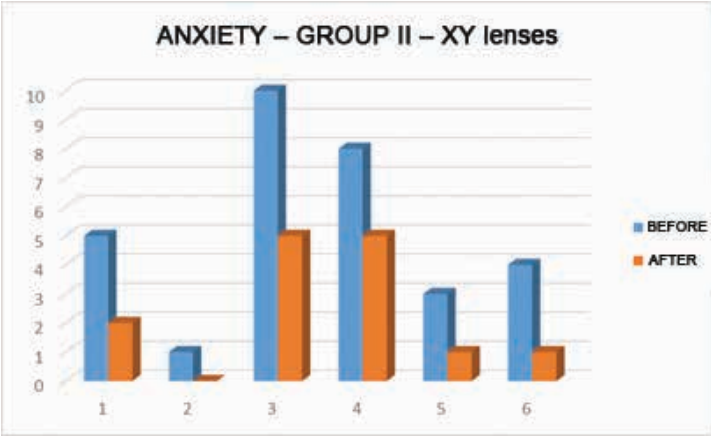


Figure 6: Display of total scores on the anxiety scale before and after wearing eyewear for each respondent (1 to 6)

Group YY (both fullerene lenses)
The average value of scores on the **depression** test before and after wearing eyewear was 4.83 and 3.17, respectively, with the standard deviation being 3.19 and 1.94, respectively. In three respondents there was a decrease in the value of scores, in one subject the value remained unchanged, while in two respondents there was an increase in the value of scores after wearing eyewear. A small change of 4.44% with a high standard deviation is the realization of the first three members of the Fibonacci order (the current situation resists the new changes, wearing eyewear must take longer, but initially, in the first three months, two hours a day, then the next six months, four hours a day; only after a year has passed during which the eyewear were worn occasionally and all four seasons pass, can they be worn constantly.

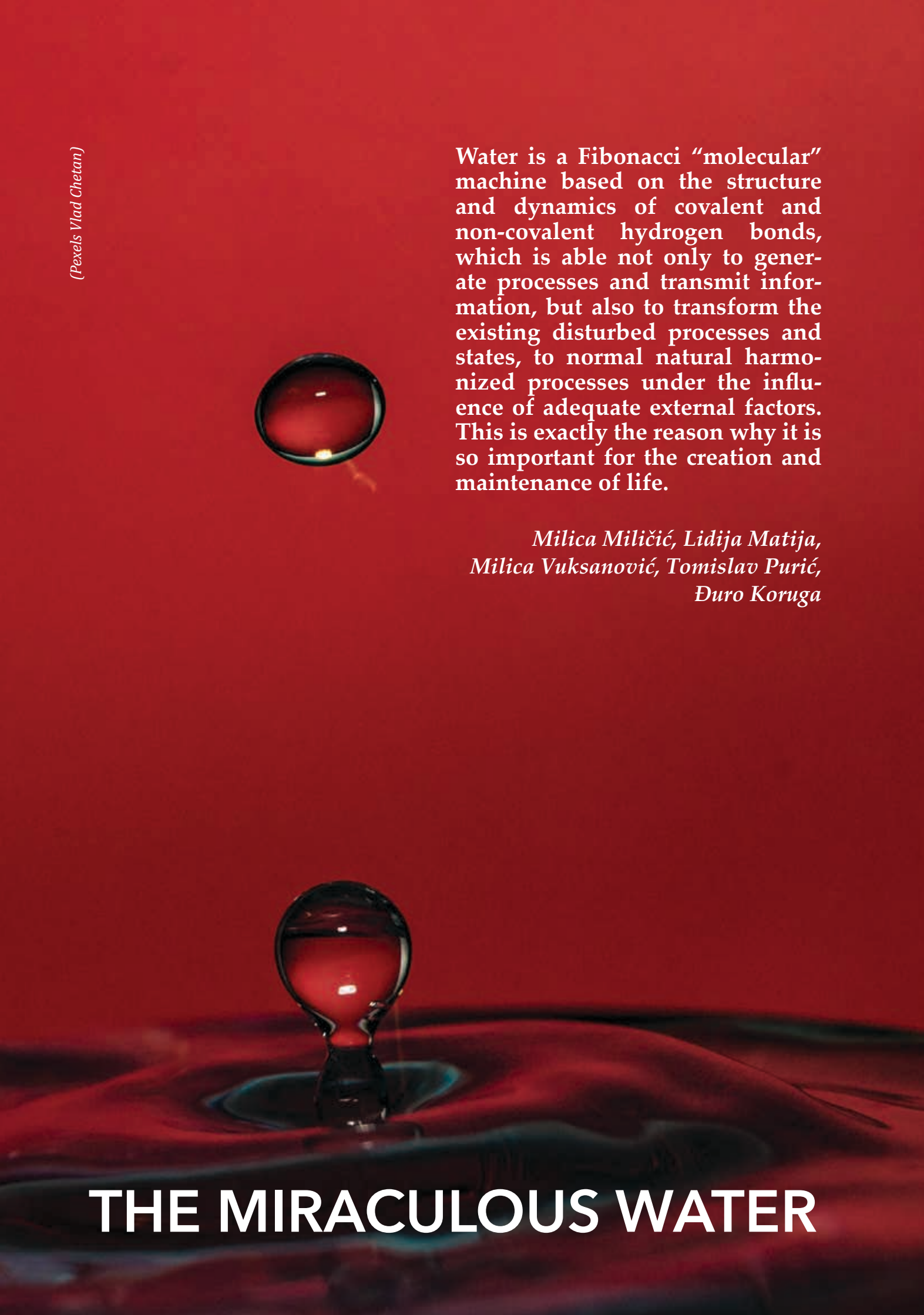
The average value of the scores on the **anxiety** scale before and after wearing the eyewear was 5.33 and 4.50, with the standard deviation being 2.73 and 2.43, respectively, after wearing eyewear. In three respondents, the value of scores decreased, in two respondents it increased, while in one subject the value remained unchanged after wearing the eyewear.

Conclusion:
The results of the t-test show that statistically significant differences between the groups exist (depression: $p = 0.04$, anxiety: $p = 0.03$) only in group II: (XY – respondents who wore eyewear with one real and one false lens).

Analyzing the obtained results, we noticed that there is an improvement in most of the respondents by individual scale items. A significant difference was observed in the sphere of somatization of anxiety disorder, depressive and anxiety mood, as well as a positive effect on the sleep.

Most respondents in the XY group improved their mental functions after wearing eyewear. This initial score of six respondents per group indicates (very interestingly) that the combination of XY (false-fullerene) lenses gives better results in the symptoms of anxiety and depression. The reason can be multiple: 1. Small number of respondents, 2. It is necessary to gradually get used to fullerene light (the dose is smaller, which means that in the beginning the length of wearing fullerene eyewear is very important), and 3. The difference in the length of wearing eyewear during the experiment – some respondents wore them for a month and some for three months (due to the COVID-19 pandemic, it was not possible to carry out the examination after the month period).

We believe that there are positive psychological changes when wearing fullerene eyewear, but that wearing should be occasional and that due to the evolution of the human brain under the influence of the sunlight, one should always be exposed to daylight without the eyewear, at least 20 percent of the time. To get more reliable results, the respondents should be psychiatric patients with a verified diagnosis of depression or any of the disorders from the anxiety spectrum. Further trials in groups of 10 respondents (30 in total) are ongoing and the results will be presented when the study is completed.



(Pexels Vlad Chetan)

Water is a Fibonacci "molecular" machine based on the structure and dynamics of covalent and non-covalent hydrogen bonds, which is able not only to generate processes and transmit information, but also to transform the existing disturbed processes and states, to normal natural harmonized processes under the influence of adequate external factors. This is exactly the reason why it is so important for the creation and maintenance of life.

Milica Miličić, Lidija Matija,
Milica Vuksanović, Tomislav Purić,
Đuro Koruga

THE MIRACULOUS WATER

„Sit down beside this well and take a draught
Of its clean,hyper harmonized, water. It will soon unveil
To thee the frightful mistery of thy fall."
P. P. Njegoš (1813-1851)
„The ray of the microcosm", II, 304-307.

Water, the substance that at first glance seams so simple and plain, and yet it has shown to be one of the most mysterious and valuable known to mankind. Why is that so? Why does water play such an important role in the existence of life? Apart from the already well known facts about it, that is actually yet to be truly revealed. Even before the science has reached the heights of the present day, people anticipated the importance of water. The ancient Babylonians believed that two primordial gods – Abzu (the god of fresh water) and Tiamat (the goddess of salt water) had mixed their waters and given birth to all the other Babylonian gods. Other than the myths such as this one which were present in different mythologies of that time, ancient philosophers were also pointing out how water is essential to everything on Earth. Thales of Miletus claimed that "water is the origin of all things". However, thanks to the development of science, many other compounds that make up nature have been discovered to present day, and we can say that Thales' claim cannot be completely true. Nevertheless, we still can't fully discard it.

To further investigate the significance of water, we should begin with basic facts. Water makes up about 70% of the cell, the rest consists from other compounds, mostly proteins (15%), RNA (6%), ions and small molecules (4%), phospholipids (2%), polysaccharides (2%) and DNA (1%). As protein synthesis takes place in the cytoplasm of the cell, the cell water contains about 20% of metabolic water. The body as a whole has about 72% water, and the rest is dry matter; the lungs, blood and brain are the richest in water. With age, the percentage of water decreases in all organs, especially in the skin (from 70% to 60%).

A water molecule is a composition of two hydrogen atoms and one oxygen atom via covalent hydrogen bonds. The strength of the OH covalent bond is 460 kJ/mol (4.77 eV), while the strength of the non-covalent O-H bond is 10-60 kJ/mol (0.09-0.48 eV), depending on the temperature and organization of water molecules in open chains or closed clusters. Two (dimer) or more water molecules (trimer or longer water chain) interact via non-covalent hydrogen bonds. It is common knowledge that the basic interaction of water molecules in water is carried out through non-covalent hydrogen bonds and that the process of self-ionization of water is also present. Depending on the ratio of $[H_3O]^+$ and $[OH]^-$ ions, water as a medium in which chemical reactions take place, and an active participant in them itself, can be neutral (the equal amount of $[H_3O]^+$ and $[OH]^-$), acidic (more $[OH]^-$) or basic (more $[H_3O]^+$).

It is also known that the free energy of a physico-chemical process is able to perform work. The second law of thermodynamics says that in spontaneous chemical reactions, a process occurs in which free energy decreases, and then ΔG is negative. In the state of equilibrium, there is no change in free energy, so $\Delta G = 0$. In that case, the closed system has the smallest amount of free energy. When the biochemical reaction approaches equilibrium, the free energy is increasingly converted into heat, which also means the increase of entropy (level of disorder). It sounds as a paradox, but in the state of equilibrium, the system is in the greatest "disorder" (that is why we say that entropy is a degree of disorder). The time needed for interaction of water molecules – non-covalent hydrogen bonds and reorganization of dipole moments, ranges between 1-100 ps, while macroscopic dynamics and conformational changes of biomolecules occur at the level of micro seconds (μs) or milliseconds (ms), and sometimes several seconds (s).

Consider the interaction of two isolated water molecules via non-covalent hydrogen bonds as shown in the figure. In the figure,

the value of the covalent hydrogen bond is marked with "1", "x" is the variable distance between the center of the hydrogen atom of one molecule and the center of the oxygen atom of another water molecule. Hence, "x + 1" is the distance between the oxygen centers of two water molecules.

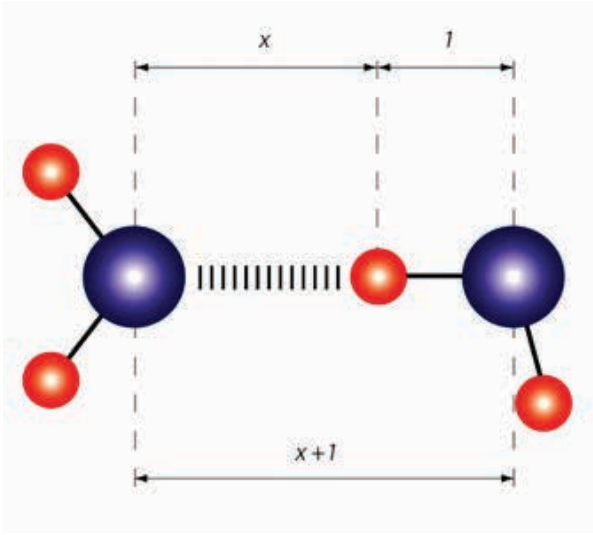


Figure 1 The distance between the oxygen centers of two water molecules.

The length of the covalent hydrogen bond is estimated to be 0.0984±0.0025 nm, and we will declare this as a unit ("*1*"), to reference the non-covalent hydrogen bond. In other words, we will observe the change of the noncovalent hydrogen bond "*x*" (as a larger part in the system "*x + 1*") in relation to "*1*" (a smaller part in the system "*x + 1*"). It is known that water molecules spontaneously organize and decompose, ie. have the property of self-organization (and self-control) based on a stable covalent hydrogen bond, "*1*". The ratio of "*x*" to "*x + 1*" should be equal to the ratio of "*1*" to "*x*" (the ratio between a larger part and a whole is equal to the ratio between a smaller part and a larger part). Based on the that, the proportion can be formulated as $x : (x+1) = 1: x$, which translates to $x^2 = x + 1$, or $x^2 - x - 1 = 0$. The solutions of this quadratic equation are $x_1 = 1.61803$, which we will denote by Φ, and $x_2 = - 0.61803$, which we will denote by -ϕ. Thus, we see that in order for two molecules to spontaneously organize into a dimer, the non-covalent hydrogen bond should be 1.61803±0.025 larger than the covalent hydrogen bond. Therefore, the oscillatory process takes place in the range of 1.59303 and 1.64303 of the value of the covalent hydrogen bond. If, however, we observe the organization of water molecules in a chain, as given in the figure below (left), then the code for one water molecule is 1, for two 1 + 1/1, for three 1+ 1 / (1+ 1) etc. We see that the system is becoming more and more complicated, and the simplified organization of water molecules shown below is only one possible solution. If we now calculate the values of the quotients (from the picture on the left) the values are 1, 2, 3/2, 5/3, 8/5 and 13/8. So, if observe a dimer, then when two molecules of water are at a distance which is twice the value of length of a covalent hydrogen bond, they enter a non-covalent hydrogen bond. As we know from mathematics, the convergent result of this series is Φ (1.61803…).

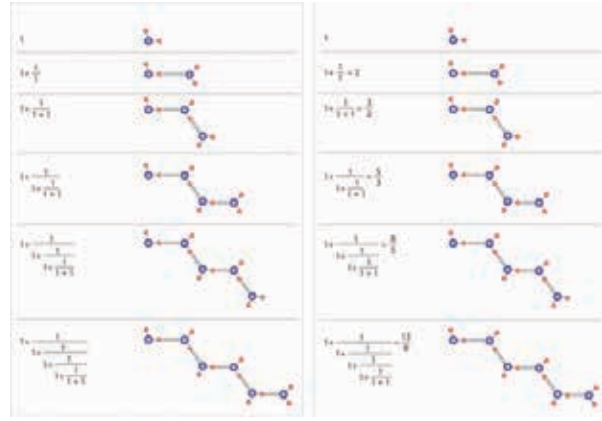


Figure 2 Water molecules organized in a chain as a harmonized water

A graphic representation of the values of the organization of water molecules in chains is given in the following figure, where we see that the establishment of a non-covalent hydrogen bond is the longest in water dimers and is equal to twice the length of covalent hydrogen bond. However, when the bond is established and stabilized, the non-covalent hydrogen bond oscillates between 1.615 and 1.625

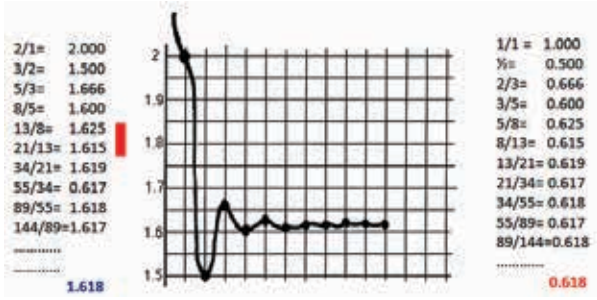


Figure 3 A graphic representation of the values of the organization of water molecules in chains

The question is: Which length of a chain of water molecules is stable? The answer lies in the determinant of the system. A chain where the determinant of the values of non-covalent hydrogen bonds is equal to zero is stable. If we form a chain of 3, 4, 5… 8 molecules of water, it will not be stable, it will be created and decomposed in a few picoseconds. However, if a chain of nine molecules of water is created (not starting from a monomer or dimer, but from a trimer), we see that the determinant of such a system is equal to zero:

$$ {}^{3}D_{(H_2O)_9} = \begin{vmatrix} 3 & 5 & 8 \\ 13 & 21 & 34 \\ 55 & 89 & 144 \end{vmatrix} = 0 $$

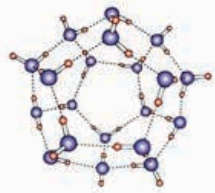


Figure 4 The determinant of the Fibonacci system and a stable water molecule as main element of "clear water" or "hyper harmonized water"

If water molecules are organized into clusters, then the on with 20 water molecules distributed on the surface of the sphere and one molecule in the center of the sphere) is the most stable. The most common water organizations in nature are dimers and trimmers, but combinations of chains and clusters may also exist. Dimers, trimers, H^+, $[OH]^-$ ions, water chains and clusters together are the ones to determine the properties of water depending on their ratio, ie. representation in water.

Water acquires special physico-chemical properties depending on the organization of water molecules in it. A particularly interesting phenomenon are water clusters, which have been thoroughly studied for more than fifty years (primarily from a theoretical aspect). The application of sophisticated computer programs simulates the processes of creation and decomposition of water clusters, starting from dimers to complex water cluster structures with over 200 water molecules.

We opted for the experimental study of water clusters based on measurements of paramagnetism and diamagnetism. In the textbook literature, you will find that water is diamagnetic, and this is true when it comes to water molecules and small clusters of water. The knowledge in question dates back to Michael Faraday in 1845. But when larger clusters are formed, the situation is different. The diagram, obtained experimentally (under the conditions of the Earth's magnetic field), shows the formation of clusters with small paramagnetic amplitudes, which are then broken down into dimers of water molecules (diamagnetism), and then reorganized into clusters. However, when they are organized into larger clusters (1-2 nT), and then reorganized into monomers, then the diamagnetic peaks are much larger, even -2.5 nT. Based on the measurement of paramagnetic/diamagnetic properties of water, we can say that water is pulsing (water clusters are created and decomposed).

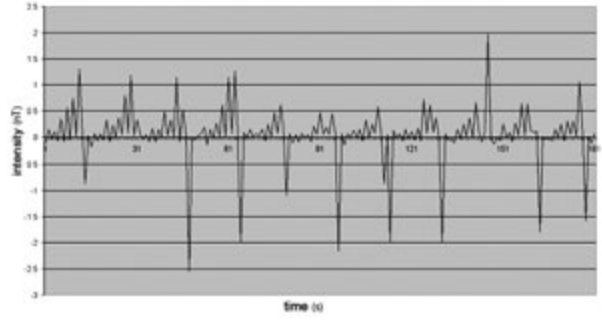


Figure 5 Paramagnetism/diamagnetism oscillation of water in the Earth's magnetic field: realities and decomposition of water clusters

When water is exposed to an oscillatory magnetic field, much stronger than the Earth's, whose oscillations are according to

the law of Φ, then three new phenomena can be observed in relation to the previous diagram. Water has relatively stable paramagnetic properties at 0.2 nT (with small changes in intensity), then after 60 seconds of exposure to an oscillatory magnetic field there is a pronounced peak value of 1.2 nT which decreases to 0.2 n until 162 seconds of stimulation, and then it abruptly turns into diamagnetism. After three seconds, it returns to a stable paramagnetic value of 0.2 nT.

Based on the diagram, we see that it is possible to organize water molecules into stable clusters (paramagnetism 0.2 nT) under the action of an oscillatory magnetic field according to the law of Φ, according to which water molecules can also be organized. But as shown, there are two other interesting areas where paramagnetism is dominant (in the first case), and diamagnetism is dominant (in the second case). When it comes to the peak of paramagnetism, it can be understood why a cluster with a value of 1.2 nT reorganizes and settles at a smaller value of 0.2 nT; but it is very difficult to explain why the water would become a diamagnetic, and then stabilize again as a paramagnetic. It was expected to oscillate around zero like the ordinary water (example from the first diagram). However, this peak strongly indicates the possibility that water in the form of nanoclusters has the property of a memristor, a kind of memory at the nano level.

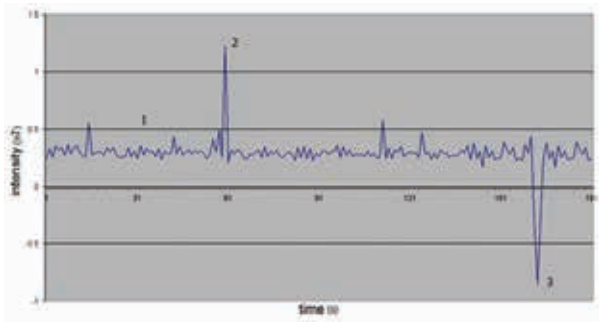


Figure 6 Paramagnetism/diamagnetism oscillation of water under the influence of a strong magnetic field: stable water clusters (hyper harmonized water)

To understand these phenomena, we must return to the structure of water molecules. Modern technological achievements, such as AFM (Atomic Force Microscopy), provide better insights into the structural organization of water molecules on the surface and in layers, but do not yet provide adequate structural arrangement of water molecules. However, in the second half of the 20th century, Duncan and Pople offered a precise map of the electron density of water molecules and the distribution of charges around oxygen and hydrogen atoms. As can be seen from the picture, the water molecule is a dipole: the blue part where the oxygen atom is located is negatively charged, and the red part where the hydrogen atoms are located is positively charged. We have two types of charges that three atoms share. But there is also a white region that is "neutral." Why is it so?

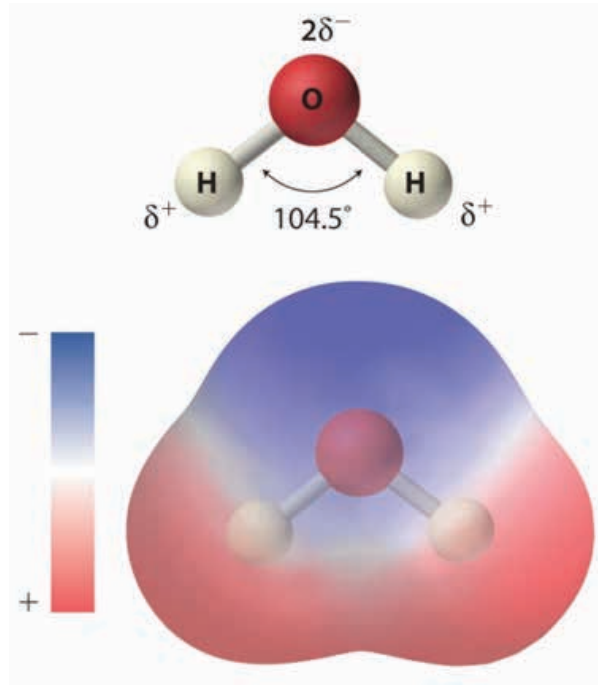


Figure 7 Fractal model of water molecules: two types of charges and three atoms

Valence electrons in the water molecule move at the speed of approximately 10^6 m/s, two orders of magnitude slower than the speed of light. The size of the oxygen atom is 66 pm, while the size of the hydrogen atom is 37 pm, so valence electrons spend more time in the oxygen region than in the hydrogen region. Hydrogen's electronic shell acts like a "magician's cloak." Calculations show

that the negative charge of water molecules has a "defect" of 9.0654% (so much is the "white", neutral zone), so that two charges for three atoms seem as if the water molecule from the aspect of charges is composed of 2,719 atoms. In other words, a water molecule is a fractal entity. If we keep in mind that the equilibrium constant $[H_2O] = H^+ + [OH]^-$ is calculated on the basis of free Gibbs energy according to the law $e^{-\Delta G^0 k}$, we see that these are the same bases in the arrangement of water molecules and their energetic processes, because $e = 2.72$.

