
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 initiated

Fullerene (Dragan Mojović)

Journey to the center of C₆₀ MOLECULE

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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 $20 \times n$ triangles as optimization of design, mass and energy (light).

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 photo-

lithography 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.

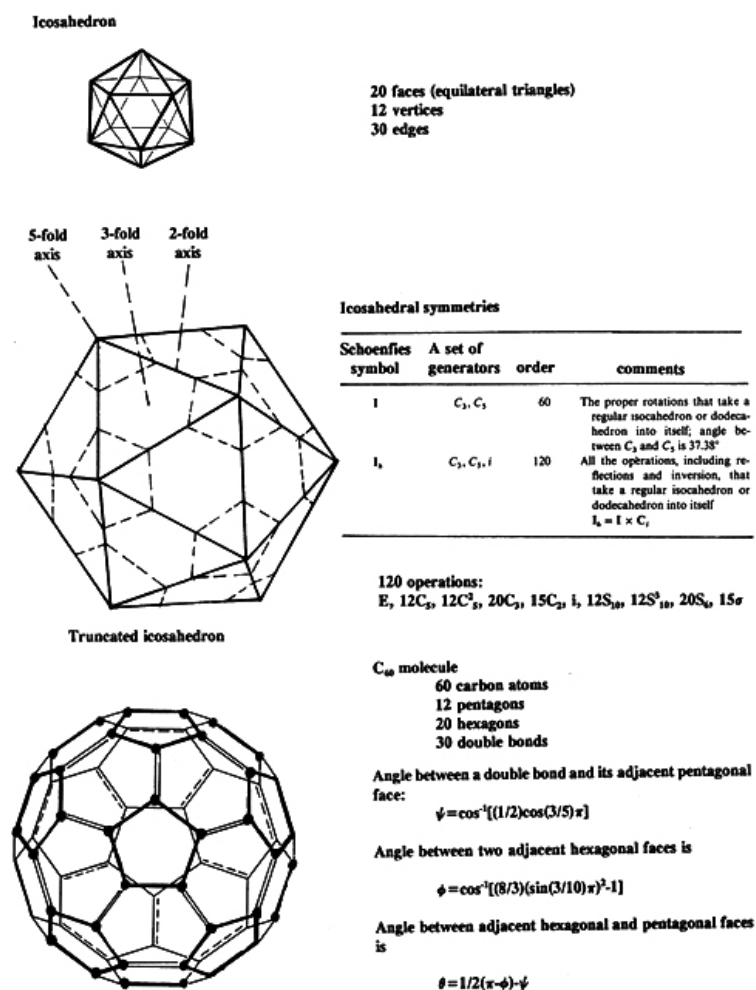


Figure 2 Icosahedron as a 3D body composed of 20 triangles (upper image), then truncated icosahedron with 120 symmetrical operations (the diamante has 48 symmetrical operations) (middle image), and stick model of C_{60} molecule with strictly defined angle between bonds (down image) (From book: Koruga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

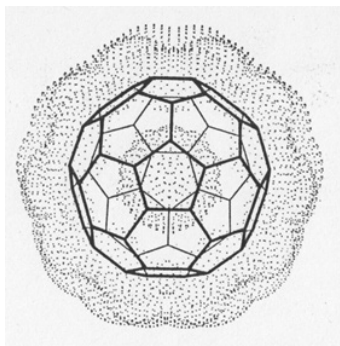


Figure 3 A stick model of molecule C_{60} composed of 12 pentagons and 20 hexagons with π electrons (outside and inside of cage – dots on image). Diameter of ground state of C_{60} (position of carbon atoms in π electrons cloud is 0.71 nm). The size of C_{60} with π electrons cloud is about 1 nm.

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 dis-

turbance 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.

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 C₆₀ 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 C₆₀ 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:

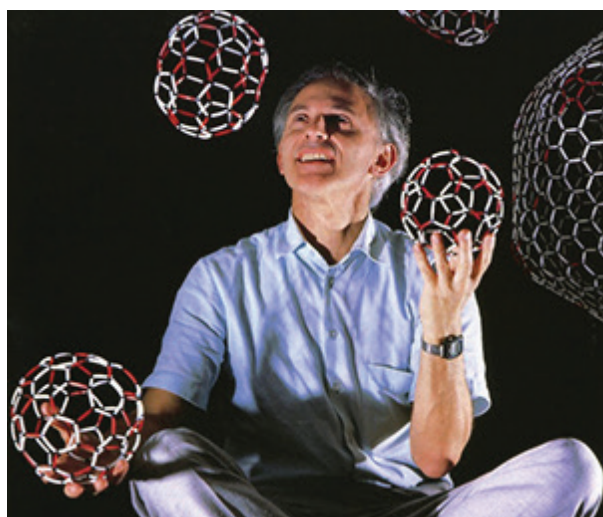


Figure 4 Harold Kroto, leader of research team, who serendipitously discovered the C₆₀ molecule in 1985 and

who gave it the name fullerene (buckyball) to molecule C₆₀ because during investigation of the structure of C₆₀, 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.

- (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 C₆₀, 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 C₆₀ 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 1.8×10^{10} 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.

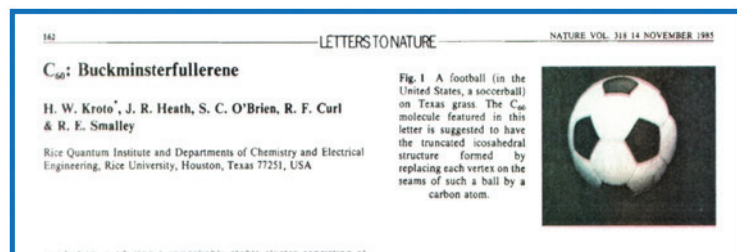


Figure 5a Paper published in Nature, 1985 about serendipitous discovery of C₆₀, so that that people know about its existence.

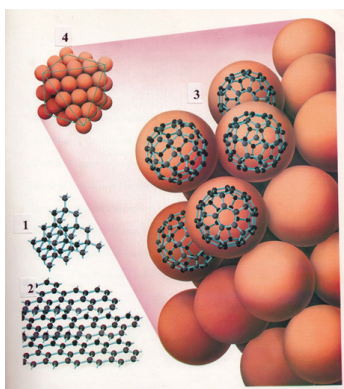


Figure 5b Five years later people compared the three forms of carbon structure: [1] diamond as a 3D structure, [2] graphite as a 2D structure, and [3] C_{60} as 0D structure in 3D space. As can be seen, carbon atoms of two C_{60} molecules are not in connection. The barrier between them are the π electrons, 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 $10^{10} s^{-1}$. 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).

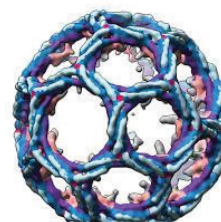


Figure 6 Clathrin, a complex biomolecule in brain, with same icosahedral symmetry as molecule C_{60} . It was mimical inspiration to Koruga to make similar structure based on carbon atoms in 1978.

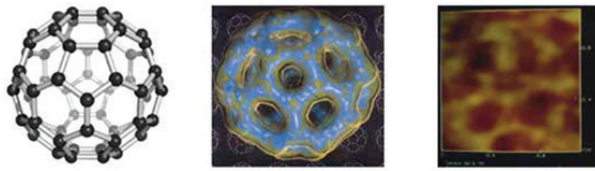


Figure 7 Model of the C_{60} molecule with 60 carbon atoms, arranged on the surface of a sphere in 12 pentagons and 20 hexagons (left), quantum-mechanical model of the C_{60} published in 1991 on the cover of *Science* (middle) and the first STM image of C_{60} molecule made in April 1992 at the Center 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 , $-\Phi$, φ , $-\varphi$ (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 $\varphi=0.61803$. 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 $\Phi=1.61803$. As microtubules are structured as thirteen, the biophysical values (dipole moments, temperature, magnetism, etc.), which depend on them, will be in the range of $1,615 \leq \Phi \leq 1,625$.

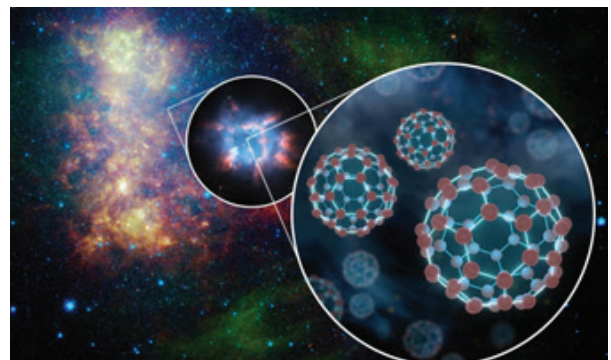