From these two aspects, it follows that the same basis lies in the structure and energy of water molecules. But, water in the process of varying in the areas of paramagnetism/diamagnetism shows the properties of "memristor", so the third aspect must be taken into account, and that is informational aspect. To choose a starting point, we should consider the optimal basis of code information capacity $K=anR$, where a is the coefficient of proportionality of information capacity (K) and code system, n is the number of elements in the code and R is the basis of the code system. For example, we know that for the genetic code $n = 3$, $R = 4$, $a = 1$, $K = 64$ (43 = 64: triplets of adenine, thymine, cytosine and guanine form the genetic code of information capacity 64). In technology, and in our brain, we have digital codes, so $R = 2$ (there is electricity, no electricity, etc.), ie the code system is of type 26 = 64 (binary with six elements in code 011101, but in 64 different combinations). In the field of coding, however, it is known that the optimal basis of the coding system is $R = e$, not $R = 2$ and $R = 4$. Thus we come to the conclusion that nature has through a water molecule (structural-energic-informational entity based on "e ") created the preconditions for the emergence of biological systems with a genetic and neurological code. So far, we have known about two codes (binary and ternary, whose bases are integers), and we also know about the third, the optimal one, which is fractal (the base is not integer but is 2.7182). It is now becoming a little easier to see how it is possible that nature could have produced life without knowing formulas and mathematics in the way we know them. But more importantly: it gave our minds the ability to create a reality based on a decimal system that corresponds to "one-on-one" with "water mathematics" because any number of the decimal system (especially its basic cell numbers: 0 , 1, 2, 3, 4, 5, 6, 7, 8, 9) can be generated on the basis of Φ and ϕ.

$$\Phi^0 - \phi^0 = 0$$
$$\Phi^1 - \phi^1 = 1$$
$$\Phi^1 + \phi^2 = 2$$
$$\Phi^2 + \phi^2 = 3$$
$$\Phi^3 - \phi^3 = 4$$
$$(\Phi + \phi)^2 = 5$$
$$2(\Phi^2 + \phi^2) = 6$$
$$\Phi^4 + \phi^4 = 7$$
$$2(\Phi^3 - \phi^3) = 8$$
$$3(\Phi^2 + \phi^2) = 9$$
$$2(\Phi + \phi)^2 = 10$$
$$\Phi^5 - \phi^5 = 11$$
$$\cdots\cdots\cdots$$
$$\Phi^6 + \phi^6 = 16$$
$$\cdots\cdots\cdots\cdots$$
$$(\Phi^3 + \phi^3)^2 = 20$$

The charge ratio (O-/H+) in the water molecule is harmonized according to the law F, and between the water molecules according to the law of Φ, so that the entire charge system of covalent-noncovalent bonds is arranged according to the law of ϕ. This indicates that water has an immanent potential harmonic arrangement, and that the presence of other elements, in higher concentrations, is a disturbing factor.

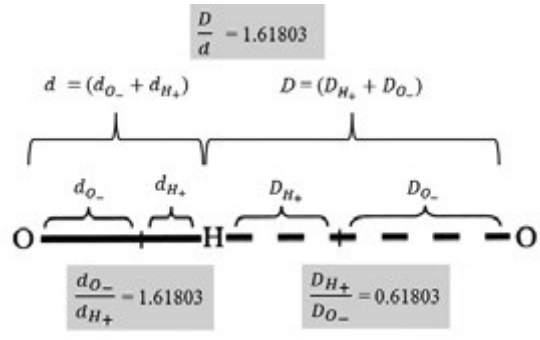


Figure 8 The harmony of charge organization in water

Water is a Fibonacci „molecular" machine based on the structure and dynamics of covalent and non-covalent hydrogen bonds, which is able not only to generate processes and transmit information, but also to transform the existing disturbed processes and states, to normal natural harmonized processes under the influence of adequate external factors. This is exactly the reason why it is so important for the creation and maintenance of life.

Water Based Nanomedicine is the type of research that is creating products at the nano and quantum level that restore impaired functions in the body) and is conducted at the TFT Nano Center (ZEPTER INTERNATIONAL) and at the Department of Biomedical Engineering, Faculty of Mechanical Engineering, University of Belgrade. Both experienced and younger researches and engineers work on investigating water properties and creating products which allow consuming water in its purest and healthiest form. Zepter's appliances such as Aqueena Pro and Edel Wasser were designed and manufactured with dedication to that cause, and are also being upgraded by various innovations that come from young engineers.

Figure 9 AqueenaPro with its recent upgrade: UVC Aqua Filter

One of such recent upgrades was a water sterilization unit based UVC light. It's well known that UVC light interacts with microorganisms such as hurtful viruses and bacteria by decomposing their cell membrane and destroying their genetic material – disallowing them to survive or replicate. Therefore, a system that consists of a high quality UVC lamp, a spiral tube made from the special FEP (fluorinated ethylene propylene – a material that doesn't degrade under the influence of that type of light) material and the length of which allows adequate water flow and hence complete purification and sterilization of it, was created.

Figure 10 The main components of Aqua UVC Filters

These appliances have been designed to improve the quality of consumed water and therefore the consumer's well-being. Especially in the modern times when the lifestyle often seems to get out of our control and we need to breathe pure air, drink pure water and eat healthy food in order to stay well-rested and healthy, it's crucial to understand the importance of quality of what we intake – particularly when it comes to an essential compound for all living beings – WATER.

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(Zepter International)

REVITALIZE, RESTORE, RENEW

BIOPTRON QUANTUM HYPERLIGHT
(Experiments from the Quantum Medicine perspective)

Olja Lopushansky

Hyperlight's energy-information manipulates energy in the segments where the energy is congested or completely blocked. As a result, it is freeing the energy-stagnations and rejuvenating the body on the quantum level. Therefore, Hyperlight can be seen as bio-regenerative therapy: it restores the subtle energy fields, bringing the entire body's system back to homeostasis (natural healthy state).

Everything that exists including crystals, plants, animals, and humans is sustained by atoms that emit radiation and energy. Every cell in the body emits more than 100,000 photon-impulses per second which are responsible for maintaining health. Human cells, tissues and organs radiate energy and light *(mostly infrared radiation, which is electromagnetic radiation with a frequency lower than visible light)*. Therefore, General Medicine cannot tend to reduce human bodies-anatomy down to a simplified version that consists of only flesh, bones and blood:

We are „pulsating light-beings" whose energy (from the atomic to the molecular level), is continuously in motion. This facet is imperative for understanding how the **body's „vital energy" directs and maintains human health.**

In Traditional Medicine TM, vital energy (*qi* or *ch'i*) is described as a vital force forming part of any living entity. *Qi* translates literally as „air" and figuratively as „material energy", „life force", or „energy flow". *Qi* is the central underlying principle in Chinese and Ayurvedic Traditional Medicine. *Qi* is a vital force, the flow of which must be unimpeded for health.

When the so-called „vital-energy" flows freely, the body is in a state of coherence (healthy condition).

In contrast, if the vital-energy flow is disrupted, the body is in a state of incoherence (unhealthy condition). If the energy in one organ is disproportional, the rest of the organs are negatively influenced, and in a domino effect, the health-system is gradually collapsing.

The incoherent state can be identified with the quantum diagnostic device Veda Pulse. It is the apparatus based on the *Heart Rate Variability HRV analysis method*, recognized by the European Society of Cardiology and North American Society of Pacing and Electrophysiology.

By registering the biopotentials generated in the heart and performing HRV mathematical analyses, Veda Pulse detects the rhythm and energy of organs, meridians, regulation systems, and other vital parameters. The software portraits the energy fluctuations and stagnations in the entire bio-system.

The energy stagnations in the organs can be restored with Quantum Hyperlight therapy.

Dr. Đuro Koruga in his book „Hyperpolarized light", comprehends Quantum Hyperlight's physical characteristics and its positive effects on bio-structures. According to Dr. Koruga, there are three characteristic peaks: 5811 nm (0.0133 eV), 8732 nm (0.0268 eV), and 13300 nm (0.0181 eV) which have a **significant influence on the quantum state of biological structures (conformational state of biomolecules).**

Quantum Hyperlight possesses the same type of symmetry (energy-structure) as human biostructures. Through light-matter interactions and the resonance principles of biomimicry, Quantum Hyperlight, which is a superior bio-resonator (constant perfect structure),imposes its energetic and informational properties onto the disturbed incoherent biostructures, bringing them back to their natural and healthy state of coherence.

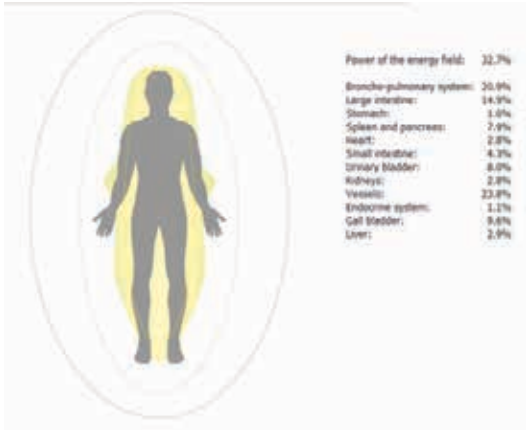
The therapeutic effects are achieved by Bioptron Hyperlight puncture on biologically active zones.

Traditional Medicine describes biologically active zones (which lie along meridians in the body) as invisible channels, where the „vital-energy" flows.

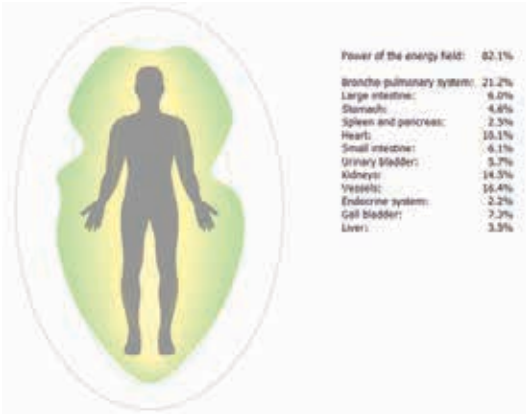
The 12 major meridians connect networks of 12 organs, organizing a system of communication throughout the body.

Hyperlight's energy-information manipulates energy in the segments where the energy is congested or completely blocked. As a result, it is freeing the energy-stagnations and rejuvenating the body on the quantum level.

Based on the quantum diagnostics results by *Veda Pulse* (functional *body-state analyses*), a noticeable positive effect on health is revealed, which is characterized by the energy harmonization in the biologically active zones that had previously an energy deficit. The BIOPTRON Veda Pulse experiment concludes: energy is transmitted exactly in the areas where there was an energy-deficit.



a. The EMF before Quantum Hyperlight exposure is very small in size, indicating energy- stagnations. This imbalanced condition, if untreated can lead to a disease.



b. After 10 minutes of Hyperlight exposure, it encourages the energy flow within the organs, increasing EMF, and establishing the harmonization in the disturbed energies in organs. The increased EMF is representing the energy replenished, energized and rejuvenating body.

Therefore, Hyperlight can be seen as bio-regenerative therapy: Quantum Hyperlight *restores the subtle energy fields, bringing the entire body's system back to homeostasis (natural healthy state).*

Since disease starts first as a „energy stagnation", before the body shows any symptoms, Hyperlight is advisable to be used as a prophylaxis treatment.

Bioptron Hyperlight Veda Pulse experiment – conducted by Oleg Sorokin, Ph.D. - Director BioKvant and Olja Lopushansky - Director Bioptron Nederland

BIOPTRON Quantum Hyperlight Experiment
Traditional Medicine Organ-pulse Analyses - Veda Pulse

The left image shows the energy-status in the body before the Bioptron Hyperlight exposure: the yellow-green boxes present the energy congestion, while the yellow boxes present the blocked energy in organs and systems. In this particular case, the energy imbalances were detected even in 9 systems.

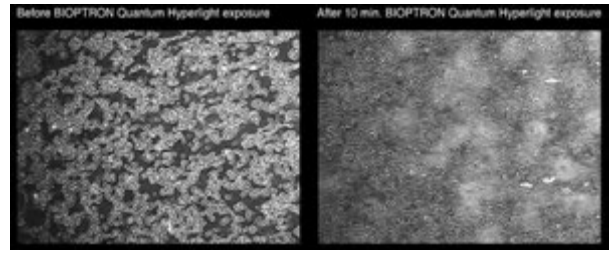
After 10 minutes of Bioptron Hyperlight exposure, the result is significant. From 9 imbalanced systems even in 6 systems is the energy revived and restored.

Scientist Prof. Dr. Đ. Koruga, the inventor of Nanophotonic Fullerene Optix (Quantum Hyperlight Optix) that generates Hyperpolarized light (Quantum Hyperlight) and Olja Lopushansky, Director BIOPTRON Nederland, looking results and analyzing the influence of Bioptron Hyperlight on the human bio-system. „Quantum Healing Festival" by Bioptron - Zepter, Perucac 2018

Renowned scientist Sir Roger Penrose (Nobel Prize Laureate in Physics in 2020), *in his book „Shadows of the mind", comprehends the research of Dr. Đuro Koruga: Understanding the geometry in bio-systems, we can decode and biohack our biology!*

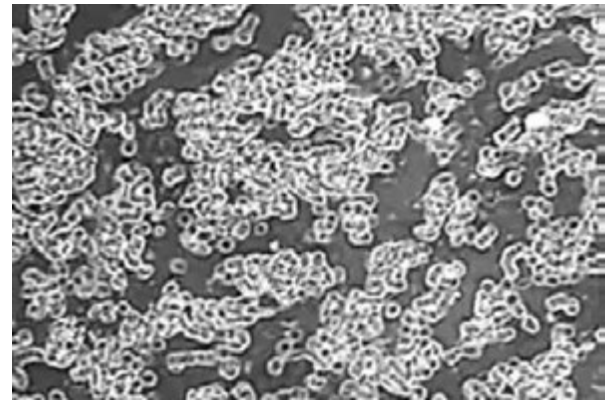
The experiment Darkfield Microscopy (Live blood cell analysis) confirms the significant positive impact of Quantum Hyperlight on biostructures:

1. Biostructure rejuvenation: *stimulation of the regenerative and reparative processes in biological structures*. Red blood cells and MICROTUBULES (tubular structures inside eukaryotic cells - part of the cytoskeleton that plays a role in determining the Torus cell's shape) are reshaped into their previous original torus shape - an ideal healthy cell condition and cell formation.
2. Quantum Hyperlight reestablishes the cell's communication: Quantum Hyperlight communicates with the molecules, cells, and tissues, conveying its ideal informational-energetic state, inducing harmonization and equilibrium in energetically disturbed biological structures, accelerating natural healing processes.
3. Improved oxygenation (supplies oxygen to tissues): red blood cells play a crucial role in the human body for their prolific ability to transport oxygen to different tissues. *„A human red blood cell is a dimpled ballerina, ceaselessly spinning, tumbling, bending, and squeezing through openings narrower than its width to dispense life-giving oxygen to every corner of the body."* (UCSD researchers, *Annals of Biomedical Engineering)*
4. *Promoted cell biostimulation at the quantum level, and in this way improves the body's defense system.*
5. Anti-coagulating effect and inhibiting blood cell aggregation: reducing the risk of blood clots (as mono or complementary therapy: prevention of myocardial infarct).
6. Increase cellular oxygenation and detoxification
7. Reinforces the body's defense system
8. Enhanced cellular energy, Increased overall energy: wellbeing treatment -replenished and rejuvenated body.



The experiment conducted by Dr. Milos Mladenovic (Zepter Medical), Jorg Klemn and Olja Lopushansky

Comparison and evaluation

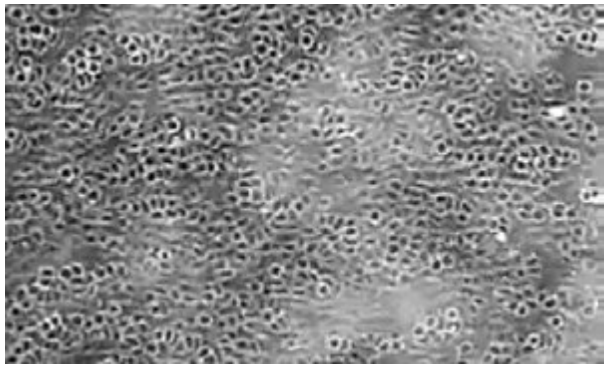


(Picture 1) after 10 minutes of BIOPTRON® Quantum Hyperlight exposure

Altered blood:
Red blood cells obviously form stacks (so-called rouleaux)

Red blood cells are clotted, unordered and inactive (clustered structures), which could

reveal (or lead) to cardiovascular diseases, inflammations and oxygen deficiency at the tissue level (hypoxia).



(Picture 2) Healthy blood: Red blood cells move individually, they don't form stacks.

After 10 minutes of Quantum Hyperlight exposure, previous clustered structures change into entirely separated blood cells which embody the entire blood revitalization: from the unhealthy state, erythrocytes/microtubules are modified into a torus shape, obtaining the same energy structure as Quantum Hyperlight, the initial natural healthy state (HYPERLIGHT ENERGY-INFORMATION STATUS = BIOSTRUCTURES ENERGY-INFORMATION STATUS).

Empowered with such inconceivable light energy (energy, information and frequency), cells move faster (remarkable anti-coagulating effect). The red cells revive from inactivity into healthy live active cells, proving that Hyperlight has quantum healing properties (rejuvenation at the quantum level). The energized blood flows unrestrictedly, effortlessly conveying oxygen into the vital organs, improving the processes of nutrient transport into the cells, facilitating removal of debris and possibly preventing hypertension, thrombosis (hazardous blood coagulation), stroke, heart attack, inflammations, etc.

BIOPTRON® Quantum Hyperlight can rejuvenate unhealthy cells and recreate vigorous energized, healthy red blood cells and microtubules (an ideal healthy cell condition and cell formation), all of which are critical to maintain a healthy body.

It is concluded: red blood cells/microtubules rejuvenation is achieved through Quantum Hyperlight exposure. Therefore, an interesting question arises:

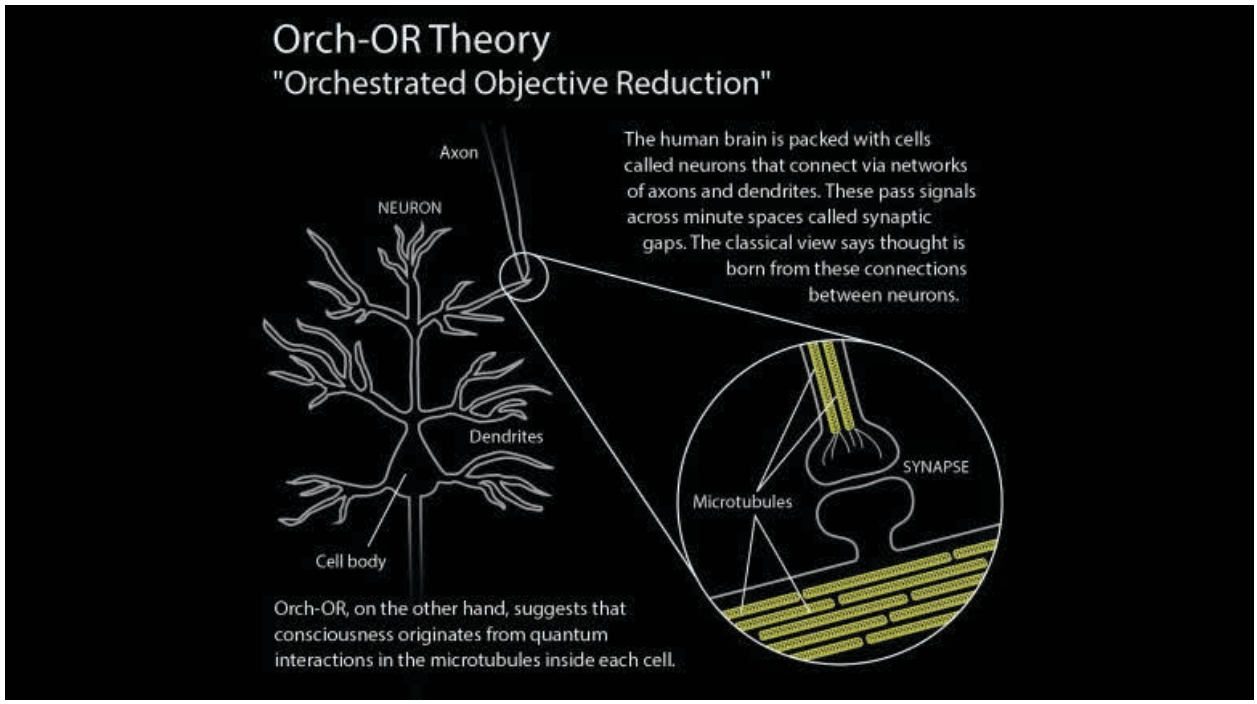
As microtubules are influenced by Hyperlight, does such light have an impact on our consciousness as well?

Sir Roger Penrose, together with Stuart Hameroff has developed the Orch OR theory. OR theory proposes quantum computations in microtubules in the brain. According to Penrose, microtubules are the 'quantum channels' responsible for consciousness. Interference of microtubule vibrations is recorded by Electroencephalogram EEG. The microtubule vibrations 'beat frequencies' arise from a deeper level in the brain. Thus, Quantum coherence happens in microtubules, inside the brain's neurons.

THE IMPORTANCE OF ELECTROMAGNETISM AND WATER FOR ULTIMATE WELLBEING

Humans are EM nature, sustained by water. Whilst the human body is made up of 70% water, at a molecular level, human bodies are more than 99% water!

Water conducts the electricity in the body. The biological structures are supplied with additional electrons (energy) and information, which is transmitted through the hydrogen water bond chain. Therefore, water is alive. And does it have the memory, because the information remains in the body?... Even after some days after being influenced by outside factors. The concept of the memory of water goes back to 1988 when Professor Jacques Benveniste claims that extremely high 'ultramolecular' dilutions of an antibody had effects in the human basophil degranulation test, a laboratory model of immune response. In other words, the water diluent 'remembered' the antibody long after it was gone. Concept of hydrogen bonds in water, an attraction between two atoms that already participate in other chemical bonds. Hydrogen bonds



In analogy to OR Theory, treating „brain-microtubule vibrations" by Quantum Hyperlight (Hyperlight eyewear), one can benefit - improving: mental, neurological, and cognitive conditions. Therefore, Hyperlight can influence not only the body and mind but possibly the consciousness aspect as well. (Credit: Alison Mackey/Discover)

form between neighboring water molecules when the hydrogen of one atom comes between the oxygen atoms of its own molecule and that of its neighbor. This happens because the hydrogen atom is attracted to both its own oxygen and other oxygen atoms that come close enough. A consequence of hydrogen bonding is that hydrogen bonds tend to arrange in a tetrahedron around each water molecule, leading to the well-known hexagonal crystal structure of snowflakes. These bonds are the primary reason water displays such interesting and unusual chemical properties, many of which aren't found in any other chemical substance.

„Hexagonal body's geometry" is directly related to Dr. Gerald Pollack and Structured Water Science. According to Dr. Pollack, structured hexagonal water affect the body in different ways:

• The hexagonal body water structure (structured water) is preferred by all biological organisms. Structured water is involved in the healthy functioning of the DNA, enzyme reactions and numerous metabolic processes, it's essentially the main carrier of all the electric signals that bodies generate. Water is unswervingly involved in the optimal functionality of all the physical and mental functions. Water is central to every function of the cell - whether it's muscle contraction, cells dividing, or nerves conducting.

• More energy from stronger mitochondria- Structured water delivers electrons to the mitochondria, and aids in generating more energy to the cells/ body.

• Anti-aging - Structured water acts as an antioxidant, protecting the cells from free radicals and slowing down cellular aging.

• Protein folding - Structured water binds to proteins and can deliver the energy they need to recover.

BIOPTRON performed an experiment at the Dr. Masaru Emoto Institute in Japan, proving Bioptron Hyperlight creates „Hexagonal Structured Water which has a vital role for the human body":

1. Tap-water crystal (molecule) is irregular, incoherent – unstructured, representing 'molecular incoherence', meaning that it is not symmetric to the body water.

2. Emoto's experiment reveals that when tap-water is exposed to BIOPTRON® Quantum Hyperlight, it affects the water structure, modifying it into a hexagonal water shape crystal that represents the ultimate state of 'molecular coherence'.

„BIOPTRON made an experiment in our Masaru Emoto laboratory in Tokyo:

Regarding the water in the human body, it is very important the meaning of „coherence". Coherence stands for health and incoherence stands for disease. „Tumor" means not more coherent „water-structure" in the human body.

…Humans resonate with the dynamic harmonic field of the cosmos, and if our body-water is in harmony with the cosmos, then we feel good, we are healthy and everything feels good.

And, BIOPTRON Quantum Hyperlight can access this field!"

Akiko Stein, Peace Ambassadress Of Water – Guardian for the heritage of Dr. Masaru Emoto
As well as helping to keep us alive and healthy, drinking the right volume of healthy Quantum Hyperlight water can be beneficial to help improve athletic performance, aid cognitive function and boost a person's mood.

Structured Bioptron Hyperlight Water is created if purified water (Edel Wasser or Aquena Pro) is exposed to Bioptron Hyperlight. The duration is 10 minutes.

In analogy to the Masaru Emoto experiment, a healthy Structured body water is created in the body cells and organ - by 10 minutes of exposure to Bioptron Quantum Hyperlight.

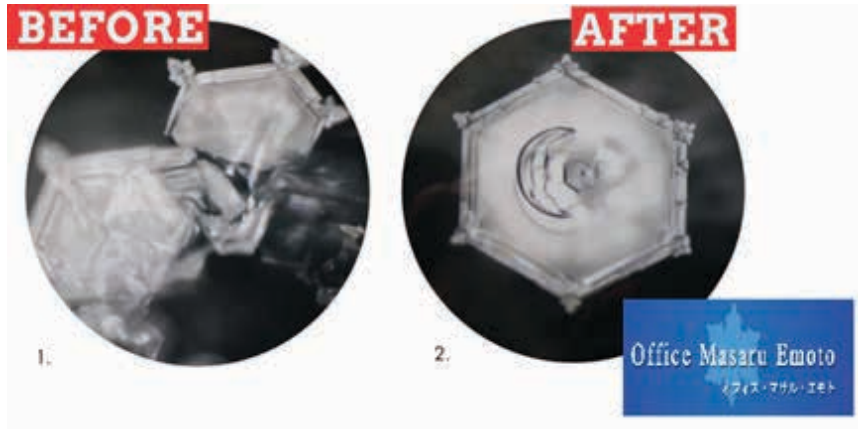
And, in the end, just to remind you: „Lifestyle is the medicine!"

Veda Pulse, Darkfield microscopy, and Emoto experiments have revealed that BIOPTRON QUANTUM HYPERLIGHT can positively influence the human body on the quantum level!

Since disease starts as an "energy stagnation" even before the body shows any symptoms, it is advisable for everyone to integrate into a daily life program ``exposure to Quantum Hyperlight`` and receive a daily dose of healthy light! … to diminish the possible energy stagnations, and maintain a healthy body:

Revitalize, Restore and Renew!

Think Healthy. Stay Safe!



Experiment conducted by Dr. Yasuyuki Nemoto Director of IHM General Institute (On Behalf of Dr. Masaru Emoto) & Olja Lopushansky, Director Bioptron Nederland

Bioptron Hyperlight Therapy

Sara Valencia Garcia

In 2017, inspired by the properties of the Nobel Prize winning discovery of fullerene molecule and understanding the biology of life, our scientists have developed and patented the unique Hyperlight Optics. Bioptron Hyperlight Devices apply light deep into the body, imposing its energetic properties on the disturbed biomolecule In 2017, inspired by the properties of the Nobel Prize winning discovery of fullerene molecule and understanding the biology of life, our scientists have developed and patented the unique Hyperlight Optics. Bioptron Hyperlight Devices apply light deep into the body, imposing its energetic properties on the disturbed biomolecule.

BIOPTRON AG continuously invests in sophisticated research and new product development necessary to achieve optimal clinical effectiveness of light therapy treatments. In 2017, inspired by the properties of the Nobel Prize winning discovery of fullerene molecule and understanding the biology of life, our scientists have developed and patented the unique Hyperlight Optics. Bioptron Hyperlight Devices apply light deep into the body, imposing its energetic properties on the disturbed biomolecule.

As a pioneer, Bioptron has deeply studied the biostimulative effects of the Hyperlight therapy in immune system. Bioptron Hyperlight Therapy already has a very extensive literature on the effect on molecules that are regulated by the polarized light, reinforcing the immune system, increasing the capacity to fight against disease and accelerating the recovery. Bioptron Hyperlight Therapy stimulates the production of specific cytokines (small molecules acting as messengers between immune cells) that activate the cellular immunity, increasing the anti-viral and the anti-bacterial defense of the human body. Bioptron Hyperlight Therapy also normalizes other blood indexes (leukocytes count, level of inflammatory markers and immunoglobulins) which contribute to maintaining a strong and efficient immune system. Thanks to the breakthrough technique used in the analysis of gene expression, other very recent peer-reviewed publications have described the cellular mechanism triggered by Bioptron Hyperlight responsible for the already observed immunomodulation.

In 2019 a study showed the genetic changes modulated in immune cells induced by Bioptron devices, responsible for decreasing inflammation. The scientists treated a type of immune cells called monocyte/macrophages which are very important in the management of inflammation, since they regulate some gene expression and present specific molecules on their surface to regulate the inflammatory process. The presence of specific molecules on the surface of monocyte/macrophages will trigger different phases of the inflammatory process. The researchers have described that the treatment of monocytes with Bioptron Hyperlight decreases the expression of those molecules, thus decreasing the inflammatory response.

The authors described changes in the expression of 6 genes. Two of them are more expressed, and are related to anti-inflammatory actions. The other 4 are less expressed, and they are responsible for mediation of the inflammatory response. In conclusion, the modification of the expression of these genes has a synergic effect to achieve a massive anti-inflammatory action at different stages of the mechanism.

In leukocytes and other cells, Bioptron Hyperlight Therapy models DNA synthesis to adapt the immune response to an antigenic stimulus. Some cellular mechanisms of immune cells are enhanced, like antibody production and phagocytic activity of monocytes and granulocytes (capacity to ingest and destroy particles, as viruses, bacteria or tumor cells). The immune cells responsible to orchestrate a coordinated and effective anti-viral and anti-bacterial response are more active and structurally modified to give a precise defense.

For the first time, we have the evidence of the change in the gene expression in response to Bioptron Hyperlight exposure, explaining on a molecular level how the immunomodulation is achieved.

The positive immunomodulatory effects in the body achieved with Bioptron Hyperlight therapy are extended to other medical indications, for example, during post-surgery period, especially in situations where the immune system is affected and unable to protect the organism adequately. Bioptron Hyperlight therapy has successfully been used as a conjunctive therapy to effectively strengthen the immune system and support the fight against diseases, promoting in parallel the regeneration of the tissues.

BIOPTRON AG collaborates with the worldwide recognize scientist to explore deeply the genetic, molecular and cellular changes induced by Bioptron Hyperlight that foster the complex process of tissue regeneration. Currently, Bioptron has a successful collaboration with Neurix, the only company in Switzerland authorized to work with embryonic stem cells (cells able to differentiate into any embryonic cell type). Neurix and Bioptron AG are performing cutting-edge research in the genetic changes induced by Bioptron Hyperlight Therapy in fibroblasts and embryoid bodies. Fibroblasts are the most common cells of tissue in animals, it synthesizes the collagen and it is very important for the tissue structure, playing a critical role in wound healing. Embryoid bodies are three-dimensional aggregates of stem cells and constitute the gold standard to study the early phases of embryo development cell differentiation and proliferation.

The study of the effect of Bioptron Hyperlight Therapy in these two cell lines it is an incredible progress in the comprehension of tissue regeneration. For the first time, scientific community will understand better the genetic changes induced by Bioptron Hyperlight, and how they influence the molecular and cellular processes that will be pivotal to increase and improve tissue regeneration.
The project is ongoing but the preliminary results are very promising. Bioptron Hyperlight affects gene expression in fibroblasts treated for 10 minutes every day for 12 days. Some of the concerned gene are upregulated (increases its expression) and other ones are downregulated (decreases its expression). Those genes appear to affect a broad range of cellular mechanisms including reconstruction of extracellular matrix (the non-cellular component of the tissues, which provides physical scaffolding for the cellular constituents and allows crucial biochemical and biomechanical cues for tissue morphogenesis), cell adhesion & motility, inflammation, psoriasis and wound healing.

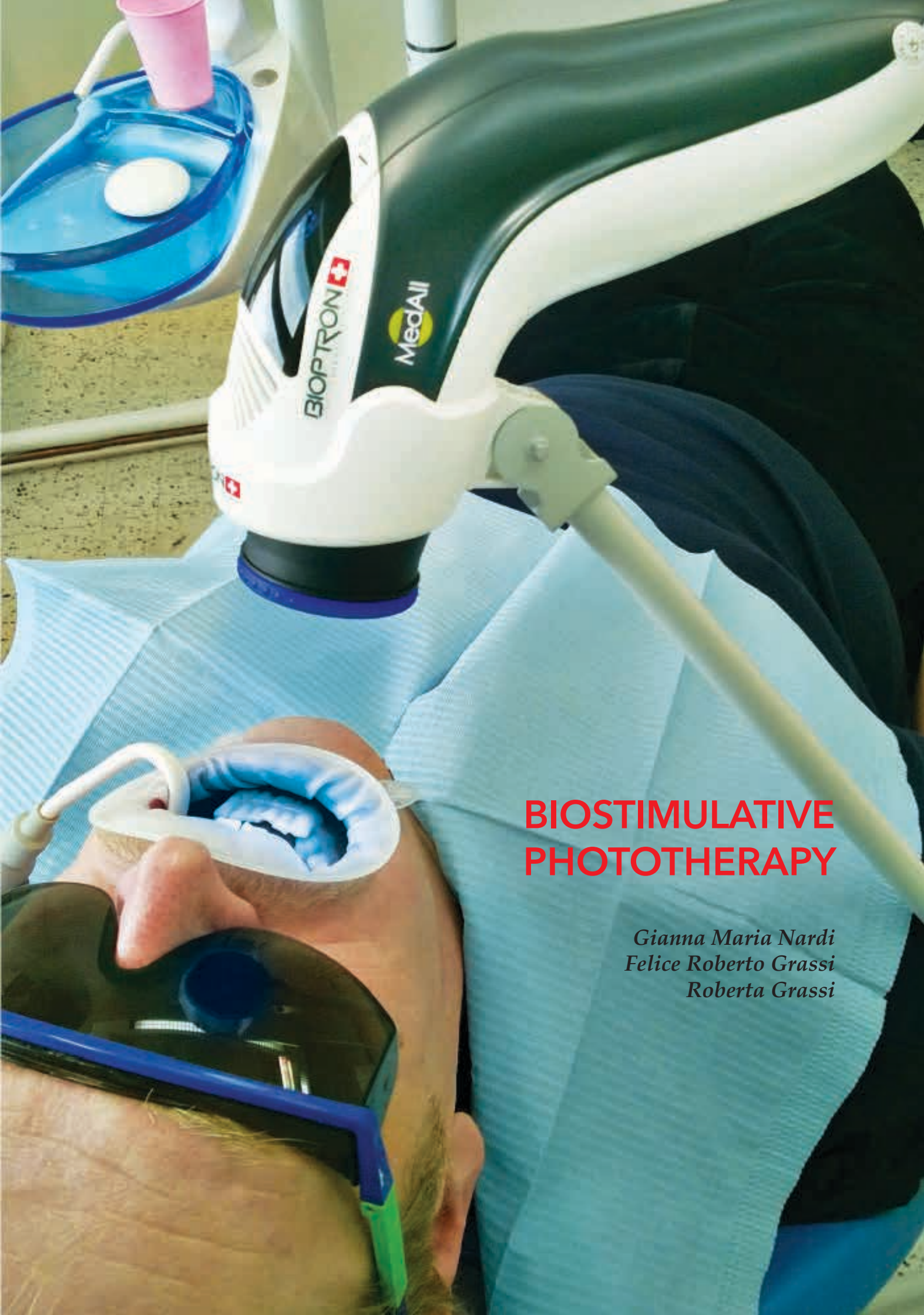
And not surprisingly, Bioptron Hyperlight Therapy has proven already its beneficial effect in those processes. But change in gene expression may not reflect variation in the protein expression (the protein they are coding for), which is key to induce any biological effect. In that project BIOPTRON AG goes beyond and analyzes the protein level related to these genes. Interestingly, the variations in protein levels follow the same tendency than the expression of their related genes. These observations tend to confirm the anti-inflammatory effect of Bioptron Hyperlight and the stimulation of wound repair. Nevertheless, scientific research is still being performed in collaboration with Neurix to confirm and increase our knowledge of these genetic and cellular changes.

In embryoid bodies, some genes expression is also altered by Bioptron Hyperlight. The preliminary results point out that the selected genes act on cell proliferation, cell differentiation or healing and repair mechanisms.

The biostimulative effects of Bioptron Hyperlight Treatment are supported by hundreds of publications, result of three decades of research, aiming to understand the biological processes triggered by Bioptron devices. BIOPTRON AG's team of engineers, scientists, doctors and other specialists are constantly engaged to increase awareness and make available the unique Bioptron Hyperlight Treatment to everyone, to achieve excellent clinically proven performance for multiple diseases.

Easy to use. Painless. Time-effective. Economical. No known side effects. Suitable for everybody.

(Illustrations Zepter International).



BIOSTIMULATIVE PHOTOTHERAPY

Gianna Maria Nardi
Felice Roberto Grassi
Roberta Grassi

In our study (2019), the effectiveness of Bioptron Hyperlight therapy was demonstrated as an additional treatment to non-surgical periodontal therapy in patients with chronic periodontitis. Another study in 2019, demonstrated the effectiveness of the Bioptron Hyperlight technology in a group of patients suffering from pathologies of the oral mucous membranes of different nature.

Bioptron phototherapy is an innovation in medicine. It is a medical therapeutic device that acts in a natural and non-invasive way, favoring the natural ability of the human body to regenerate itself. Thanks to its optical unit that emits a light similar to a part of the electromagnetic spectrum produced naturally by the sun, but devoid of UV radiation. It's a low-energy light, presenting a density that reaches the area with constant intensity.

The penetration throughout the mucosa, induces biostimulative effects in the whole region, although the irradiation happens in a specific location. This is because the circulating blood in the capillaries receive biostimulative effects, thanks to the irradiated light and provides oxygen to the cells of all adjacent tissues. All biological processes are stimulated bringing a significant improvement to the entire organism.

Clinical international research, has demonstrated the validity of supportive treatments in the conservative management of acute and chronic injuries as well as in post-operative injuries. The use of Bioptron Hyperlight Therapy can be helpful in different areas: it facilitates the treatment and healing of chronic wounds, stimulates the regenerative and reparative processes of the entire organism, control the painful symptoms in rheumatology, physiotherapy and sports medicine. It is a complementary therapy in the treatment of dermatological problems and strengthens the immune system. Phototherapy with Bioptron has also proven effective in dental therapies, in the resolution of periodontal inflammation, in the healing of post-surgical wounds with a significant process of preservation and regeneration of the oral tissues.

The oral cavity represents a specific anatomical and physiological entity, with particular specificities such as the presence of pathogenic microorganisms, the possible chronic inflammation of the gingival mucosa and the influence of saliva: all factors that can affect tissue health. In recent years, our research has shown that, even in dentistry, the use of Bioptron Hyperlight Therapy can be a valuable aid to implement traditional protocols for the treatment of oral mucosal lesions, gingivitis and periodontitis. The technology has been very effective in controlling atypical facial pain, joint pain, post-extractive pain, burning mouth syndrome, stomatomucositis (inflammation affecting the mucous membranes of the mouth and lips).

In our study (2019), the effectiveness of Bioptron Hyperlight therapy was demonstrated as an additional treatment to non-surgical periodontal therapy in patients with chronic periodontitis. Already after the first month of treatment, inflammation and all periodontal clinical indices have statistically improved compared to the control group (group of patients who had not been received Bioptron Hyperlight Therapy). In addition, the use of Bioptron Hyperlight Therapy improved the gingival clinical situation (Gingival Index) after three months. These positive effects of Bioptron have been published in a peer-reviewed scientific journal (*Use of photobiomodulation induced by polarized polychromatic non-coherent light of Bioptron in the management of adult chronic periodontitis.)* 2019. pp.293-297. JOURNAL

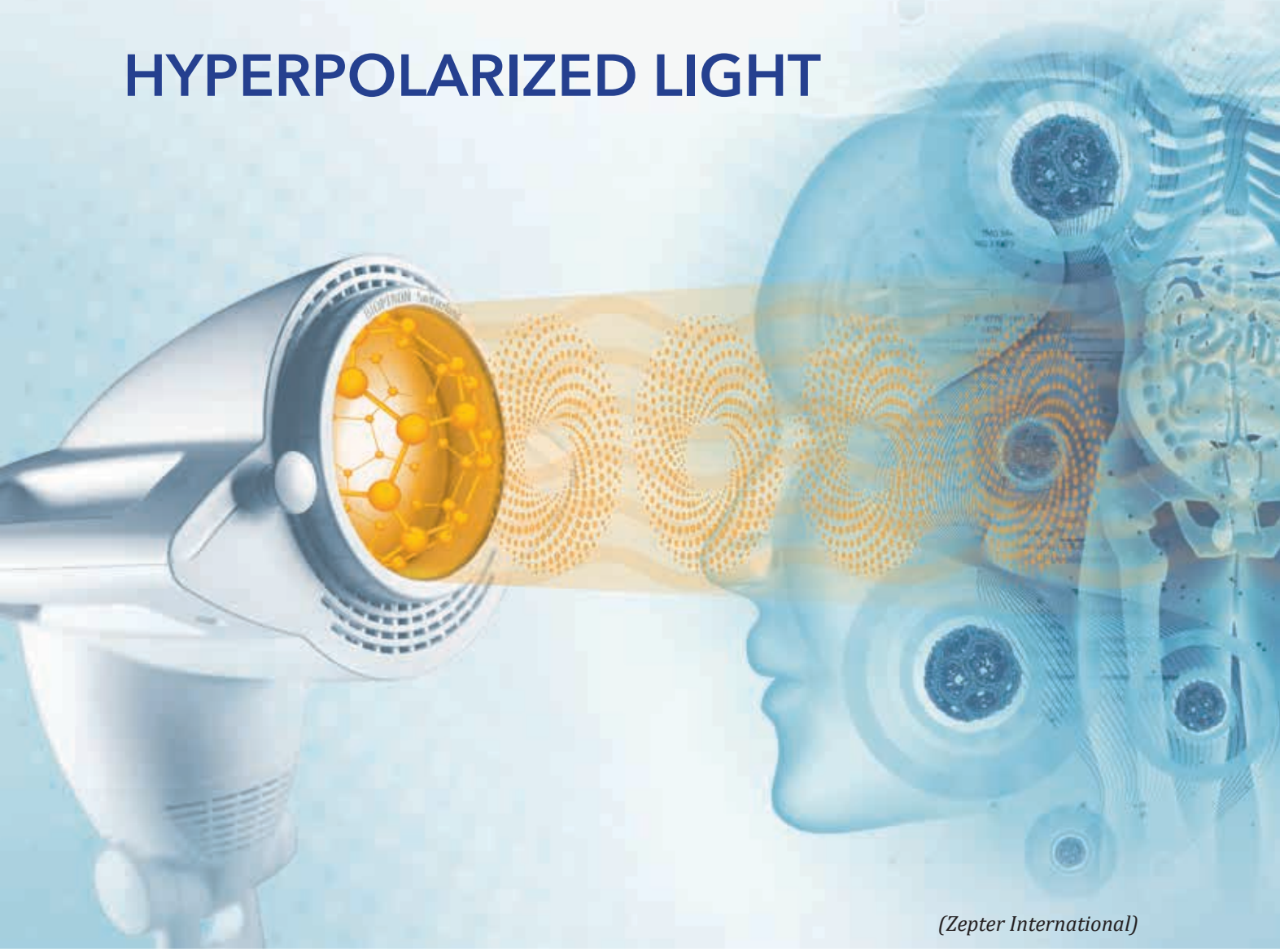
OF BIOLOGICAL REGULATORS & HOMEOSTATIC AGENTS - ISSN:1724-6083 vol. 33 (1).Nardi, Gm; Grassi, R; Grassi, Fr; Aragona, S; Rapone, B; Della Vella, F; Sabatini, S

Another study in 2019, demonstrated the effectiveness of the Bioptron Hyperlight technology in a group of patients suffering from pathologies of the oral mucous membranes of different nature. The results obtained with use of Bioptron as adjuvant therapy to standard treatment are very encouraging: compared to the control group (no use of Bioptron) the patients receiving Bioptron treatment showed greater pain reduction typical of some mucosal lesions, and a faster tissue healing. They also presented significantly reduction of flogosis (inflammation) and edema compared to the control group. These promising results were published in a peer-review scientific journal. For more information: *Polarized polychromatic noncoherent light (Bioptron light) as adjunctive treatment in chronic oral mucosal pain: a pilot study*. DOI:10.1089/photob.2018.4576. pp.227-232. In PHOTOBIOMODULATION, PHOTOMEDICINE, AND LASER SURGERY - ISSN:2578-5478 vol. 37 (4). Petruzzi, M.; Nardi, G. M.; Cocco, F.; Della Vella, F.; Grassi, R.; Grassi, F. R.

Certainly over the years further studies will be carried out to confirm the effectiveness of Bioptron technology in other pathological situations that will confirm that the use in dental therapies of phototherapy with Bioptron allows the maintenance of the health of the oral cavity in an effective and minimally invasive way.

(Illustrations Zepter International).

HYPERPOLARIZED LIGHT

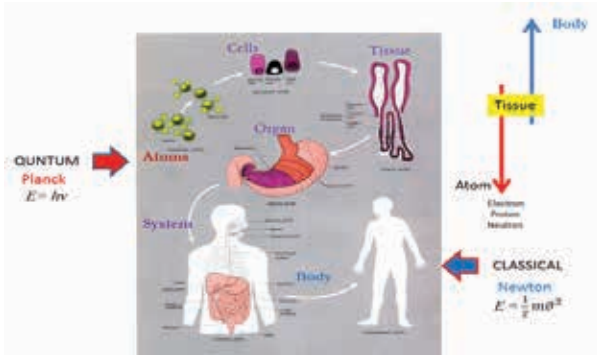


(Zepter International)

Bioptron Hyperlight, as a method of medical rehabilitation, has been included in the latest updated 7th version of Methodological Recommendations for the prevention, diagnosis and treatment of new coronavirus infection (COVID-19) released on June 3rd, 2020 by the Ministry of Healthcare of Russia. It contains information about COVID-19, the ways of infection spreading, clinical symptoms, diagnostic methods, treatment recommendations for various clinical forms of the disease.

Aleksandar Nešković

ZEPTER MEDICAL has outstanding results in the application of Bioptron light therapy, the prevention of modern chronic diseases by spreading healthy eating habits and the prevention of diseases caused by polluted air and water. The doctors at Zepter Medical are pioneers in the use of hyperpolarized light. Several pilot studies, led by the most eminent doctors and professors of the Faculty of Medicine, were conducted in the premises of Zepter Medical. The first case reports were published in the book of Professor Đuro Koruga „Hyperpolarized Light – Fundamentals of NanoBiomedical Photonics".



Human organism as classical-quantum system

Hyperpolarized Light Applied in the Therapy of Burn Wounds

Dr. Milica Komnenić

Case Description

The research subject is a female, 52 years old. The burn was caused by hot cosmetic wax. Burn is located in the region of the left-hand thumb, 2 cm long, 1 cm wide; 2nd degree burn.

Other therapy was not used immediately after injury and later on. Injury was accompanied with intense pain in the hand region and with reduced range of motion.

Conservative Therapy

Standard conservative therapy of such injuries includes: protection and burn wound management; prevention of infection, because necrotic tissue is an excellent basis for the development of infection; surgical debridement of a burn affecting more than 1% of body surface. This type of burns often heals with scar tissue and changed pigmentation at the site of injury. The time necessary for healing is up to 40 days.

Protocol

Application of BIOPTRON Hyperpolarized Light: BIOPTRON light is applied locally at the injury site, once a day, for 8 minutes, at a distance of 10 cm, 7 days continuously. Action mechanism: second-degree burns affect the epidermis and the deep dermis layer, the sweat glands, sebaceous glands and hair follicles. In pathogenesis, the key factor is the diffusion of plasma – liquid and proteins, and their build-up in the interstitium. The hyperpolarized light accelerates the process of lipid organization into nano layers, between which the H_20 molecules are located as the main protective factor. Histamine receptors of type 1 are also blocked, thus preventing formation of edema. Hyperpolarized light activates natural defense mechanisms, preventing the development of infection in the necrotic tissue.

Retarded healing, sometimes longer than 40 days, accompanied by the formation of scars, is now accelerated by hyperpolarized light that activates collagen of type VII and II, thus the wound heals two, even three times faster; in 14 to 21 days.

Conclusion

1. Edema in the vicinity of the wound receded already on the third day of therapy.
2. Secretion from the lesion is reduced and the wound dries and heals faster.
3. Antibacterial effects of the light spectrum prevent the development of infection.
4. Wound healed after seven days.
5. According to the patient, the pain was relieved and the range of motion improved – "the skin was not rigid" after the first treatment.
6. My opinion, as the physician following the case: lesion healed without scarring and pigmentation change in an extremely short time, in spite of the fact that the lesion was deep, of the IIB degree, and that the tissue was additionally damaged during wax removal.
7. By applying hyperpolarized light, we stimulate the immune system to resist the threat and to activate the regenerative processes already existing in the body.

Hyperpolarized Light Applied in Psoriasis

Dr. Miloš Mladenović, Dr. Jelena Simić

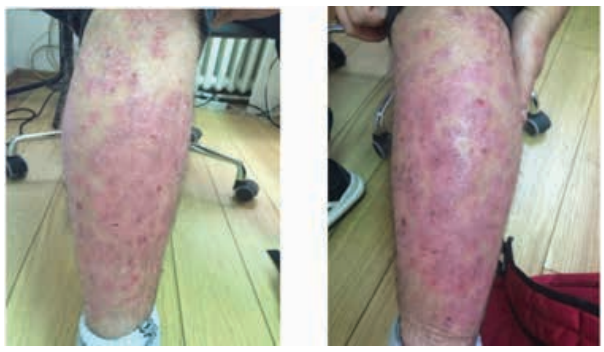
Case Description

The patient is male, 32 years old. During the previous 6 years suffering from psoriasis vulgaris L40.0 (MKB 10). Dominant changes on crura. Treated both locally and systemically, without effect. Currently, he is not undergoing neither systemic, nor topical therapy. Occasionally sunbathes, uses regenerative cream.

Protocol

Application of BIOPTRON hyperpolarized light in the area of both crura, once a day. Light is applied for 8 minutes and 30 seconds at a distance of 7-10 cm. Cycle of 10 weeks, i.e., 50 treatments overall.

Patient Status before Treatment



Diffuse psoriatic changes in the area of crura accompanied by pruritus, bilaterally; minor changes in the elbow region. Positive phenomenon of hemorrhagic rosiness.

Patient Status after 50 Treatments

After two months of therapy and intensive treatment, significant improvement is registered in psoriatic changes on the skin of lower extremities in the patient with prolonged problems. During treatment, initial inflammation occurred with exacerbation within the first two weeks in the surface skin layer, followed by receding redness, and even improvement in the skin changes. The initial inflammatory reaction receded after the third week, and changes receded gradually, concentrating on smaller formations. After the fiftieth treatment, changes have almost completely receded, in contrast to the initial diffuse state. Patient also observed and enthusiastically confirmed considerable improvement and absence of pruritus. Redness subsided; skin is no longer dry and splitting.

Action Mechanism

Psoriatic lesions differ biologically from the normal and classical dry, scaling skin. The inflammatory reaction in deeper dermis and upper epidermis, proliferation of keratinocytes and the impaired cell cycle cause skin desquamation. This results in excess water loss. Due to the effect of the hyperpolarized light at the lesion site (on lipids, collagen, basement membrane and the regulation of water passage from dermis into epidermis), instead of the accelerated formation of squamae in the stratum corneum resulting from the dysfunction of stratum granulosum, conformation changes occur, nano layers of water in stratum granulosum are regularly formed, leading to a regular cell cycle. The basement membrane is regenerated and collagens are adequately organized, so the physiological skin cycle is restored.

Conclusion

Case description demonstrates that application of hyperpolarized light resulted in the improvement of overall condition and in the decrease of psoriatic skin changes. Hyperpolarized light used as monotherapy resulted in skin regeneration and receding of psoriatic changes in the crura area, with decreased inflammatory skin reaction. Pruritus was eliminated as well.

Hyperpolarized Light Applied in Treatment of Acne

Dr. Biljana Lučić

Case Description

The patient is a female, 21 years old, diagnosed with acne vulgaris, on both cheeks, lasting about four years. The treatment: hyperpolarized BIOPTRON light was applied locally on both cheeks (distance between treated zones 5 cm), each treatment lasting eight and a half minutes. There were fifteen treatments, every second day. The BIOPTRON Pro 1 device was used as well as the Oxy Sterile Spray. Objective finding at the beginning of the treatment: adipose, glossy skin with pronounced papular/pustular form of acne on both cheeks. Subjectively, patient describes occasional stinging and pruritus of the skin and dissatisfaction with her esthetic appearance.

Day 1

Day 5

The effect of therapy led, at first, to intensified inflammation, followed by gradual reduction of inflammation, decreased number of papules and pustules and healing of skin changes. After 10 treatments, no pustules could be discerned on the skin. After 15 treatments, esthetic improvement in the skin appearance is noticeable, only scarce papules can be observed.

Day 15

The patient described the treatments as very comfortable; the stinging and itch are reduced and she is exceptionally satisfied with her esthetic appearance.

The patient was recommended to continue treatment due to the positive effect of polarized light on the stimulation of collagen fiber production, and the regulation of scar tissue.

Action Mechanism

Hyperpolarized light activates phagocytosis and prevents excessive Propionibacterium acne reproduction, it decreases the excessive sebum secretion and acts anti-inflammatory via cytokine. In the healing process, collagen of type I and III is activated, followed by type VII collagen, and through laminin and integrin, the migration of keratinocytes, the healing of the surface skin layer occurs.

Conclusion

Application of BIOPTRON hyperpolarized light on the papular/pustular forms of acne vulgaris led to an increased inflammatory reaction at first, followed by a gradual decrease in the number of pustules and papules, and tissue healing. Objectively, significant esthetic improvement can be observed.

Since the beginning of the application of the new fullerene filter, more than 2,000 patients have been treated with hyperpolarized light at the ZEPTER MEDICAL office. It has been successfully used in the treatment of pain, skin diseases, wounds, including the most severe ones such as pressure ulcers, venous ulcers, diabetic foot, postoperative wounds, etc. The results show up to 30% better and faster recovery compared to polarized light.

HYPERLIGHT against COVID-19

Bioptron Hyperlight, as a method of medical rehabilitation, has been included in the latest updated 7th version of Methodological Recommendations for the prevention, diagnosis and treatment of new coronavirus infection (COVID-19) released on June 3rd, 2020 by the Ministry of Healthcare of Russia. It contains information about COVID-19, the ways of infection spreading, clinical symptoms, diagnostic methods, treatment recommendations for various clinical forms of the disease.

According to these Methodological Recommendations, Bioptron Hyperlight therapy is recommended (section 5.9, page 63) for the following benefits:

- Anti-inflammatory effect – eliminates the residual effects of the inflammatory process in the lungs and prevents scarring and adhesions. Both complications appear during a lung infection and induce formation of stiff tissue, which in return causes shortness of breath.
- Strengthens the immune system – enhances the antiviral defense of the body for a faster and better recovery from viral infections while creating impenetrable barrier for future infections.
- Improves microcirculation and accelerates blood flow – for resorption of areas of edema and/or compaction of the lung tissue. While edemas are collections of liquid in the lung, compaction means that lungs deform due to low level of oxygen in them. Both can happen during a viral infection and minimize the capability of normal breathing.
- Regenerative effect – repairs destroyed lung tissue.
- Increases the energy reserves of the body – restores strength and activates the process of self-healing.
- Soothing, harmonizing effect on the central nervous system – to overcome stress, depression, prevention of psychosomatic disorders and normalization of sleep.

References:

1) Koruga, Đ, Hyperpolarized Light: Fundamentals of Nano-Biomedical Photonics,
2) Zepter Book World, Belgrade, 2018.
Official Methodological Recommendations released by the Ministry of Healthcare of Russia (Original article in Russian) ВРЕМЕННЫЕ МЕТОДИЧЕСКИЕ РЕКОМЕНДАЦИИ ПРОФИЛАКТИКА, ДИАГНОСТИКА И ЛЕЧЕНИЕ НОВОЙ КОРОНАВИРУСНОЙ ИНФЕКЦИИ (COVID-19) Версия 7 (03.06.2020).

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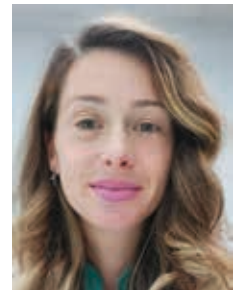
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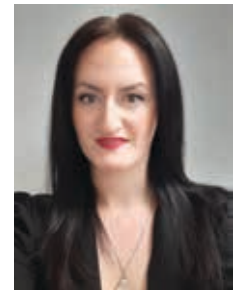

Aleksandra Vasiljević, *MD*

At the very beginning, I would like to take you back to the past, to 1903 – the year when the Danish Professor Niels Finsen received the Nobel prize in medicine for the treatment of lupus vulgaris, a serious skin condition, with concentrated light. This prize opened a totally new field in medicine: the field of light therapy.

It is a well-known fact that life without light is impossible, although we often forget this. We all need a daily dose of light.

But which light? And is every light healthy?
No. Unfortunately, we are living in the time of extreme pollution. The air is polluted. The water is polluted. The light is polluted as well. What often goes unnoticed is that polluted light is a „hidden" cause of numerous serious health conditions, such as eye problems, insomnia, depression, and anxiety.

The light that we all need is the light that protects and heals at the same time. The only healthy light with these characteristics is Hyperlight.

What is Hyperlight?
Before I answer this question, we will travel through time again, this time back to 1985, when C_{60} molecule was discovered, and to 1996, when the Nobel Prize for Chemistry went into the hands of 3 scientists. Kroto, Smalley and Curl were awarded for the dis-

(Zepter International)

According to our knowledge, the only way to absorb your daily dose of hyperlight – the healthy light that protects and heals – and to keep your „body and mind" balance is to opt for the Hyperlight Eyewear.

Katarina Bajec

covery of fullerene C_{60} – the unique allotropic form of carbon, which is characterized by icosahedral symmetry, structured by Fibonacci sequence, identical to the symmetry observed in healthy, functional human biological structures and processes.

The discovery of fullerene C_{60} opened a new chapter in quantum medicine and contributed to completely new medical treatments, granting better life. Fullerene C_{60} has unprecedented quantum properties, including a unique rotation with a twist rate of 18 billion times per second.

According to the Resonance principles of biomimicry, when two resonators possess the same type of symmetry, nano complex based on C_{60} molecule with its superior constant ideal structure can impose its energetic and structural properties on the damaged molecules, adjusting them to its ideal energy structure, giving them back a much-needed balance and returning them to a natural healthy state.

Hyper-harmonized light, unlike other polluted forms of light, conforms and corresponds to the unique principles of the Golden Ratio, one of the most prominent geometric phenomena associated with Leonardo Da Vinci, thus interacting with biostructures through Resonant principles.

Furthermore, Hyperlight has the same symmetry as 85% of healthy biomolecules in human body.

Due to various factors, such as pollution, aging, stress, etc., biomolecules lose their balance, resulting in illness and premature aging.

Thanks to the resonant transmission of quantum energy and information, Hyperlight uniquely maintains the structure of healthy biomolecules and restores energy frequency and vibration in damaged biomolecules, thereby restoring the whole body to a natural healthy state.

C_{60} and Hyperlight Eyewear (Zepter International)

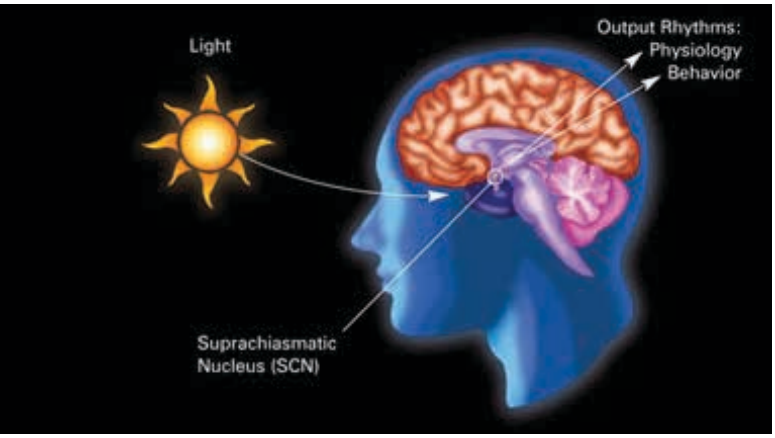
Hyper-harmonized light – Hyperlight – originates from the polluted light which passes through Fullerene Hyperlight Lens. Any polluted light passing through Fullerene Hyperlight Lenses is transformed into a uniquely structured Hyper-harmonized light complex called Quantum Hyperlight.

As we are living in the era of pollution, naturally, indoor as well as outdoor light is polluted. Indoor radiation coming from artificial light sources (electronic devices, LED bulbs, neon lights, etc.) is harmful, as is outdoor natural sunlight radiation (some window spectra of the sun).

But how does indoor and outdoor polluted light affect our health?
Major components of light are absorbed by our eyes. Harmful UV and high-energy blue light from electrical devices and the sun is extremely polluted, thus damaging our eyes, as well as accelerating the process of cataract and macular degeneration formation. Furthermore, blue light is a major cause of Computer Vision Syndrome, or Digital Eye strain.

But the eye is not the only structure affected by the polluted light. Many processes in the brain are mediated by light.

The fact that in 2017 the Nobel Prize in Medicine was awarded to the scientists Hall, Rosbash, and Young for the discovery of circadian rhythms speaks in favor of the aforementioned statement.



Circadian rhythm (NIH/Wikipedia)

Circadian rhythm is a natural bodily process mediated by the neurotransmitter melatonin, which alters in response to light over the course of the day.

Two additional neurotransmitters – dopamine and serotonin – are mediated by light as well. Dopamine, also known as the „pleasure hormone", regulates the reward system and is responsible for addiction behavior, while serotonin, also known as the „happiness hormone", affects our mood.

Exposure to harmful and polluted indoor and outdoor light affects these processes and is responsible for sleep disorders, cognitive failure, lethargy, depression, nervousness, and anxiety.

With all of this in mind, a major question arises: **How can we protect ourselves from the harmful and polluted light that surrounds us and how can we restore the much-needed health and body balance?**

Thanks to the ingenious Zepter R&D team, the answer is by means of the unique, revolutionary Hyperlight Eyewear. The patented unique BIOPTRON Hyperlight Eyewear comprises specifically designed nano complex Fullerene Hyperlight lenses. Thanks to the properties of fullerene nano complex and this unique Swiss product, Hyperlight Eyewear enhances concentration, attention, and memory, thus improving cognitive abilities, decision making, productivity, and efficiency.

Hyperlight Eyewear reduces intraocular light scattering, and enhances contrast sensitivity and color intensity, thus improving vision, reducing eye fatigue and discomfort, and preventing cataract and macular degeneration.

Furthermore, the unique properties of Hyperlight Eyewear affect the secretion of melatonin, serotonin, and dopamine, therefore improving mood; reducing stress, depression, and anxiety; regulating the sleep cycle; and restoring complete psychological balance.

In these „pandemic" times of social isolation, global uncertainty, and stress, we need Hyperlight Eyewear to maintain our overall health more than ever. Whether healthy or not, young or old, everyone needs a daily dose of hyperlight to keep his or her health in balance.

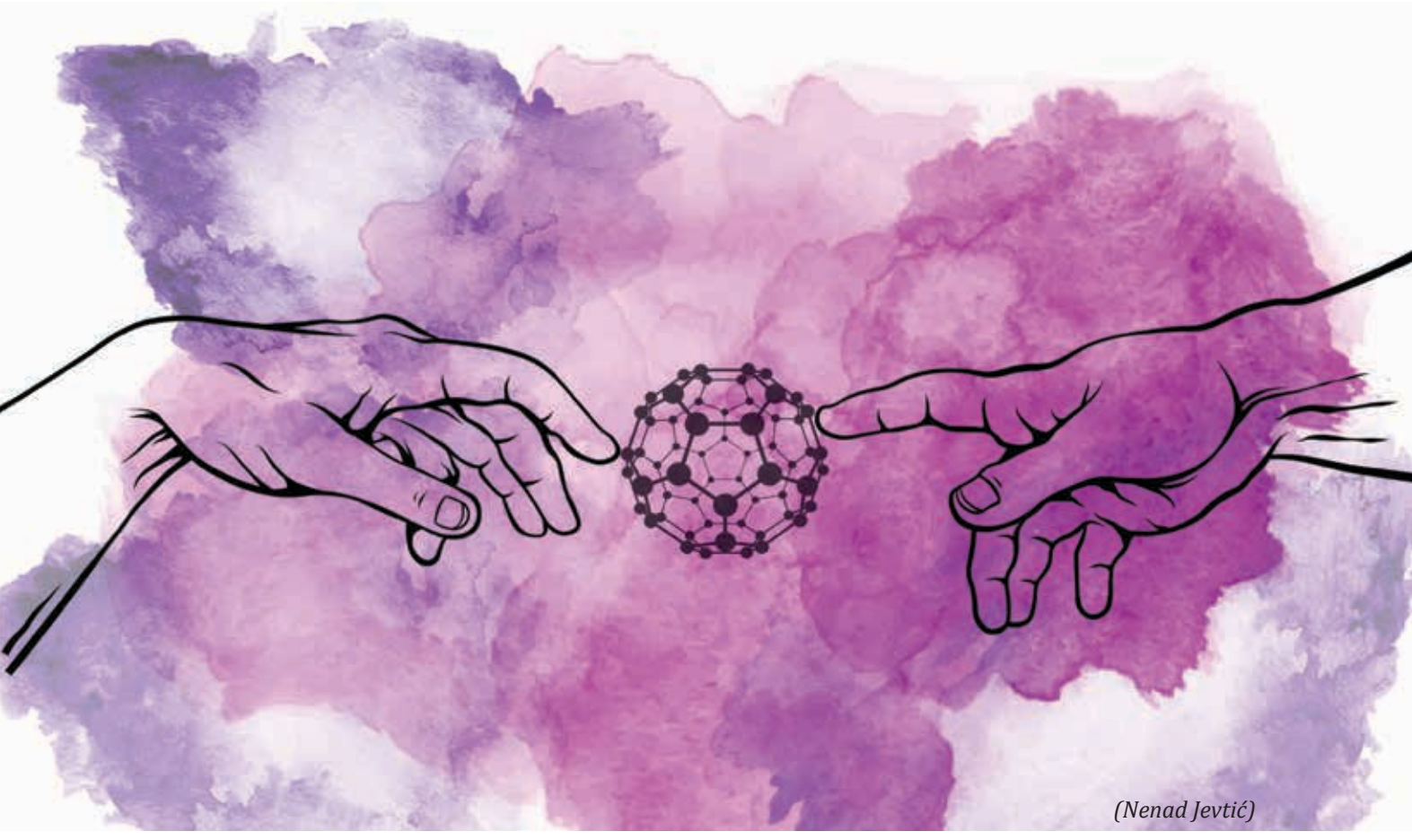
According to our knowledge, the only way to absorb your daily dose of hyperlight – the healthy light that protects and heals – and to keep your „body and mind" balance is to opt for the Hyperlight Eyewear.

Nanotechnology is a swiftly rising field that significantly contributes to the present progress in the development of effective biomaterials. Among various nanomaterials, carbon nanostructures and their derivatives like fullerenes have attracted significant attention due to their extraordinary properties and potential applications in a vast number of existing and emerging conditions.

Fullerenes offer a promising potential to engage with biological molecules. In particular, they have been found to possess powerful bactericidal properties toward pathogenic microorganisms. The mechanism by which fullerenes inactivate bacteria is complex and depends on the intrinsic properties of particular nanostructures, such as composition and surface modification, the nature of the target microorganisms, and the characteristics of the environment in which cell-nanostructure interactions take place.

A science – based product with superior prerformace – 3HFWC

High-performance **Hyperlight fluid fusion subcellular complex**, with the chemical name *Hyperharmonized hydroxylated fullerene water complex (3HFWC)* and chemical formula $[C_{60}(OH)_x]_y@[(OH)_m(H_2O)_n]$, is a patented



(Nenad Jevtić)

ZEPTER'S INNOVATIVE PRODUCTS

According to the company vision, the two guiding principles behind all our actions are making improvements and establishing the balance between health and beauty. Zepter International has long been at the forefront of applying nanotechnology to its products.

Nataša Knežević, Nenad Jevtić, Zorana Jović, Đuro Koruga

and innovative product with unique composition made by the functionalization of the C_{60} molecule with OH groups and through the addition of OH groups by water layers. This complex possesses similar properties to the liquid crystals with diameter size ranging between 8 and 12 nm enabling dual properties at the nano-quantum level in a classical way through energy transfer, and in a quantum way through energetic wave function. Hyperlight fluid fusion subcellular complex interacts through resonance and light fusion (frequency, vibration, information) with the electromagnetism of biomolecules, aligning covalent and non-covalent hydrogen bonds, and bringing the biomolecules back into their natural, harmonized state. As a final effect, it improves the biophysical characteristics of the skin and the functionality of the basal membrane accordingly.

Figure 1 . Zepter's Hyperlight Fluid Fusion Subcellular Essential Complex

Beauty – the attractive power of perfection

Zepter's highly effective personal care concept has proven itself effective in case of microorganism infections and is designed for maintaining oral cavity hygiene, intimate zone care, alleviation of itching and dry skin, rebuilding the skin barrier, boosting skin natural defense, protecting the skin against external negative influences (UV, hazardous blue light, electromagnetic smog), helping in acne treatment and deep hydration of the skin.

Generally speaking, the bactericidal action of carbon nanostructures including fullerenes typically involves a combination of physical and chemical mechanisms. Physically, it may cause considerable structural damage to the cell wall and the membrane of the microorganism. Chemical interaction between carbon nanostructures and the microorganism surface may lead to the production of toxic substances, such as reactive oxygen species (ROS), placing the cell under oxidative stress. The interactions between carbon nanostructures and cells may cause an electron transfer phenomenon, whereby electrons are progressively drained from the microbial outer surface, which may cause ROS-independent oxidative stress, leading to biological death.

Figure 2. A beautiful woman with a rose [8]

Many published reports demonstrate the biological activity of fullerene-caged particles. Several mechanisms have been proposed to describe the bactericidal action of fullerene materials. One possible explanation for this bactericidal behavior is related to the unique structure of the fullerene particle. From the structural design point of view, fullerene is a closed-cage nanoparticle, where the conjugation is extended through π-electrons. This structure is perhaps the main reason why fullerenes can absorb light and subsequently generate

reactive oxygen species. ROS are generally regarded as responsible for eukaryotic lipid peroxidation and eukaryotic cell membrane interruption. A high level of ROS is acutely lethal to microorganisms, triggering damage to cellular molecules like lipids, proteins, and nucleic acids.

The physical interaction between fullerenes and the outer microbial membrane is another antibacterial mechanism, in which fullerene nanoparticles induce cell membrane disruption and/or DNA cleavage due to the high surface hydrophobicity of the particle, which can easily interact with membrane lipids. Diversity in cell wall components between bacterial species may contribute to dissimilar fullerene-cell interactions. Generally, fullerene particles are found to be more biologically active toward gram-positive bacterial species rather than gram-negative microorganisms; hence the bactericidal success is reliant on the fullerene insertion into the bacterial cell wall. This suggests that deterioration of the microorganism related to the cell wall damage, namely alterations in membrane lipid structure and membrane permeability, may be an important aspect of fullerene bioactivity.

The secret world inside us

Microorganisms are living things. They are not trying to hurt us. They are not trying to help us. They are just trying to stay alive, like the rest of us. With their numbers ranging anywhere between 30 trillion and 100s of trillions, there are more microorganisms in our body than there are stars in the Milky Way. While no one has bothered to count them, the exact number does not matter as much as the idea that there are certainly more bacterial cells in our body than human ones. Today, they are often compared to an extra "organ", since together they weigh about the same as our brain and seem to perform countless functions in our body. Microbial genes outnumber our own human DNA by a ratio of about 100:1. As humans have evolved, these microbes have evolved with them. A whole lot of viruses call humans home, too.

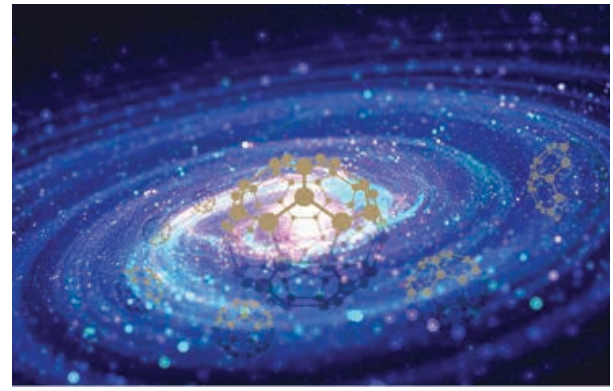


Figure 3. Milky Way [9], redesigned by N. Jevtic, TFT Nano Center

Did you know that you are born bacteria-free? With all these bacteria living inside, it seems natural that humans would just be born with them. Not so. People are born without bacteria and acquire them in the first few years of life. Babies get their first dose of microbes as they are passing through their mother's birth canal. A baby acquires most of its microbiome by the age of 3, during a period of time when the baby's metabolic, immune, cognitive, and reproductive systems are undergoing an extensive development.

Figure 4. Baby's Microbiome Development [10]

It is important to realize that our knowledge of the microbial world is continually evolving. The word 'microbe' sounds scary because we associate microbes with a myriad of bacteria and viruses. According to microbiologists, we are covered in a cloud of microbes that are promoting our welfare rather than killing us. For example, good microbes keep us healthy: they play defense and pro-

tect us from pathogens simply by taking up space. They boost our immune system, protect us from autoimmune diseases, and may even fight off stress. Eventually, do not forget that the flavors of wine and cheese depend upon the types of infecting microorganisms.

Once upon time…

Can you imagine the excitement felt by the Dutch biologist Anton van Leeuwenhoek in 1674 as he peered at a drop of water through his carefully ground microscopic lenses and discovered a world of millions of tiny "animalcules"? The world that van Leeuwenhoek discovered was complex, consisting of protozoa and bacteria of all shapes and sizes. However, the complexity of medical microbiology we know today was beyond his imagination. We now know that there are thousands of different types of microbes that live in, on, and around us, and hundreds that cause serious diseases in humans.

Key facts about bacteria and viruses

While both can cause disease, viruses are not living organisms, whereas bacteria are. Viruses are only "active" within host cells which they need to reproduce, while bacteria are single-celled organisms that produce their own energy and can reproduce on their own.

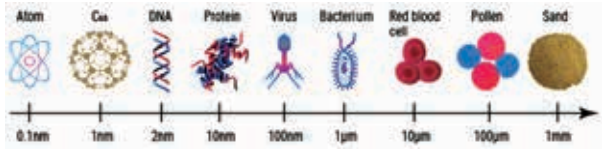


Figure 5. Bacterium and virus sizes compared to C_{60} molecule. Designed by N. Jevtic, TFT Nano Center.

Viruses are the smallest infectious particles, ranging in diameter from 18 to 600 nanometers (most viruses are < 200 nm and cannot be seen with a light microscope). Viruses typically contain either deoxyribonucleic acid (DNA) or ribonucleic acid (RNA) but not both; however, some viral-like particles do not contain any detectable nucleic acids (e.g., prions), whereas the recently discovered mimivirus contains both RNA and DNA. The viral nucleic acids required for replication are enclosed in a protein shell with or without a lipid membrane coat. Viruses are true parasites, requiring host cells for replication. The type of cells they infect and the host's immune response to the infection dictate the nature of the clinical manifestation. More than 2000 species of viruses have been described, with approximately 650 infecting humans and animals. Infection can lead either to rapid replication and destruction of the cell or to a long-term chronic relationship with possible integration of the viral genetic information into the host genome. The factors that determine which of these takes place are only partially understood.

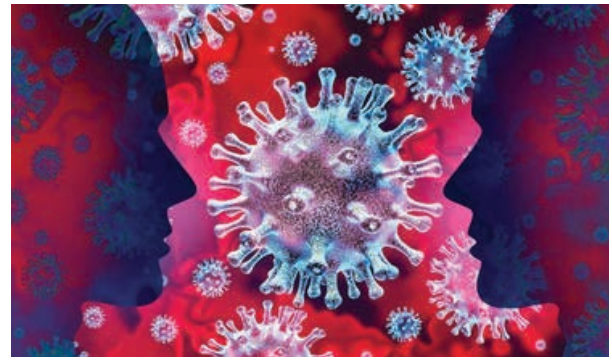


Figure 6. COVID-19 virus illustration [11].

When compared to viruses, bacteria are giants with distinctive simplicity in structure. They are prokaryotic organisms, simple unicellular organisms with no nuclear membrane, mitochondria, Golgi bodies, or endoplasmic reticulum. The bacterial cell wall is complex, consisting of one or two basic forms: a gram-positive cell wall with a thick peptidoglycan layer, and a gram-negative cell wall with a thin peptidoglycan layer and an overlying outer membrane. Some bacteria lack this cell wall structure and compensate by surviving only inside host cells or in a hypertonic environment. The size (1 to 20 μm or larger), shape (spheres, rods, spirals), and special arrangement (single cells, chains, clusters) of the cells are used for the preliminary classification of bacteria, and the phenotypic and genotypic properties of the bacteria form the basis for the definitive classification. Human body is

inhabited by thousands of different bacterial species, some living transiently, others in a permanent parasitic relationship. Likewise, the environment that surrounds us, including the air we breathe, the water we drink, and the food we eat, is populated with bacteria, many of which are relatively avirulent and some of which are capable of producing life-threatening diseases. Disease can result from the toxic effects of bacterial products (e.g., toxins) or from bacterial dissemination throughout the body, particularly via sterile body fluids.

Finally, viruses can infect bacteria, so bacteria are not immune to viral hijackers, which are known as bacteriophages. This may be one more reason to put viruses one notch higher in the nasty germ's hierarchy.

Research results presentation

The Minimum Inhibitory Concentration (MIC) is defined as the lowest concentration of an antimicrobial ingredient or agent that is bacteriostatic (prevents the visible growth of bacteria). MICs are used to evaluate the antimicrobial efficacy of various compounds by measuring the effect of decreasing concentrations of the targeted molecule over a defined period in terms of inhibition of microbial population growth. These evaluations can be quite useful during the R&D phase of a product to determine the appropriate concentrations required in the final product.

In vitro investigation of the potential 3HFWC antimicrobial activity was performed at the Department of Microbiology and Immunology, Faculty of Pharmacy, the University of Belgrade using the broth-microdilution method on seven standard bacterial strains (three Gram-positive and four Gram-negative bacteria) and one standard yeast strain. Testing was performed on the following strains of microorganisms: *Staphylococcus aureus* ATCC 6538, *Enterococcus faecalis* ATCC 29212, *Bacillus subtilis* ATCC 6633, *Escherichia coli* ATCC 8739, *Klebsiella pneumoniae* ATCC 13883, *Salmonella enterica subsp. enterica serovar Typhimurium* ATCC 14028, *Pseudomonas aeruginosa* ATCC 27853 and *Candida albicans* ATCC 10231.

Figure 7. Bacteria and viruses ilustration [12], redesigned by N. Jevtic, TFT Nano Center.

Interpretation of the results was performed by reading the minimum inhibitory concentrations (MIC). MIC is the lowest concentration of the tested sample that inhibits the growth of a given strain of bacteria. Triphenyl-tetrazolium chloride was used as an indicator of bacterial growth. The growth of *C. albicans* was assessed based on the occurrence of turbidity of the liquid medium. Obtained MIC values are presented in Figure 8.

Microorganism	3HFWC MIC (microgram/mL)
S. aureus ATCC 6538	75
E. faecalis ATCC 29212	75
B. subtilis ATCC 6633	75
E. coli ATCC 8739	75
K. pneumoniae ATCC 13883	75
S. Typhimurium ATCC 14028	75
P. aeruginosa ATCC 27853	75
C. albicans ATCC 10231	75

Figure 8. Antimicrobial activity of 3HFWC expressed in MIC (μg/mL) values.

Based on those results, it can be concluded that 3HFWC inhibits the growth of different bacteria at the concentration level of 75μg/

mL, meaning that dilution of product in ratio 1:2 gives quite satisfying results and prevents our product from microbiological contamination during the prescribed shelf life. Finally, this is the reason why we were able to declare our product as preservative-free.

Nano system for wound healing

The second part of our investigation was focused on product application in case of an infected superficial wound. The process of wound healing involves four stages: a hemostatic phase, inflammatory phase, proliferative phase, and remodeling phase (Figure 9).

Figure 9. The four stages implicated in wound healing [13].

As shown in the figure, the wound healing process involves an inflammatory stage, as well as a proliferative phase that stimulates the formation of new blood vessels. Topical treatment is currently the mainstay in wound healing, but this way of application is hampered by the barrier nature of the stratum corneum. Nanoparticle-based products have recently emerged as a very promising approach to dermatological diseases, including wounds attributed to different causes. Apart from the acceleration of the wound healing process, they are proven to reduce the risk of infections associated with the delayed healing process.

In vivo studies were conducted in accordance with the rules for the care of experimental animals, approved by the Ethics Committee of the Faculty of Pharmacy, University of Belgrade, as well as the Ministry of Agriculture, Forestry and Water Economy of the Republic of Serbia.

I Sterile Oxy spray with 3HFWC in combination with nano quantum cream

The experiment included a total of 42 Wistar rats divided into seven groups:

– G1, not infected, treated with 0,9% NaCl;
– G2, not infected, treated with Sterile Oxy spray with 3HFWC;
– G3, not infected, pre-treatment with Sterile Oxy spray with 3HFWC following with nano quantum cream application;
– G4, infected with *S. aureus*, treated with 0,9% NaCl;
–G5, infected with *S. aureus*, treated with Sterile Oxy spray with 3HFWC;
– G6, infected with *S. aureus*, pre-treatment with Sterile Oxy spray with 3HFWC following with nano quantum cream application;
– G7, infected with *S. aureus*, treated with Mirobact (mupirocin)® 2% unguentum.

Figure 10. Zepter' s Sterile Oxy spray.

Superficial wounds were induced in the form of abrasions, on the shaved part of the rat's back, according to the model described by Pastagia et al. (2011). The wounds were disinfected and in animals from the groups with infected wounds the overnight culture of *Staphylococcus aureus* was additionally inoculated. Sterile gauze was fixed with a medical patch to cover the wounds after induction, as well as after each subsequent treatment. After 24h, the animals were ran-

domized, and treatment was started twice daily for six days, with topical application of 0,9% NaCl (negative control-group G4); Sterile Oxy spray with 3HFWC (Group 5); Sterile Oxy spray with 3HFWC as pre-treatment and subsequent application of a nano quantum cream (Group G6). Mupirocin antibiotic was used as a positive control in groups with infected wounds (Group 7) according to the predefined protocol.

The impact on pathophysiology and wound healing was examined using macroscopic and microscopic evaluation. The macroscopic evaluation was performed by quantitative measurement of the surface and redness of the photographed wounds using computer software. The Microscopic evaluation was performed using histopathological analysis on biopsy wound samples. Qualitative assessment of inflammation, re-epithelialization and the presence of inflammatory cells were performed single-blindly, using a 0–3 scoring system, as described by Turtay et al. (2010).

Additionally, in infected groups, wound swabs were taken every third day to assess the antibacterial effect of the treatment. Measurement of bacterial growth levels was performed using the bacterial colony counting technique. Statistical analysis was performed using SPSS v24.0 software (IBM, USA). Group comparison was performed using one-way analysis of variance (ANOVA). The normality of the distribution was examined by the Shapiro-Wilk test. Results are presented as means ± standard deviations (SD). P values <0.05 were considered statistically significant.

The area of treated uninfected wounds was not significantly reduced compared to the control, but therefore the treatment with nano quantum cream contributed to a significant reduction of redness in the wound area (P <0.05). Redness of uninfected wounds from group G3 (treated with Sterile Oxy spray with 3HFWC following with nano quantum cream application) had decreased significantly on the first day of treatment (by 63.43%) and remained at the lowest observed value until the end of the experiment with a statistically significant difference on the second, third and fourth days of wound induction compared to control. The redness of wounds treated only with Sterile Oxy spray with 3HFWC (group G2) was also reduced, but without a significant difference compared to the control. Reduction of redness indicates the possibility of influencing the level of inflammation, meaning that the treatment reduces the inflammatory process in the wound area. Those results were confirmed in the histopathological analysis as well: in both groups with treated uninfected wounds, the presence of inflammatory neutrophil cells was not detected on samples taken on the seventh day after induction, unlike in control groups, where a slight presence of neutrophils was noted. Also, complete re-epithelialization of wound tissue was observed on samples of treated uninfected wounds, but on the other hand, in control group wounds re-epithelialization was not complete.

The effect of the treatment on the healing of wounds infected with *S. aureus* is shown in Figure 11.

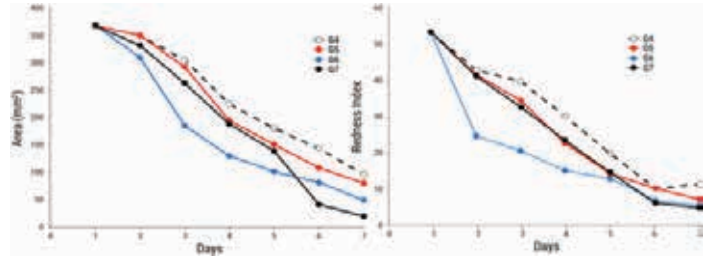


*Figure 11. Relative ratio of surface area and redness of differently treated infected wounds. The redness index in the wound area was calculated using histogram analysis after classifying digital photos by color red green/blue, combining logarithmically transformed R and G images, and brightness correction. Data are presented as mean values (± SD). #P <0.05; ## P <0.01 compared to the positive control. * P <0.05; ** P <0.01; *** P <0.001 compared to the negative control. Redesigned by N. Jevtić, TFT Nano Center.*

In the experiments with infected wounds, the antibiotic mupirocin as positive control was included (marked on the graphs in black). The best effect on the healing of infected wounds was shown by the application of the nano quantum cream immediately after pre-treatment with Sterile Oxy spray with 3HFWC (group G6). From the beginning of the treatment until the end of the experiment, the wound area from this group was significantly smaller compared to the negative control ($P < 0.05$; $P < 0.01$; $P < 0.001$). Wound redness from this group was reduced immediately on the first day of the treatment and was statistically significant on the second, third, and fourth days of wound induction ($P < 0.01$) compared to the negative control. Mupirocin (positive control) caused the fastest healing, since the surface area of wounds from this group (G7) was the smallest on the sixth and seventh days of induction ($P < 0.01$; $P < 0.001$), but without a statistically significant effect on redness. The effect of mupirocin-treated wounds on the healing rate can be explained by the rapid elimination of *S. aureus* from the infected wound tissue, since no bacterial colony was detected in wound swabs from this group on the third day after the treatment. On the other hand, treatment with Sterile Oxy spray with 3HFWC or nano quantum cream did not significantly affect the number of bacterial cells in infected wounds. These results were confirmed in histopathological analyses, since the presence of neutrophils, the primary components of the immune system in the fight against bacterial infections, was not observed in group G7 (treated with mupirocin). For other immune parameters, the best results were shown by the treatment with nano quantum cream, with a lower degree of angiogenesis or edema, or with a smaller number of macrophages compared to other groups. Also, as in the case of uninfected wounds, re-epithelialization of wounds from the groups treated with Sterile Oxy spray with 3HFWC or nano quantum cream (G5 and G6) was complete on the seventh day of induction, and in wounds treated with mupirocin, despite the greatest reduction surface at the end of the experiment, complete re-epithelialization was not present.

Conclusion

Treatment with Sterile Oxy spray with 3HFWC (Group 5) or nano quantum cream applied immediately after the pre-treatment with Sterile Oxy spray with 3HFWC (Group 6), stimulates re-epithelialization of the injured skin tissue. In addition, the nano quantum cream has a beneficial effect on the wound pathophysiology in terms of significantly reduced inflammation, and in the case of wounds infected with *S. aureus*, it contributes to faster healing.

II Hyperlight fluid fusion subcellular complex (HFFSC) in combination with nano quantum cream

A new pilot study which is still in progress has focused on investigation of the effect of Hyperlight fluid fusion subcellular complex and nano quantum cream on a model of infected superficial wound on rat's skin.

The experiment included a total of 42 Wistar rats divided into eight groups:

- G1, not infected, treated with nano quantum cream base (negative control);
- G2, not infected, treated with HFFSC following the nano quantum cream application;
- G3, infected with 10^7 CFU/mL *S. aureus*, treated with nano quantum cream base;
- G4, infected with 10^7 CFU/mL *S. aureus*, treated with HFFSC following the nano quantum cream application;
- G5, infected with 10^8 CFU/mL *S. aureus*, treated with nano quantum cream base;
- G6, infected with 10^8 CFU/mL *S. aureus*, treated with HFFSC following the nano quantum cream application;
- G7, infected with 10^9 CFU/mL *S. aureus*, treated with nano quantum cream base;
- G8, infected with 10^9 CFU/mL *S. aureus*, treated with HFFSC following the nano quantum cream application.

The effects have been assessed by classical bacterial cell counting. For experimental

purposes, we applied the OMIS (Optomagnetic Imaging Spectroscopy) method and made a correlation with the microbiological analysis. The light source of the device emits light of different wavelengths (ultraviolet, green, red, infrared, and white), which goes through the skin to different depths, so it is possible to determine biophysical properties of the skin layers. Based on the results obtained by bacteria counting (Figure 12), the OMIS method provides a clear group separation as well as a classification within each group for different durations of the treatment with Hyperlight fluid fusion subcellular complex and nano quantum cream.

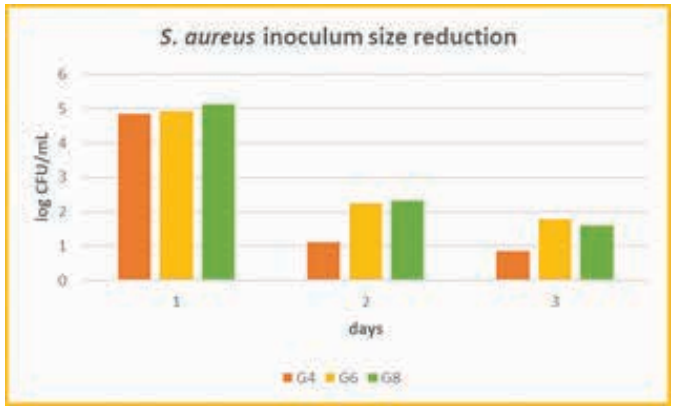
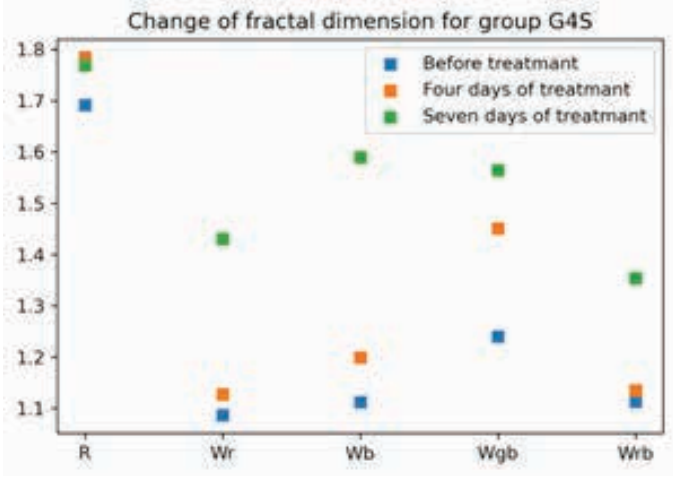
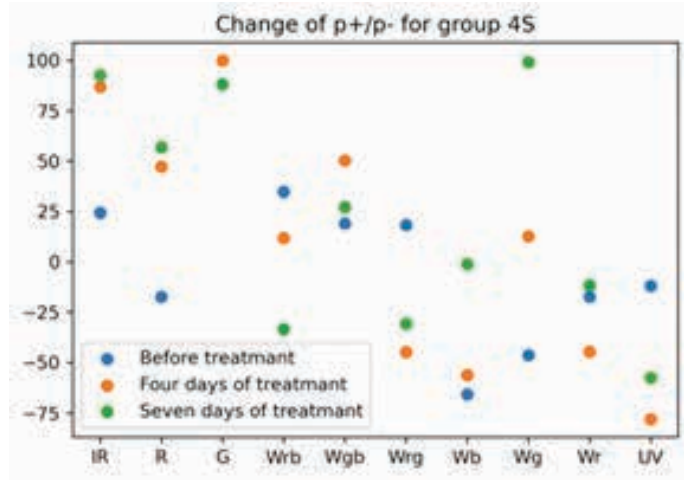


Figure 12. S. aureus inoculum size reduction



Graph 2. The average change of Higuchi fractal dimension of infected wounds in three rats that were in group G4S. The graph shows an increase in the fractal dimension for every type of light at the end of the treatment, indicating a more dynamic oscillatory process which can correlate with wound healing.



Graph 3. The average change of ratio of paired and unpaired electrons in infected wounds in three rats that were in group G4S for all wavelengths. The increase in the ratio indicates that the cream and spray influenced fibroblasts and collagen synthesis.

In summary

Regarding the first study, we have reached the conclusion that both of the tested formulations combined in two different ways of treatment (Sterile Oxy spray with 3HFWC and Sterile Oxy spray with 3HFWC following nano quantum cream application) exhibit positive effects on the wound healing process in rats. Pathohistological analysis proved that both formulations stimulate reepithelization and subsequently tissue regeneration at the injured site. Additionally, Sterile Oxy spray with 3HFWC in combination with nano quantum cream significantly reduces inflammation, as demonstrated by the low occurrence of inflammatory markers and profoundly decreased redness around the wound site. Moreover, significantly reduced redness could be observed immediately on the next day following the beginning of the treatment, which suggests that the pain and suffering of animals due to the injury was momentarily alleviated. Finally, formulations accelerated the healing process in case of *S. aureus* infected wounds.

The results of new pilot study in which the wound healing activity of Hyperlight fluid fusion subcellular complex and nano quan-

tum cream was compared to the activity of cream base alone (negative control), indicate that the 3HFWC indeed reduces the redness around the site of uninfected and *S. aureus* infected wounds. Once again, this effect appeared immediately on the next day following the beginning of the treatment, thus suggesting that the pain and suffering of animals was momentarily alleviated in these groups too.

In short, based on the unique properties of the fullerene molecule, the product possesses several characteristics that may counteract the underlying pathological mechanisms preventing a wound from healing. As shown herein, we have demonstrated that certain fullerene derivatives can accelerate wound healing and these molecules may be a novel way to treat wounds. Zepter's goal is to develop them into therapies that will accelerate this process on numerous levels.

The Zepter's nanotechnology story – an unbeatable success

We dare to believe that our ideas can change the world. Using nanotechnology, the science of beauty, new classes of magic molecules, like vitamin C60, can be introduced into the cosmetic market enabling new approaches in skincare products. Zepter's Hyperlight fluid fusion subcellular complex as a product with superior performance provides clear advantages such as exceptional antioxidant capacity. Additionally, it helps prevent breakouts and acne by balancing the sebum production of the skin. It also tightens pores and improves skin texture, while reducing redness and contributing to skin brightens. In addition to the cosmetic application in accordance with the outstanding premise Feel comfortable in your own skin, we are facing new challenges in the product development, being truly dedicated to the company mission. Success is a normal outcome of the synergy of a healthy body and a healthy spirit. To be completely healthy, we have to realize a majority of our mental and physical potentials. This kind of health is the ultimate achievement, as it is the precondition for all others.

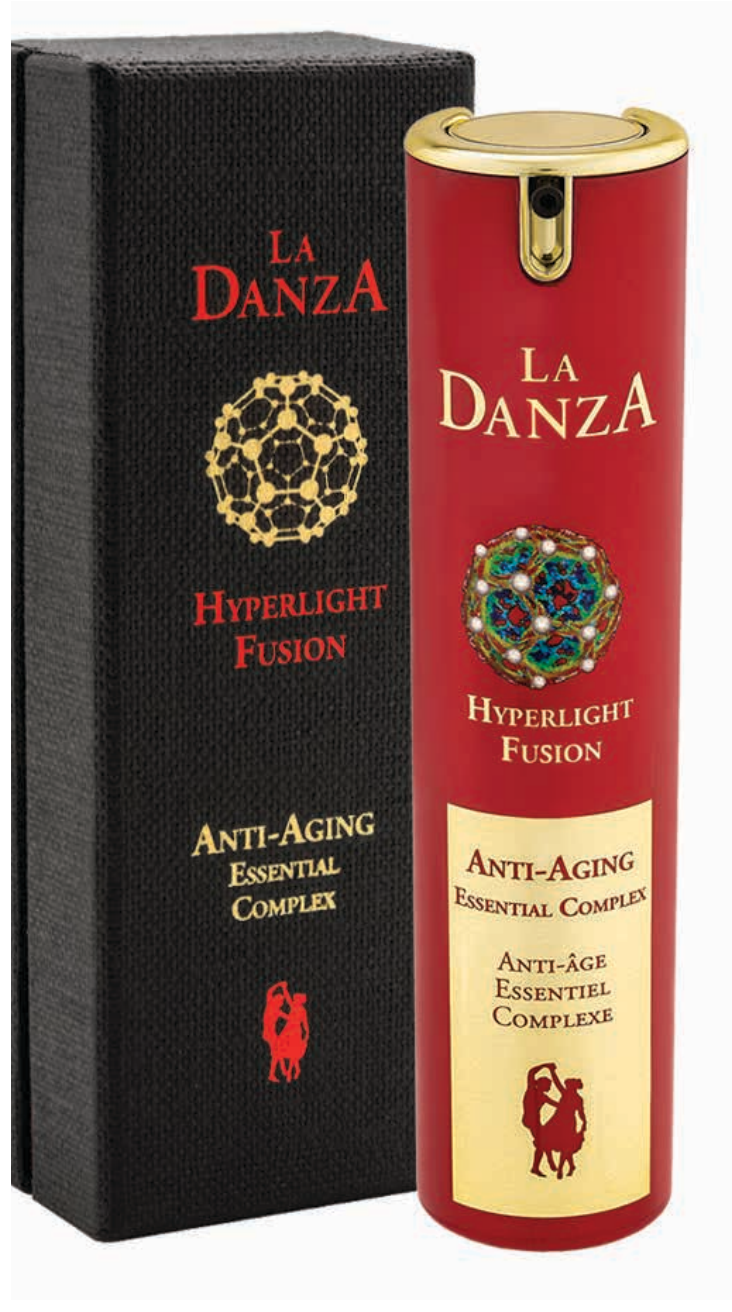


Figure 13. Zepter's La Danza Anti-Aging essential complex

Ackowledgements

We would like to express our deep and sincere gratitude to Professor Marina Milenković and her assistant Dušan Ušjak, who have provided invaluable guidance throughout this research and enabled the successful completion of this project.

"No one who achieves success does so without acknowledging the help of others. The wise and confident acknowledge this help with gratitude."

Alfred North Whitehead

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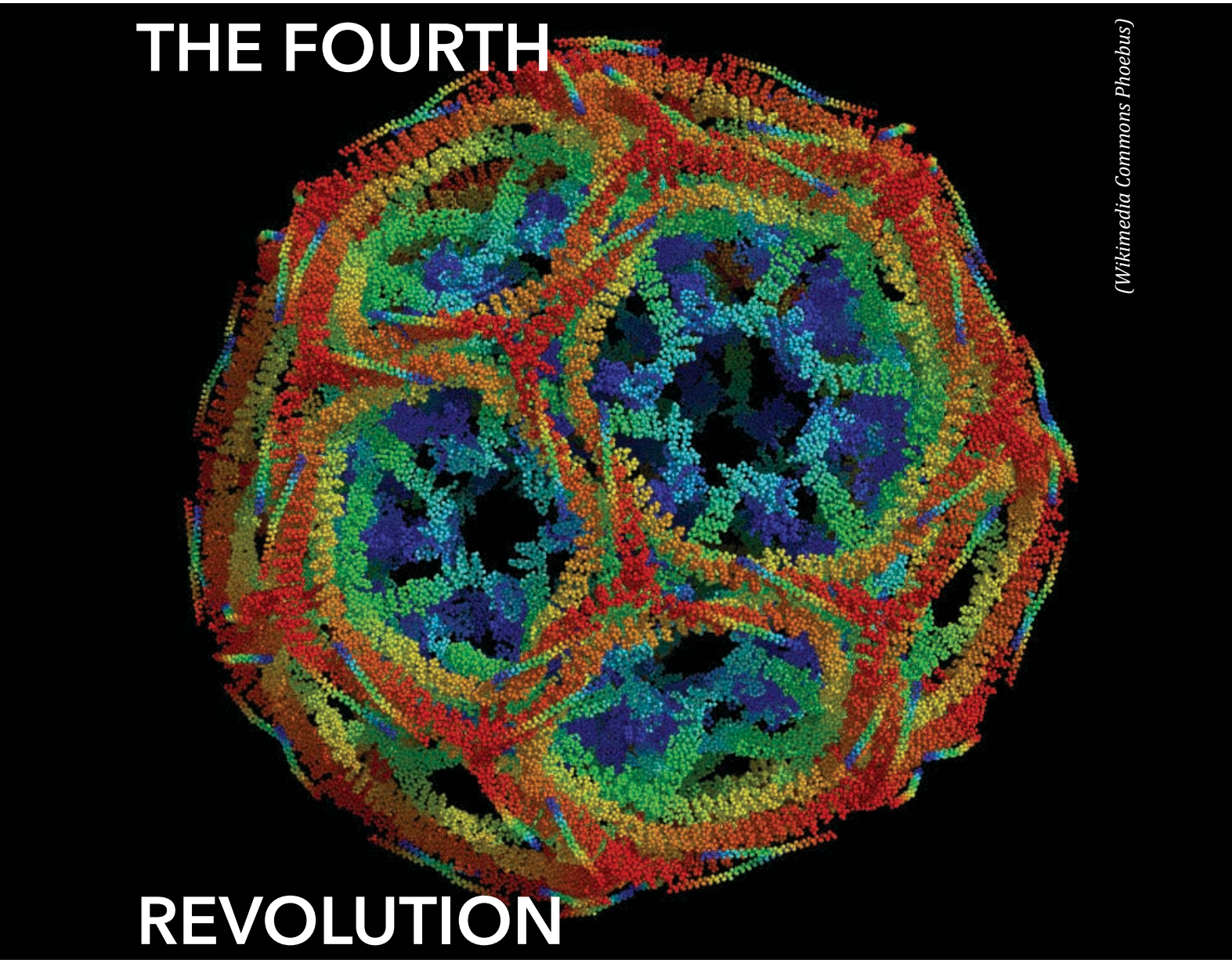
THE FOURTH REVOLUTION



(Wikimedia Commons Phoebus)

Compared to the three previous ones, embodied in the terms Primordial, Nature and Human, the Fourth Technological Revolution brings about, on the one hand, a new relationship that suggests the fulfilment of Albert Einstein's thought on the ultimate knowledge that "The most incomprehensible thing about the universe is that it is comprehensible", while on the other it generates through labor and capital accumulation an organization that affirms Adam Smith's idea of the wealth of the people. Finally, it puts man and human health in the focus of all challenges because, as Gottfried Wilhelm Leibniz, one of the protagonists of the first technological revolution, said "things of this world after spiritual peace, nothing is more important than health, the knowledge and achievement of which requires deep thinking in physics and technology".

Aleksandra Dragićević

Dear readers, do not forget that you are on a spaceship called Earth and that "Man, however", as Nikola Tesla said, "is not an ordinary mass, consisting of spinning atoms and molecules, and containing merely heat-energy. He is a mass possessed of certain higher qualities by reason of the creative principle of life with which he is endowed. His mass is as the water in an ocean wave." To understand the principle of creative action, which is the foundation of the Fourth Technological Revolution, we must start from the First, to see how revolutionary (scientific-technological) and evolutionary (industrial-economic) actions were born, permeated, and generated a new one that, compared to the previous ones, is not something absolutely new, but its own other.

Let us start with this question: What do we consider a technological revolution? Bearing in mind that the focus is on man (better to say our being, which is both "human" and "divine"), as a measure of all things, then it is logical to accept the point of view that Prof. Đuro Koruga, a pioneer in nanotechnology, presented in 2008: a technological revolution comprises activities, procedures, and inventions (from an idea to its realization) that replace human labor with engineering.

What is human labor? By human labor, we will consider a complex activity in which man, with his mental and physical abilities he is endowed with (as Tesla would say), changes the environment [space, mass, etc. in time] and himself. How does a person do that? In two ways: by repeating operations – routinely and by finding a new operation – creatively. Thus, we have four (or five) basic types of work: mental, physical, routine, and creative (including destructive). The first four basic types are networked in our daily activities or, as we would say, they form the basis of the matrix of our being. This is what stands before us as active beings. But, as Johann Wolfgang Goethe puts it, "The hardest thing to see is what is in front of your eyes".

So, we have in front of us a complex system of human activities, in which from the Stone Age until the 19th century – from "bare-handed industry" to "prosthetic industry" – man manually changed his environment and began to make basic elements for machines and devices by evolutionary production activities and processes. This manual evolutionary activity ("Industry !0.0!") created the preconditions for the First Technological Revolution.

THE FIRST TECHNOLOGICAL REVOLUTION represents the replacement of manual-routine human work with machine work. The main protagonists were Papen, Leibniz, and Watt.

Denis Papen (1647-1712), a physician, was one of the initiators of the First Technological Revolution. He invented the pressure cooker. Realizing that the closed steam tended to lift the lid, he realized that it was possible to use steam to drive the piston in the cylinder. He proposed the first cylinder for the first steam engine, which included a safety valve that prevented the vessel from exploding. He was aware of the epochal nature of the discovery: "I assure you that the more I progress, the more I appreciate the value of this invention, which will infinitely advance theory and human power. As for the practical side, I believe that I can say without exaggeration that with the help of this tool, a single person will do the work of a hundred".

Gottfried Wilhelm Leibniz (Wikipedia)

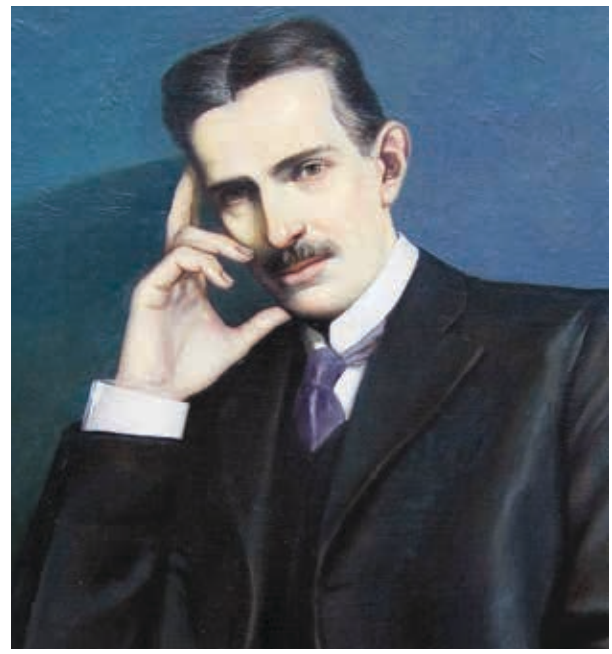
Gottfried Wilhelm Leibniz (1646-1716), a German philosopher, mathematician, and innovator, the originator of the idea of the Second Technological Revolution, was Papen's collaborator in perfecting the vapor devices. He was a participant in the invention and construction of steam engines. He constructed pumps, hoses for extinguishing fires, parts for ships, lighting, etc. He invented the calculating machine very different from Blaise Pascal's, which could only add and subtract, while Leibniz's machine could multiply, divide, and extract the square root. In mathematics, he researched the idea of a universal mathematical-logical language based on a binary system. He believed that following spiritual peace, health is the most important thing for a person, and that it could be preserved with the help of technology. He claimed that the world had been created from a monad and that every monad was a small world clashing with force, from which every activity and aspiration to perfection originated.

James Watt (1736–1819), a Scottish engineer and inventor, worked at the University of Glasgow, in a workshop for repairing measuring instruments and calibrating devices. By improving the existing machines, in 1765 he increased the efficiency of the pumping engine by adding a special condenser, and in 1781 he designed a machine for rotating the shaft instead of generating a pump start. His idea was to separate the two operations, heating the cylinder with hot steam and cooling to condense the steam for each engine stroke. He patented a mechanical rotary engine and a steam indicator, which records the steam pressure inside the engine, resulting in a steam pressure regulator in the cylinder, based on which a modern steam engine was created.

The Second Technological Revolution was not to be waited for for thousands of years, like the First one, but for a mere a hundred. This was considered as "Industry 1.0" (which largely replaced "Industry 0.0"), in which small evolutionary changes took place, but now not based on human manual energy, but on a machine.

THE SECOND TECHNOLOGICAL REVOLUTION represents the replacement of the mental-routine work of man by machine. The main protagonists were Faraday, Tesla, and Turing.

Michael Faraday (1791-1867) was an English physicist and chemist, whose experiments greatly contributed to the understanding and development of devices based on the principles of electromagnetism. He discovered several new organic compounds, including benzene. He was the first to produce electricity from a magnetic field, invented the electric motor and the dynamo, and showed the connection between electricity and chemical bonding. He discovered and named diamagnetism, the behavior of certain substances in strong magnetic fields. He discovered the effect of magnetism on light known as the Faraday effect.



Nikola Tesla (Wikimedia Commons/Ivan Veličković)

Nikola Tesla (1856-1943), a Serbian-American scientist and inventor, discovered and patented a rotating magnetic field, the basis of most of today's alternating current machines. He developed an alternating current system and a three-phase electricity transmission system. He invented the Tesla coil, an induction thread that is widely used in radio technology. He contributed to the de-

velopment of electromagnetic devices which represent the basis not only of modern calculating machines that have replaced mental-routine work with machine ones but also of control and telecommunication devices for signal (information) transmission. What is more, he initiated a new method, which may be described as "holographic virtual engineering".

Alan Turing (1912-1954), an English mathematician and cryptographer, is considered the founder of the modern computer system and computer technology. He perfected the concept of algorithms used today in the world of computing using the Turing machine, and the Turing test opened a new part that changed light, and he would then begin to think:. During World War II, several deciphering techniques (for breaking codes) were developed, which included a method and a machine that could crack the Enigma code.

THE THIRD TECHNOLOGICAL REVOLUTION represents the replacement of the mind-creative work of man by the machine. The main protagonists are Minsky, Wiener, and Grosberg ("Boston Trio").

Marvin Minsky (Wikipedia)

Marvin Minsky (1927-2016), an American mathematician and computer genius, was one of the first and most famous scientists who dealt with artificial intelligence based on mathematica instrumentalis. For his pioneering work in the field of artificial intelligence, he received the Turing Award, the highest recognition in the world of computing.

Steven Grossberg (1939-), an American scientist and engineer, a pioneer in neuromorphic technology, mathematician, biomedical engineer, and one of the pioneers of artificial neural networks (mathematica naturalis). A professor at Boston University, he teaches cognitive and artificial neural systems, mathematics, psychology, and biomedical engineering. He is working on the development of a brain model that visually recognizes objects, listens and speaks, learns and remembers, cognitively processes data, and has a sensory-motor control.

Norbert Wiener (1894-1964), an American mathematician and scientist, founder of cybernetics. He made a very innovative and fundamental breakthrough, which is today called a stochastic process, and made advances in the theory of Brownian motion and generalized harmonic analysis. Cybernetics is an interdisciplinary field based on common relations (communication and management) between people and machines.

While in all the three scientific-technological revolutions, and as well as in the industrial evolutions man was an external actor who created devices (man-machine system), in the Fourth Technological Revolution man "inhales to the material", first elements of adaptive behaviors, and then intelligence.

THE FOURTH TECHNOLOGICAL REVOLUTION represents the replacement of physical and creative work of man with that of the machine, i.e., the creation of machines whose material (electro-mechanical, machine system) has creative features (self-organization, reproduction, and intelligent behavior). The main protagonists are Feynman, Kanaseki-Kadota, and Osawa.

Richard Feynman (Wikipedia)

Richard Feynman (1918-1988), an American physicist with a wide range of scientific interests, was recognized as one of the most influential scientists after the Second World War. He was the founder of quantum electrodynamics – the theory of the interaction of light and matter, introducing a new way of explaining the nature of waves and particles. In 1959, he put forward the idea of nanotechnology – the idea that atoms could be manipulated one by one, and atomic structures could be created at will. In 1965, he received the Nobel Prize in Physics. In 2005, the unit One Feynman (φ, which is equal to one nanometer) was accepted in science. He believed that "we use numbers in all our theories, but we do not understand them – what they are and where they come from."

In 1969, Kanaseki and Kadota, two "unknown heroes" of the Fourth Technological Revolution, discovered the biomolecule clathrin, responsible for releasing neurotransmitters in the brain. The basis of the brain's information process is the signalization between neuronal synapses. This molecule has an icosahedral symmetry, a three-dimensional structure, and consists of 12 pentagons and 20 hexagons. Its uniqueness is the stimulation of the work of zero dimensions in our brain. Motivated to replicate these properties, scientists (Prof. Đuro Koruga, University of Belgrade and Prof. Stuart Hameroff, University of Arizona) attempted to make an intelligent material based on carbon atoms and icosahedral symmetry.

Figure 1 The feat of "unknown heroes of science" – the discovery of clathrin in the human brain – the basic principle of the symmetry for the material that is the basis of the Fourth Technological Revolution. (Kanaseki, T., Kadota, K., The Vesicle in a Basket, J. Cell Biol 42: 202-220, 1969). Sixteen years later, Kroto used a soccer ball to represent the icosahedral symmetry of the C_{60} molecule.

Eiji Osawa (1935-), a Japanese scientist, founder of the research and development company Nano-Carbon Research, was the first to predict the existence of a structure with 60 carbon atoms, arranged according to the law of icosahedral symmetry in 1970. It is a material (electro-mechanical system, i.e., a molecular machine rotating randomly, "spinning", a billion times per second), with a potential characteristic of generating self-organization as a basis for self-creation of something new (creativity). The mentioned molecule corresponds to clathrin in the brain.

The bases for industrial revolutions are technological revolutions, and as they cannot be realized without economic revolutions, which implies the necessity of changes in the organization of labor and capital, the formation of new business systems adapted to local (factories, state) and global (world) legal regulations (commercial law). Effective man's activity could not be understood without taking into account economic and social revolutions as other, invisible sides of technological revolutions. That is why they must be synchronized with each other, because otherwise neither of them would be

realized. In that light, Victor Hugo was right when he said that "Nothing is more powerful than an idea whose time has come". That is why we will briefly say a few words about economic protagonists (and social changes that go with them).

Ljubiša Milović, a pioneer in the application of the Japanese production philosophy in former Yugoslavia states in his book "Organization of Labor and Capital: From Adam Smith to the Fourth Technological Revolution" that the protagonists of economic-social-business revolutions were as follows: the First Revolution – Adam Smith and Karl Marx; the Second Revolution – Henry Ford and Frederick Taylor; the Third Revolution – Shigeo Shingo and Michael Hammer; and the Fourth Revolution – Elon Musk and Philip Zepter. According to his analysis, their work correspond to those of technological revolutions.

Adam Smith (Wikimedia Commons)

Adam Smith (1723-1790), a Scottish economist and theorist of the philosophy of morality, is well-known for his major work "Exploring the Nature and Causes of the Wealth of Nations," which represents the beginning of political economy as a science. Two and a half centuries ago, he advocated that "philosophers for production" be engaged in production, with the task of improving it.

Karl Marx (1818-1883), a German philosopher developed a theory of social relations (today known as Marxism), based on economics with a wide circle of collaborators. He was classified as one of the three most original economists in the world and was considered a genius analyst in the professional literature because in his doctoral dissertation "Difference between Epicurus and Democritus' philosophy of nature" (in Greek) he had already identified the differences that had not been noticed before. He did similar analyses and made similar observations in "Capital", which is very relevant now in the West in terms of finding a solution to the relationship between labor and capital in the modern world. Although he highly valued the work of Adam Smith, he criticized it in several places as the exclusive example of capitalist social relations.

Henry Ford (1863-1947), as chief engineer in 1893, after two years of being employed by Edison Illuminating of Detroit, invested his free time and money in making gasoline engines. Three years of painstaking work was enough to complete the self-propelled Ford Quadricycle. While testing the new vehicle, he was constantly thinking about improving this four-wheeler. The most important moment in the constant innovative activity was the year 1908, when he presented the production model, known as "Model T".

Friedrich Taylor (1856-1915), an American mechanical engineer, is known for establishing a scientific organization, formulating the control theory, and advancing industrial production. In addition to working on improving industrial efficiency, he patented an improved version of steel production and published the book "Principles of Scientific Management", which marked the first half of the twentieth century.

Shigeo Shingo (1909-1990) created the "Toyota production system", and he is known for his book "New Japanese Production Philosophy". In the USA, an award with his name is given every year for achievements in improving production processes. During his stay in the former Yugoslavia, he claimed that potential of Yugoslav's engineers, with whom he worked, is enormous. He revolutionized production systems of any type of manufacturing under the motto: "Just in time".

Michael Hamer (1948-2008). The exchange of experiences and theoretical approaches between the USA and Japan and Japan and Europe (the example of Sweden), was intensified by order of the Second World War. This is symbolized by "Ford" (USA) before the First World War and "Toyota" (Japan) after the Second World War, until M. Hamera and J. Champia, creator of BPR. The two of them claimed that in defining the production program, they morally started from the needs of customers and not from what they could do, where the "Breakpoint Strategy" plays an important role.

Elon Musk (1971-), an engineer and entrepreneur, one of the richest people in the world, founded several companies and has been known for running Tesla Motors since 2003. In 2007, he made the first sports electric car. He is a supporter of space flights and the Fourth Industrial Revolution.

Philip Zepter (Wikipedia)

Philip Zepter (1950-), an economist and a businessman of international reputation, whose motto is WOR (work-order-result), has been running his company Zepter International in more than 50 countries for 30 years. Its main products are based on air, water, food, and light to save and improve human health and longevity, which is a unique approach business philosophy in history. He has been significantly improving the products by applying nanotechnology. He founded the TFT (Thales-Fibonacci-Tesla) Nano Center in Belgrade, and ZeptoHyperTech innovation center, in which a group "Innovations Hunters" works. His business calendar has 13 months, in accordance with the "Lunar calendar" and Fibonacci number 13.

All three areas – industry, health, and business – within the business philosophy of Zepter International are in line with the Fourth Scientific and Technological Revolution, and in the spirit of Leibniz's words "that after spiritual peace, health is most important for a man whose preservation is an important technique". Technology (Industry 4.0) in the Fourth Technological Revolution is focused on mastering space and time for the purpose of optimal prevention, protection, and regulation of external and internal factors of human existence, as well as of preservation of health and longevity. The mentioned goals and tasks stem from the needs of healthcare (medicine 4.0), which is moving from the medicine of statistics to personalized medicine, which requires a real new revolution in biology and medicine.

The aforementioned book "Organization of Labor and Capital" cites one of the examples of the synergy between Industry 4.0 and Medicine 4.0 through the TESLA HYPER LIGHT® glasses lens and the BIOPTRON medical device filter. Glasses lenses convert external light (or any electromagnetic radiation, including electromagnetic smog) into the photon arrangement harmonized with the electromagnetism of biomolecules and tissues. We are spending more and more time indoors with artificial lighting, polychromatic and diffuse (LED, neon, halogen), which is partly incompatible with human eyes and brain. Additionally, being exposed to the effects of daylight (sunlight) uncontrollably can be harmful for human health

(UV, high energy blue, and some infrared light). TESLA HYPER LIGHT® lenses partly block the undesirable spectrum of light radiation (sun, artificial lighting, electromagnetic smog) and partly transform it into a spectrum beneficial for the human body (for the secretion of serotonin, melatonin, dopamine, and cortisol).

As it is well known, "A swallow does not make a summer": good synchronization and harmonization of work and capital, social and private, is needed everywhere. What are the social opportunities for any country? The answer can be found in the book "SERBIA 4.0 – A Future That Must Not Be Missed", Prof. Radivoje Mitrović, PhD, Dean of the Faculty of Mechanical Engineering in Belgrade. If one should point to a single sentence which conveys the main message of the author of the book, that would be "Learn from the world, not about the world."

And, if you were to ask "natural intelligence" what the future brings, what is hidden in the molecule C_{60}, what kind of a relationship there should be between labor and capital, and the wealth of the people and the surplus-value, or what the relationship between the private and the social should be, the answer would be unequivocal: Nature-Man-Engineering as the Golden ratio!

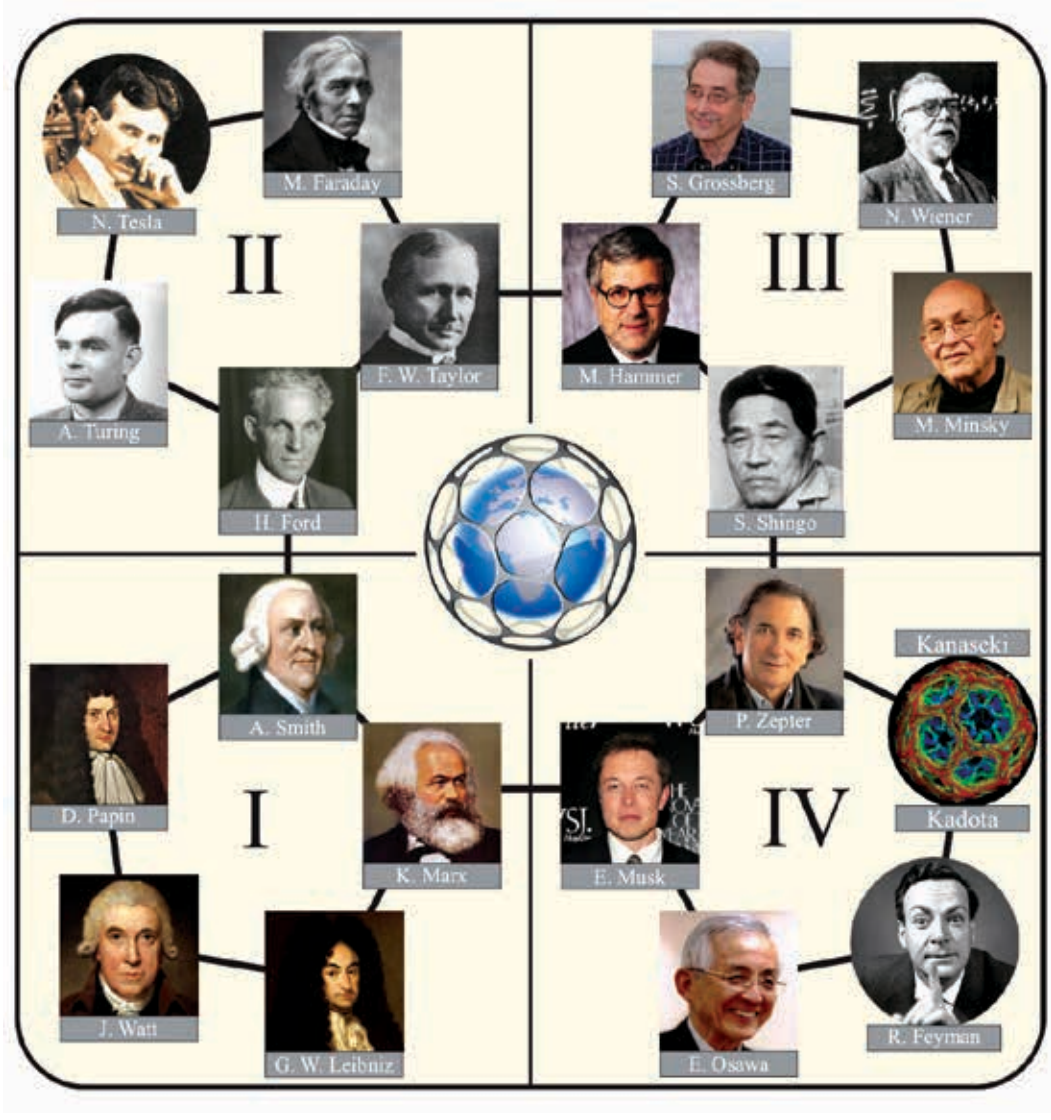
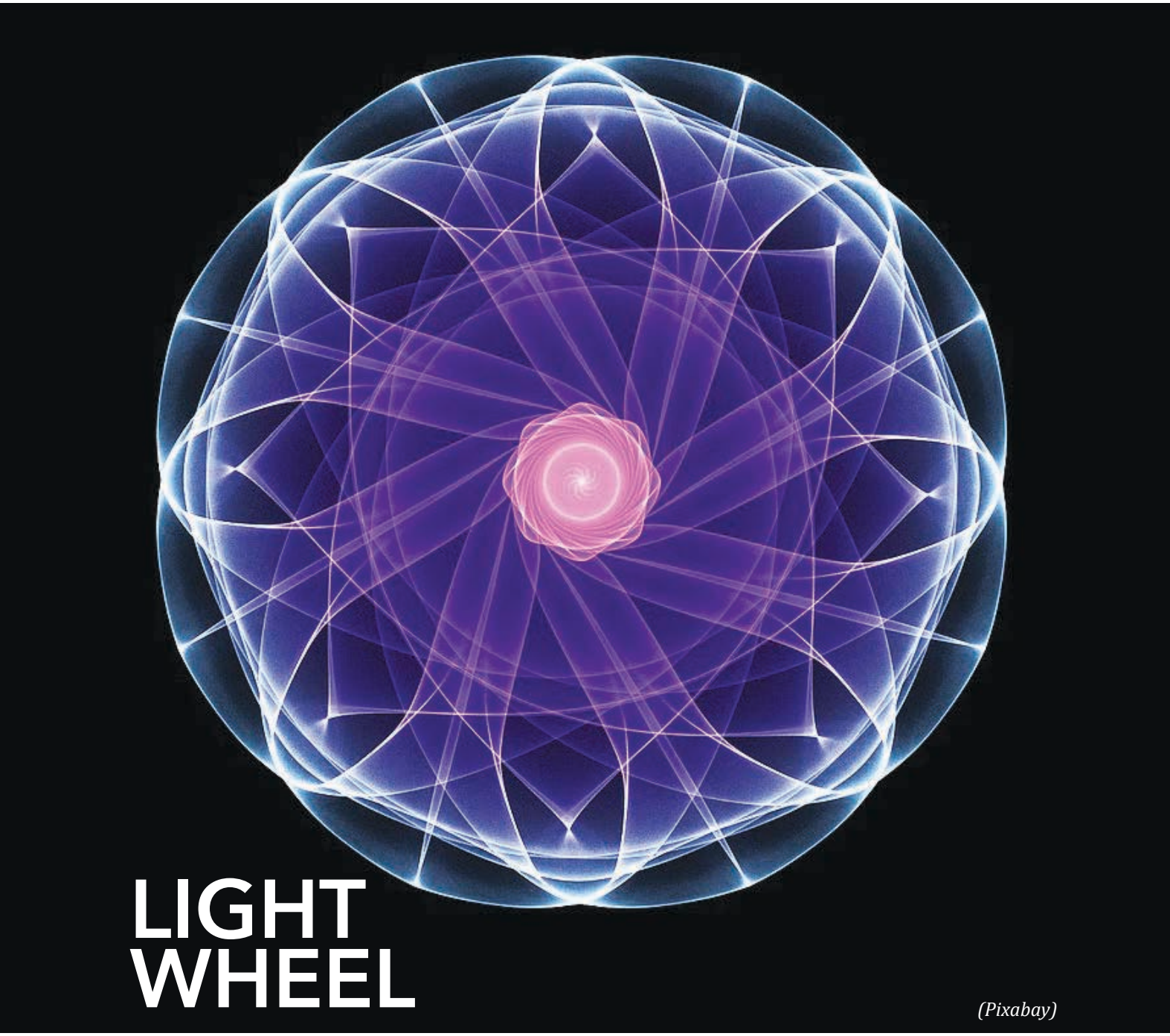


Figure 5 Protagonists of techno-economical and business revolutions (Milovic,Lj. "Organization of Labor and Capital: From Adam Smith to the Fourth Technological Revolution", Davos, Belgrade 2019).



LIGHT WHEEL

(Pixabay)

Biophysical signaling in the human body is a very complex process. We have analyzed biophysical signaling based on both covalent and non-covalent hydrogen bonds. Using symmetry as a driving force for oscillations, we have found that harmony and synchronization of oscillations, from biomolecules; cells; and tissues to organs and the organism as a whole, are possible in accordance with the principle "contraria sunt complementa" (the coupling of high and low frequencies). This principle was used in science for the first time in 1957 by Niels Bohr, who won the Nobel prize in physics in 1922.

Ana Jovanović, Teodora Torbica, Đuro Koruga

We are creatures of photons and electrons, and we peruse scientific knowledge as the most important thing we have, although, as Einstein puts it, "all our science, measured against reality, is primitive and childlike, and yet it is the most precious thing we have". In this article we deal with photons, i.e., with devices and substances that operate on the basis of photons and electrons (light/electromagnetism) and that are used for medical and cosmetic purposes. This is why it is necessary, first of all, to understand how signals are formed and transmitted, and then how the oscillatory electromagnetic processes of biological structures – from biomolecules to organisms – are intertwined, all being in sync. This process of synchronization can be explained by the principle *contraria sunt complementa*, which was introduced into science by Niels Bohr in 1957. The C_{60} molecule, as well as its derivatives, which has been implemented in Zepter's products as a perfect "light wheel" embodies this principle in the human body on the basis of hydrogen bonds, for which Linus Pauling said that they are more important than any single organ in the human body (than the brain, heart or lungs).

The photon is still the central enigma in current science, in spite of the fact that it has been about 70 years since journalists asked Einstein what the photon was. He somewhat unexpectedly replied that he had been unsuccessfully searching for the answer to that question most of his life, adding that it would be far more beneficial to learn what the electron was. This sounds a bit like "no lemon, no melon"; we do not know what the photon is ("no lemon"), or what the electron is ("no melon"), but their essence is contained in themselves.

This is clearly a palindrome phenomenon, but the physical reality cannot be read backwards like the human language: its code sequence orders the reality. In biology, the solution to this code is realized in Y chromosome at the molecular level. It is enough to know half of the DNA sequence to have information about all the chromosome sequences. And a very strange solution it is: a half is equal to the whole! Another view of this problem is reflected in Plato's thought: "There is not anything that is truly one, even the number two is scarcely one". This opens new possibilities for light: photon half –quantization, which was experimentally demonstrated in 2016 (Ballantine et al., There are many ways to spin a photon: Half-quantization of a total optical angular momentum. Science Advance 2 (4):1-7, 2016).

At the same time, between 2014 and 2016, Zepter's research team came to a similar solution regarding orbital angular momentum and photon spin quantization, with the energy of the ground state of the photon E0 =1/2 hv. (it was published two years later in Koruga, Hyperpolarized light, Zepter Book World, 2018). Since there are the left and right directions ("sunflower" solution) of angular orbital momenta, their crossing point gives E =hv, and does not violate Planck's quantum law. What is more, scientists have determined that two photons may form entangled rings. One possible illustration of this phenomenon is given in the image above the text. (Chen et al., Realization of the Einstein-Podolsky-Rosen Paradox Using Radial Position and Radial Momentum Variables, Phys. Rev. Lett. 123, 060403 – Published 8 August 2019). Photon and light possess self-organization properties, and in spite of the fact that we know a lot about light, human civilization today is in the "stone age" of biomedical photonics.

Biophysical signaling in human body

Zepto column (Figure 1 and poster): Three main ZEPTER products based on the C_{60} molecule are shown: (a) glasses lenses; (b) BIOPTRON filters; and (c) the 3HFWC substance in medicine and cosmetics. What all these products do is generate "TFT oscillations" based on hydrogen bonds. Water comprises about 70% of the human body; DNA biomolecules, collagen, elastin, microtubules, etc., amount to the additional 15%, which means that about 85% of the human body relies on hydrogen bonds. The network of hydrogen

bonds intersperses the human body much more subtly than the circulatory, nervous, or lymphatic systems. The reason for this is the fact that these systems are mainly classic systems of the human body, while the system of hydrogen bonds is a quantum-classic one. Experimental evidence that in addition to classic features (Coulomb's forces) hydrogen bonds show quantum features as well (Ψ-wave functions) was obtained in 1999 (Isaacs, E.D., Covalency of the hydrogen bond in ice: A direct X-ray measurement, Physical Review Letters, 82:600-603, 1999). The significance of hydrogen bonds to biological systems was noted as far back as in 1939, when the double Nobel prize laureate Linus Pauling stated that hydrogen bonds were more important for the functioning of the human organism than any organ (Pauling, L., The Nature of the Chemical Bond, Ithaca, 1939).

Thales of Miletus (640–548 B.C.E.) considered that water, or rather the principles of its functioning, are the original basis of everything existing, while Tesla believed that the Universe is alive because all things have a frequency, and all things vibrate. It these vibrations and frequencies in water and biomolecules follow the Fibonacci Laws, which constitute the icosahedral symmetry, then this results in the TFT (Thales-Fibonacci-Tesla) oscillator, which can help to repair the biomolecular conformation state and stimulate the production of new ones.

a): There are three types of glasses lenses: sunglass lenses (outdoor, with 70% light reduction); bright light lenses (outdoor/indoor, with 45—50% light reduction); and indoor lenses (LED, neon, and halogen light, or cloudy day; 85—92% transmittance). When hit by incident light, these lenses generate an exciton (a quantum cavity phenomenon), which coupled with a photon results in a polariton. This type of lenses is unique on the market (since June 12th, this invention is a registered patent PCT/EP2019/083307).

Biomolecules column: The basis of oscillatory processes that biomolecules and their intermolecular interactions display consist of covalent (O-H and N-H) and non-covalent (O…H and N…H) hydrogen bonds, respectively. There are six basic types of non-covalent hydrogen bonds that generate and transmit electromagnetic signals through water, biomolecules, and tissues. The complexity of signaling is further enhanced by ions, so water as a complex system can be diamagnetic at one given moment and paramagnetic at another, because water creates and breaks water clusters at the speed of several picoseconds (10^{-12} s) to 50 femtoseconds (10^{-15} s). Despite such rapid changes at the molecular level, macroscopically water "breathes" very slowly, in intervals of several seconds. DNA abounds in hydrogen bonds, as its nucleotides – adenine (A), thymine (T), cytosine (C) and guanine (G) – are linked by double (A=T) and triple (C≡G) non-covalent hydrogen bonds. The DNA oscillatory processes are at the scale of giga- and terahertz, so the oscillation reduction of DNA three orders of magnitude that of water. The cell membrane lipid layer, an electromagnetic structure itself, also oscillates very quickly, from several megahertz to one petahertz (i.e., to one femtosecond).

Cells column: Although all cells originate from one fertilized egg cell, during embryogenesis cells differentiate in order to form various tissues and organs. Human body contains around 10^{14} (100,000 billion) cells, but there are only about 200 cell types different in their structure and function, which means that approximately 500 billion cells constitute an organ or a tissue. Within the group of about 200 basic cell types, there are variations in the presence of different biomolecules inside a cell (in each group), resulting in remarkably complex and diverse cell oscillatory processes. Every cell type and subtype has its typical electromagnetic oscillatory processes ranging between 10^4 and 10^{10} Hz. Out of possible 200, six possible cellular oscillatory types are shown in Figure 1 in the Cells column.

Organs and tissues column: Billions of cells of the same or similar type, whose activity is

synchronized, such as the cells of the brain (EEG, MEG, fNMR – different numbers of signals that can be instrumentally identified), heart (ECG, MCG), muscle tissues, lymphatic system, etc., oscillate much more slowly, in the range of 10^0 and 10^3 Hz. These oscillations have been well researched from the perspective of being healthy or not, even though the essence of superposing their biomolecular and cellular oscillations has still not been elucidated. Hydrogen bond oscillatory processes open new possibilities for understanding these oscillations, and simultaneously designing new devices and appliances for better diagnostic and therapeutical purposes.

Body column: At the level of human body, the synchronization of very rapid biomolecular (10^7–10^{15} Hz) and cellular (10^4–10^{10} Hz) oscillations occurs, with somewhat slower organ oscillations of (10^1–10^3 Hz), and very slow body oscillations (10^1–10^{-5} Hz). For instance, oscillatory processes of hormones or circadian and acupuncture processes within a 24-hour period are well known, with the oscillatory process being at about 10^{-5} Hz (1/(24 x 60 x60) = 1/86400= 1.15 x 10^{-5} Hz).
Light speed is the product of the photon wavelength (λ) and its frequency (ν) and is expressed as $c = \lambda \times \nu$. This linear system is represented in Figure 2, with the visible spectrum in a very narrow range (4–7 × 10^{-7} m, that is 4.2–7.5 × 10^{15} Hz). This linear model of light provides an important piece of information: the ratio between the wavelength and frequency of any photon is ~ 10^8 (Figure 2).

However, a linear model does not show how the end points meet. To see how the end points meet and how opposites intertwine, i.e., how rapid biomolecular oscillations (10^7–10^{15} Hz) couple with the slow oscillations of organs (10^1–10^3 Hz) and body (10^0–10^{-6} Hz), we must switch to the cyclic model, or, in other words, we must bring the opposites

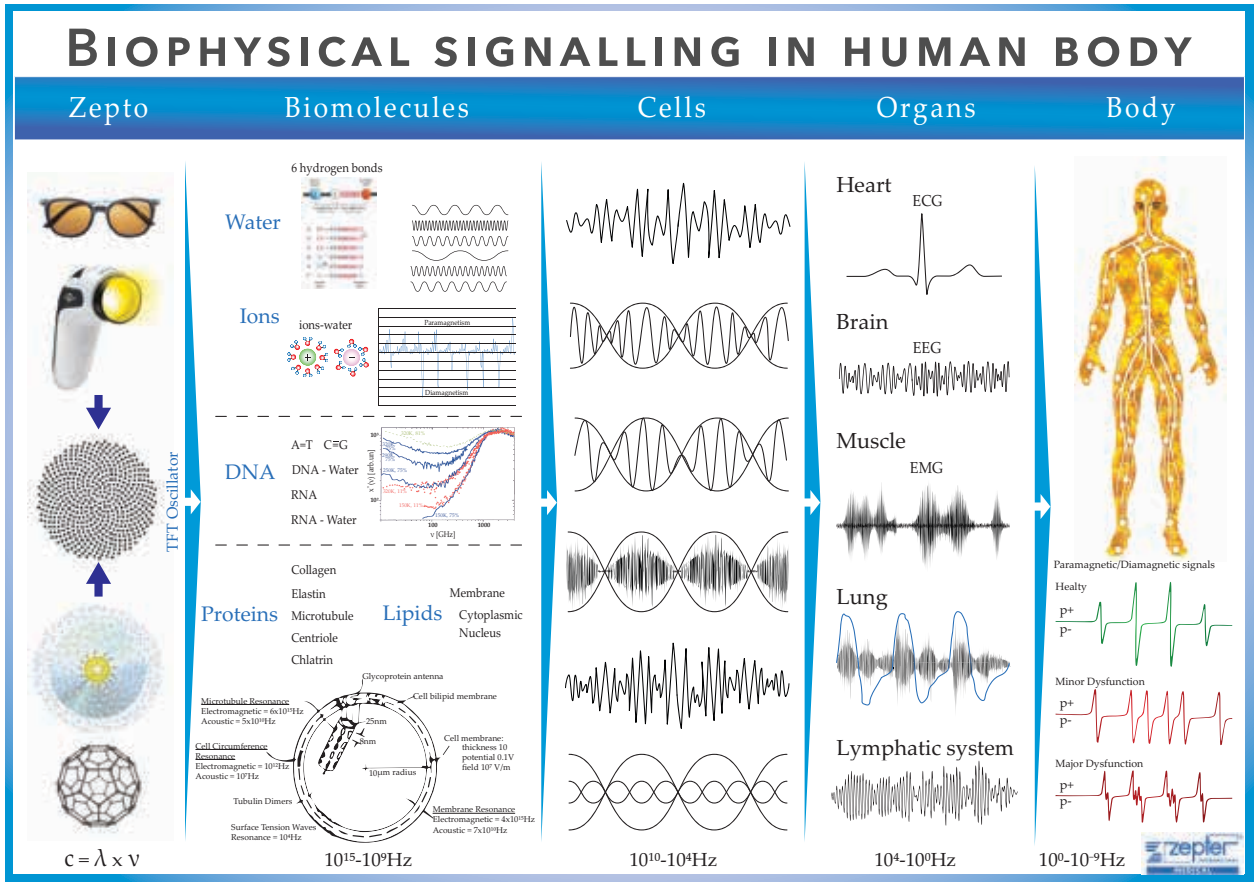


Figure 1: Schematic representation of biophysical signaling in the human body: from biomolecules to organism (a larger image of this schematic representation is printed as a poster in this edition of Galaksija).

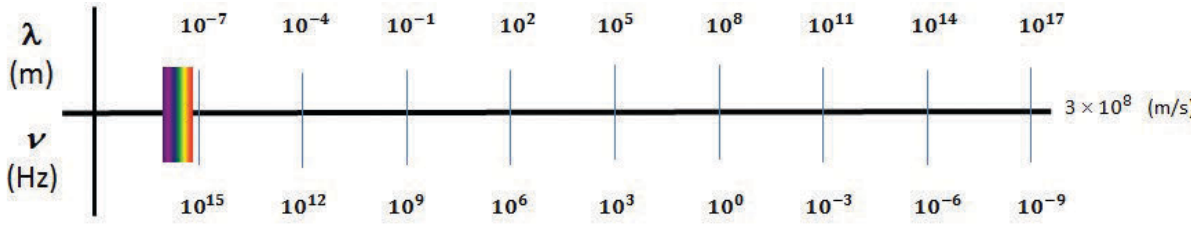


Figure 2: Linear model of light based on wavelength (m) and frequency (Hz). From this model, it follows that the ratio between the wavelength and frequency is ~ 10^8.

together – the rapid biomolecular oscillatory processes and low frequencies of tissues and body (Figure 3). This figure shows that the symmetry of the energy-information processes based on the icosahedral symmetry (Fibonacci's Law – the sunflower) brings the oscillatory electromagnetic processes in the human organism as a whole into harmony.

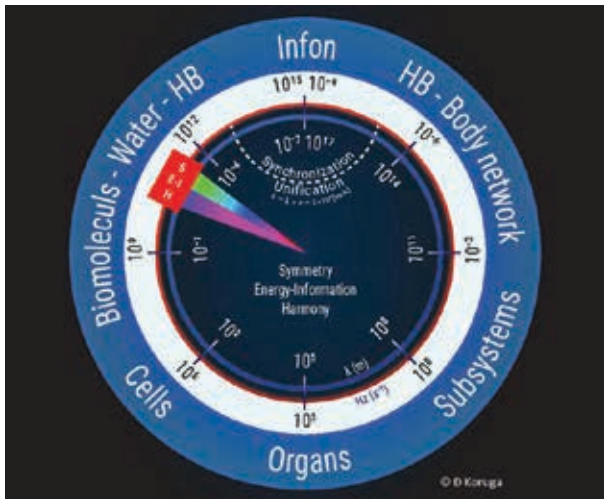


Figure 3: Light wheel of human body based on symmetry, energy-information, and harmony (S∴E-I∴H, where ∴ means that all three elements are in synergy) between wavelength and frequency, whose ratio is expressed by $c=\lambda \times \nu$. Synchronization and unification occur under the second-order reduction because $c= 3\times10^8$ m/s. When the wavelength reaches ~ 10^8, then a new effect, known as Infon, appears (Stonier, T., Information and the Internal Structure of the Universe: An Exploration into Information Physics, Springer, London, 1990).

The expression "Contraria sunt complementa" was introduced into science by Niels Bohr in 1957, even though this principle had been known since ancient times in China (Yin-Yang), dating back to several centuries B.C.E.

The Yin-Yang principle and a light wheel

The C_{60} molecule is a perfect light wheel, because it has six axes of the fifth order, which twist (or rotate anisotropically) due to other symmetry transformations. It is well known that 6 is the first perfect number, as the sum of its factors 1, 2, and 3 equals 6. However, it has another important feature as well: the sum of the reciprocals of its divisors equals 2, so C_{60} as a three-dimensional body has 2x6=12 pentagons. In other words, to each axis of the fifth order we can attribute a group of "visible" frequencies that we call colors. So, for instance, if we illuminate the 3HFWC substance, which is an integral part of a skincare cream, and which contains the C_{60} molecule, with the UV photons of 370—390 nm, then, in addition to the second harmonic (740—780 nm) the whole visible spectrum will appear (Figure 5d). In the Zepter Company, the resulting effect was named "hyperlight fusion".

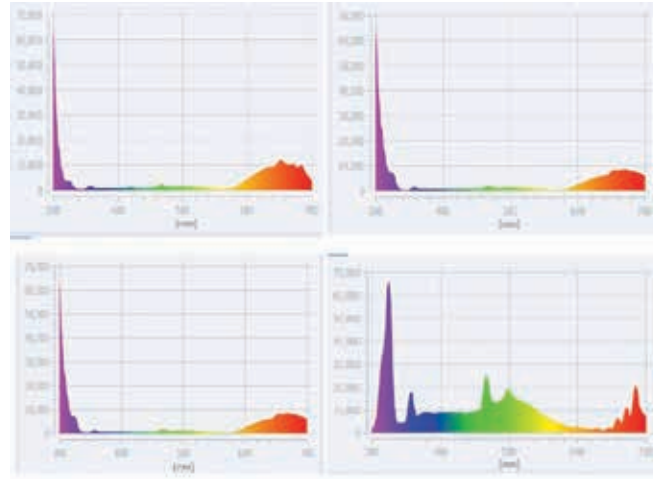


Figure 4: Hyperlight fusion effect: a) spectrum of LED UV radiation (λ=380 nm) with the appearance of the second harmonic in the range of λ=680–780 nm. b) The UV radiation spectrum affecting the skin

after the application of skincare cream base (spectrum similar to that in a)). c) The UV spectrum affecting the skin after the application of a commercial skincare cream with the same base as in b) and in c) and with the 3HFWC substance. In an interaction with C_{60}, the peak shifted from 380 nk to 405 nm, which results in the UV photon "defect", so in the interaction with the 3HFWC substance, their energy was transformed into a visible part of the spectrum, creating the "hyperlight fusion effect". The image shows that due to this effect, the spectrum of the second harmonic is different from those in the previous cases.

The set of six "basic" Zepter spectra is enhanced to 12 spectra that represent a "light wheel" (Figure 6). The C_{60} molecule fully harmonizes these 12 spectra in accordance with the Yin-Yang principle. The oscillatory process of the amplitude change dynamics develops in accordance with the Fibonacci Law, which means that the whole system is harmonized.

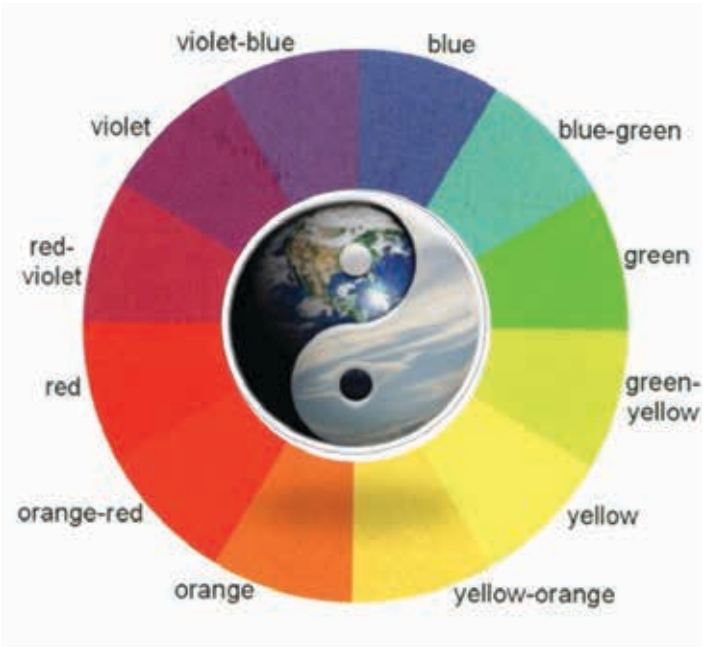


Figure 5: A perfect light wheel ("contraria sunt complementa"; Yin-Yang) as a palindrome of light spectra based on the symmetry and harmony of the first perfect number (six colors – blue, green, yellow, orange, red, and violet), whose sum of the reciprocals of the divisors, $\Sigma div\ 6 = \frac{1}{1} + \frac{1}{3} + \frac{1}{6} = 2$, giving six additional twin colors (dyadic system): blue-green, green-yellow, yellow-orange, orange-red, red-violet, and violet-blue. Then the dyadic system becomes triadic: ["violet-blue"- "blue"- "blue-green"], ["blue-green"- "green"- "green-yellow"], ["green-yellow" - "yellow" - "yellow-orange"], ["yellow -orange" - "orange" - "orange-red"], ["orange-red" - "red" - "red-violet"], ["violet-red" - "violet" - "violet blue"].

Figure 6: ZEPTER'S light wheel "ANNA", based on the symmetry and harmony of the C_{60} molecule (from Figure 5d). There is a slight asymmetry of the wheel because this is a dynamic system based on the first perfect number (the order of perfect number divisors is asymmetrical: for example, the second perfect number 28 = 1+2+4+7+14 has an asymmetry between 4 and 7, because 8 is expected after 4, but there is 7 instead (1×2=2, 2×2=4, 4×1.75=7 and again 7×2=14).

Biophysical signaling in the human body is a very complex process. We have analyzed biophysical signaling based on both covalent and non-covalent hydrogen bonds. Using symmetry as a driving force for oscillations, we have found that harmony and synchronization of oscillations, from biomolecules; cells; and tissues to organs and the organism as a whole, are possible in accordance with the principle "contraria sunt complementa" (the coupling of high and low frequencies). This principle was used in science for the first time in 1957 by Niels Bohr, who won the Nobel prize in physics in 1922.

(Young engineers and researchers)

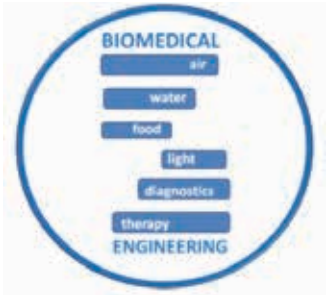
INNOVATION HUNTERS

Today, technological innovations do not only represent a shift in that area, but without them medicine, pharmacy, economy, and many other major lifelines of modern society would be almost inconceivable. Young engineers and researchers who have been given the opportunity to try their hand at the development of biomedical engineering and innovations that lead to discoveries that have the potential to improve the quality of life continue to tackle new challenges.

Milica Vuksanović

"Experiment is the only means of knowledge at our disposal. Everything else is poetry, imagination" were the words of Max Planck, one of the most important physicists in history and the winner of the Nobel Prize in Physics in 1918 [1]. His words stemmed from the fact that anything that emerges as the fruit of our thought process and is formulated as a theory has no weight or confirmation without experiment. Bearing this in mind, it is clear that any innovation cannot be achieved only through a well-developed theory, but also through a carefully controlled and precisely executed experiment. Without innovation, of course, there would be no progress in science, technology, engineering, and civilization in general.

ZEPTER INTERNATIONAL, which has dedicated decades of its work to products that improve the quality of life, is tirelessly investing in research that could contribute to it. Its previous symbiosis with scientists, researchers, and other members of the scientific community has led to innovations that are extremely important in that sense. As ZEPTER continues to invest in science and development, supporting young people who have ambitions and abilities to contribute to these fields, a fruitful cooperation between the company itself and the Department of Biomedical Engineering at the Faculty of Mechanical Engineering, University of Belgrade is being created. Undergraduate, master's, and PhD students in the field



"Theory leads, experiment decides"
Faraday

of Biomedical Engineering are dedicated to research and optimization of ZEPTER appliances in the service of health and general well-being of those who use them. They invest their freshly acquired knowledge, abilities, and skills to improve several factors considered to be the most important for human well-being: air, water, food, light, and care.

Air

It is clear that the air we breathe is necessary to sustain life. Its quality and purity directly affect our health. In recent decades, the air we inhale every day has become increasingly polluted and harmful to health, especially in large cities and industrial zones. The contemporary lifestyle imposes the need to spend up to 90% of the day indoors, where the air is even 4–10 times more polluted than that on the outside (when the pollution rate is considered "normal"), and we are constantly inhaling tiny particles that can cause weakening of the immune system, as well as the diseases such as asthma, bronchitis, respiratory infections, and lung cancer. MSc students at the Faculty of Mechanical Engineering, Department of Biomedical Engineering, Stefan Kostić and Stefan Taricić, worked on the optimization of Therapy Air Ion air purifiers, which operate based on a multistage purification system (five filters: antistatic, antibacterial, HEPA, antiallergic, and activated carbon filter), and which have been shown to eliminate 99.99% of harmful airborne particles, such as the finest dust particles including PM10 and PM2.5, mites, microbes, toxins, viruses, and bacteria. This system effectively eliminates viruses that are transmitted by droplets, such as SARS-CoV-2, i.e., the Corona virus (certificate Gui-lab, Germany, April 2020), and was declared the best air purifier on the global market according to independent German experts (expertentesten.de 2016 and 2020). In order to make this device more efficient, Kostić and Taricić have developed three new solutions that can provide almost absolute safety when it comes to the quality of the purified air. Two of these – the magnetic and electro-magnetic filters – have been adapted to the already existing purifier casing. The magnetic filter consists of 39 strong neodymium magnets, at a distance of 60 mm from each other, so that they generate a large magnetic force of 2100 nT. The main role of this filter is to collect magnetic particles and neutralize microorganisms, unpleasant odors, and volatile compounds, as well as to condense excess moisture. This filter can be easily removed from the device, as can the magnets themselves, and is suitable for easy maintenance. The electro-magnetic filter is designed and made according to such measures that it can take the place of an antibacterial filter. It consists of two parallel plates that are placed under DC voltage, which has an adverse effect on microorganisms and is designed to attract charged particles. The plates are made of aluminum, which has antimicrobial effects itself. On the front side of the plate, which faces the air inlet, a 1.5-mm thick magnetic tape is added, which serves to keep all magnetic particles, even the finest ones, such as those of 0.1 micron in diameter (considered the most dangerous because of their ability to enter the bloodstream), which would otherwise pass through the HEPA filter. The third solution, which involves changes to the main assembly of the casing, is the introduction of another class F9 filter. This filter belongs to the fine filters, i.e., high-efficiency filters located in the classifications just below the HEPA filters. It retains PM1 particles, up to 1 micron in size, with an efficiency of 90%, and in addition removes bacteria, viruses, mites, and tobacco smoke with an efficiency of 95%, which is higher than that of the antibacterial filter. [2]

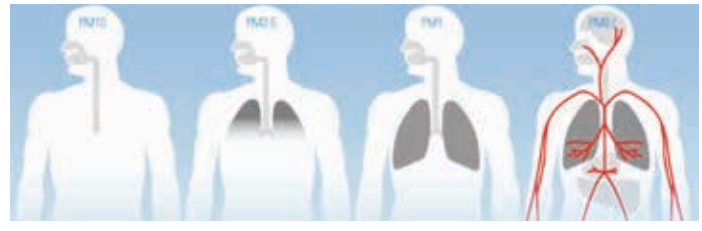


Figure 1 Penetration of particles of different diameters into the human body [2]

Water

Although most modern philosophers would reject the claim of the ancient philosopher Thales of Miletus that water is the origin of everything since it is only one of many molecules that make up nature, its importance for the sustainability of life as we know it is not to be questioned. It took more than two thousand years after Thales for Cavendish and Lavoisier to discover that water is made up of oxygen and hydrogen, and it was not until 1805 that Gay-Lussac and Humboldt figured out that their ratio was 1:2. Today, it seems to us that everything that about the H_2O molecule is already very well known, but we must ask ourselves whether it is really so. Milica Miličić, a doctoral student of Biomedical Engineering, under the mentorship of Professor Đuro Koruga and Professor Lidija Matija, paid special attention to water and its hidden properties, observing it as a Fibonacci's molecular machine. She came to the conclusion that the fractal properties of water indicate that it has an immanent potential for a harmonious spatial arrangement (which is of particular importance when it comes to its effect on the human body), and that the presence of other elements in higher concentrations is a disturbing factor [2]. With this in mind and understanding the importance of consuming water of satisfactory purity and quality, Tomislav Purić, an MSc in Mechanical Engineering in the field of Biomedical Engineering, created a water purification device based on UVC filters, which can be used both as an addition to the existing Zepter devices - AqueenaPro and EdelWasser, and as an independent purification unit. The principle of operation of this filter is based on UVC radiation, which has the ability to destroy cell membranes and genetic material of microorganisms and thus annihilate them. Water passes through a hose made of the special FEP material (fluorinated ethylene propylene), which is spirally wound around a UVC lamp in order to keep water in the vicinity of the radiation source for as long as possible, resulting in a longer sterilization time. The FEP material was carefully selected for this purpose because it is chemically inert, which means that it does not degrade and thus does not endanger the quality of water that passes through it, while transmitting UVC light. [2] Our next step in research using UV light is "artificial aqua purine nanofiltration" – deigning a device based on molecule-by-molecule filtration, when the ratio between hydrogen and oxygen charge is not 2:1 (H_2O), but 3:2 (H_3O_2). [4]

Figure 2 New Aqua UVC filter as a separate water purification unit [3]

Water is the main agent of many compounds in our environment, and the ones we consume are no exception. According to the old Latin proverb "In vino veritas", for which the credit is attributed to Pliny the Elder, and as the doctoral student Valentina Matović and the MSc student Borivoje Protić showed in their experiments, the truth indeed lies in wine, or better said, in water. The main challenge in modern wine production, especially the production of white wine, is oxidation, which leads to premature aging of wine and degradation in color and aroma. Wine is rich in polyphenols, compounds susceptible to enzymatic and non-enzymatic oxidation, so the interest in high-quality production in the wine industry is growing, prompting the usage of automated and precise analytical systems for monitoring the qualitative and quantitative characteristics

of white wines. It is in this context that spectroscopic techniques, such as near-infrared (NIR) spectroscopy, provide the opportunity for simple, reliable, and rapid analysis in the production chain, from grape testing to spectroscopic wine scanning. Using aquaphotomics based on NIR spectroscopy, Matović and Protić examined the oxidation of wine and its prevention by using Zepter cookware through which electricity generated from three different sources – battery, thermoelectric generator, and a combination of these two (battery + generator) – was transmitted. Also, the behavior of wine in the non-oxidized and oxidized states after the addition of the 3HFWC substance was examined. Observing the wine treated with the current generated from the thermocouple or the battery, they came to the conclusion that the so-called "perfect structure" was created from the aspect of aquaphotomics. A "perfect structure" in that sense would be the organization of water that displays a uniform absorption at almost all wavelengths. In both cases, the oxidized wine changed its structure and acquired the ability also to create hydrogen bonds with the surrounding water molecules and break them if needed. It became a hydrophilic structure. Moreover, it has been shown that the addition of the 3HFWC substance to both oxidized and non-oxidized wine results in pronounced absorption in the free-bound water region, suggesting that the addition of the substance results in more free water molecules, more free OH-bound water molecules, and generally more weakly bound water that participates in the hydration of ions and builds water hydration shells. [5]

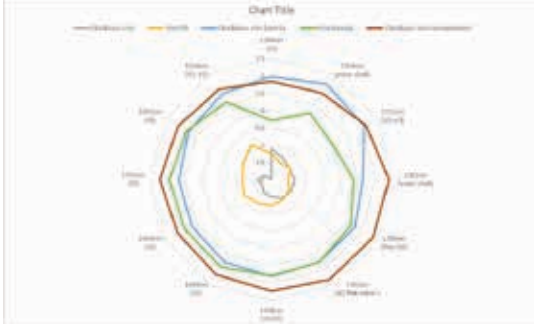


Figure 3 Aquagram of wine after using the battery and the thermocouple for antioxidant purpose [5]

Food

In addition to experiments with wine oxidation, Borivoje Protić also concentrated on those with food oxidation. During preparation and heat treatment, the foods we consume are exposed to the oxidation process, which can lead to the loss of nutrients and vitamins that our body needs, increasing the likelihood of some carcinogenic substances being produced. That is why Zepter cookware is designed and manufactured in such a way as to minimize the harmful effects of the heat treatment of food, as well as to maximize the preservation of all nutrients in foods important for human health. To prevent the loss of nutrients and vitamins, oxygen atoms must be supplied with electrons to become more stable. This can be achieved by creating mild cold electron plasma, which is generated by passing current through the content of the dish. This can be done, as in the above-mentioned experiment with wine, by using a power generator – a battery or a thermocouple in combination with Zepter Mastercook cookware. First, the food was fried in a ZEPTER pan without electricity to examine the sample prepared in the usual way; then the test was done again with electricity sources. It has been noticed that the method of antioxidation using a current generator is successful because the oil appeared to be much less contaminated when prepared using the ZEPTER method than in the classical way. FTIR spectroscopic analysis performed in the NanoLab of the Faculty of Mechanical Engineering in Belgrade also shows the advantages of the ZEPTER method, with the application of the battery giving the best results. [6]

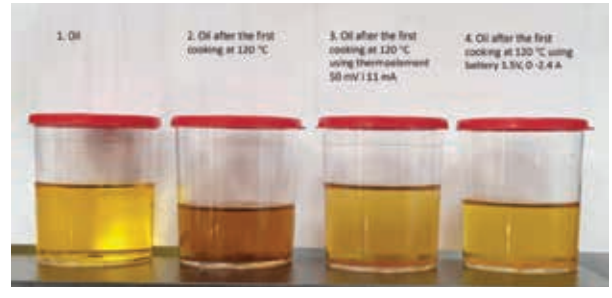


Figure 4 Oil before frying (1), after frying at 120°C (2), after frying at 120°C using a thermocouple (3) and after frying at 120°C using a battery (4), [6]

Light

It is quite clear that life on Earth without light would be absolutely impossible. Electromagnetic radiation as such is responsible not only for sustaining life on our planet, but also for many other phenomena in the universe. Since Niels Finsen, a Danish physicist, received the Nobel Prize in 1903 for his experiments with diffuse light which he used for healing, the fact that light can be used very successfully for therapeutic purposes has officially been confirmed. Milica Vuksanović, MSc in Mechanical Engineering at the department of Biomedical Engineering, studied exactly how different types of light affect the human cardiovascular system through the prism of its fractal properties.

Unfortunately, according to the statistics of the World Health Organization, cardiovascular diseases have long been classified as the primary cause of death globally (more than a third of premature deaths are caused by some form of cardiovascular disease). Bearing that in mind, it is necessary to investigate thoroughly the characteristics of the circulatory system and understand them in the best possible way. As the circulatory system in humans is a very complex structure to study both from the aspect of hemodynamics and from the aspect of medical diagnostics, observing it as a fractal system provides opportunities for simplified and more precise calculations and more advanced and efficient diagnostics. Starting from the smallest segments of this structure and their mutual connection – microcirculation – conclusions that are essential for its integrity can be reached.

Microcirculation and its proper function are responsible for providing blood supply to vital organs; therefore, it is necessary to ensure its uninterrupted work. Linearly polarized light, i.e., light that interacts with a tissue at a precisely determined angle for a given medium (Brewster angle) was shown to have a distinctly positive effect on microcirculation. After the interaction, light is subjected to a linear polarization, after which the photons are arranged in the plane of polarization according to the energy levels. Hyperpolarized light gives even better effects (25% better compared to linearly polarized light, and 40% better compared to diffused light). Hyperpolarization of light is achieved by passing it through a fullerene filter, which has the role of a nanophotonic filter that regulates light according to Fibonacci laws, which are based on the laws of fractal mechanics. As such, hyperpolarized light is the most suitable for biomolecules in the human body, which, like many other things in nature, are arranged according to Fibonacci, i.e., fractal law. Zepter's BIOPTRON is a light therapy device that has

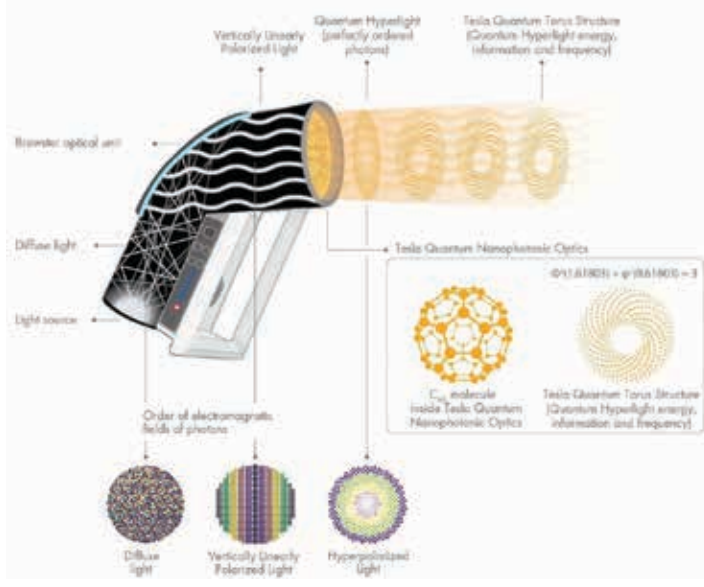


Figure 5 - Principle of operation of BIOPTRON device, emission of hyperpolarized light [8]

a hyperpolarizing fullerene filter, whose effect on microcirculation and other vascular flows has been proven to be very favorable, and whose additional improvement is currently being worked on. [7]

In addition to therapeutic purposes, light of certain wavelengths can also be used to disinfect the environment in which we move every day. There is a special need for that in times like these, when it is necessary to take all available measures to prevent the spread of the infection. The efficiency of the UVC light has already been mentioned when it comes to fighting microorganisms such as viruses and bacteria, and having that in mind, Ivana Živković, an MSc student, designed a sterilizer based on the UVC radiation in the wavelength range between 245 and 275 nm. Its effect was tested on certain viruses and bacteria, one of which was E. Coli, and the efficiency was estimated to be between 83.6% and 100%. Therefore, UVC light can be used in hospitals in operating rooms (for sterilization of utensils, dishes, tables, protective suits, etc.), as well as in patient rooms (for air sterilization, with installation in one of the air purification devices); in households for sterilization of utensils, drinking water, surfaces, and/or wardrobes; and in the overall daily struggle to control and prevent the infection. [9]

Care

The skin is the first visual indicator of the condition and health of the organism. Every day, facial skin is exposed to various external influences, such as wind, rain, snow, or sunlight, but genetics, diet, and lifestyle can also accelerate the aging of facial skin or cause changes in it. Proper care is extremely important, because it is the only way to slow down the aging of the skin and generate a "feedback signal" to coordinate the heart and brain better. It is known that the skin is the largest human organ and that it absorbs a large percentage of what impacts the body. The average absorption of matter through the skin can be up to 900 grams of cosmetics per year. Because of this characteristic, it is very important what we protect and nurture our skin with. The MSc student Zorana Jović worked on testing cosmetic products with the quantum substance 3HFWC, based on a double derivative of C_{60} molecules (TFT Nano Center, Belgrade), which acts biophysically in the epidermis and the basement membrane, establishing

Figure 6 Sterilizer based on the UVC light with a wavelength of 245 nm (left) and Sterilizer based on the UVC light with a wavelength of 275 nm (right) [9]

harmonization of the oscillatory process of peptide planes of collagen and other proteins, forcing the molecules to oscillate in a natural way, i.e. to repair molecules, and also investigating its synergistic effect with gold nanoparticles "GNP" (Zlatarna Celje, Slovenia). In order to test this, a study was conducted during which the effect of a cream containing gold nanoparticles and a cream containing the 3HFWC substance in addition to gold was examined. The study lasted six weeks, during which every seven days the subjects (women) had their forearms scanned in two spots. Subjects of the third group applied the nano gold cream to one region, and the fourth group applied the nano gold cream with the 3HFWC quantum substance, while the other region was smeared with a base, which was common to both creams. The study involved 33 subjects (women), with an average age of 37, with the oldest subject being 66 and the youngest 21 years old. We performed the imaging using opto-magnetic imaging spectroscopy (OMIS), an innovative diagnostic method developed and patented by Prof. Đuro Koruga, PhD and his associates (Patent: US 10,085,643 B2, awarded by WPIO as the best patent in 2018). OMIS made it possible to monitor changes in individual layers of the skin, as well as changes in their entirety, thanks to different depths of light penetration of different wavelengths. Monitoring the subjects on a weekly basis and calculating the fractal dimensions of the graphs obtained from OMIS led to the conclusion that the cream containing only the 3HFWC substance achieved an improvement of 28% compared to the cream that had the same base but classic bioactive ingredients, and when gold nanoparticles were combined with the 3HFWC substance, the effects were improved by 73.7% (a difference of 45.7%), which is an obvious beneficial effect of the new cream containing a combination of nano quantum substance and gold nanoparticles (3HFWCGNP). [10]

Young engineers and researchers who have been given the opportunity to try their hand at the development of biomedical engineering and innovations that lead to discoveries that have the potential to improve the quality of life continue to tackle new challenges. Their work, under the mentorship of Aleksandra Dragičević, PhD, Research Associate and Mijat Lalić, MSc team leader, supervised by Professor Đuro Koruga, promises a bright future for Zepter International.

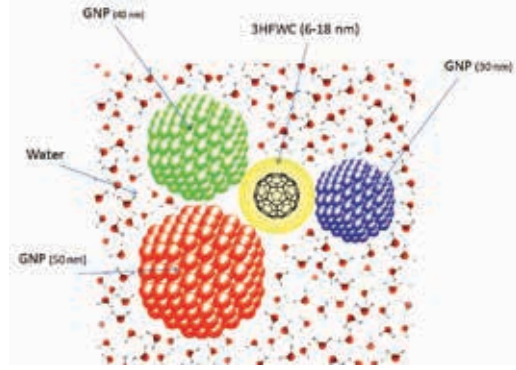


Figure 7 Size ratio and schematic representation of the structure of the 3HFWC nano-edging substance (Hyper Harmonized Hydroxylated Fullerene Water Complex, INCI name "(water (and) hydroxylated fullerene") and GNP (Gold Nano Particle) of different sizes and therefore different colors: green, red) [10]

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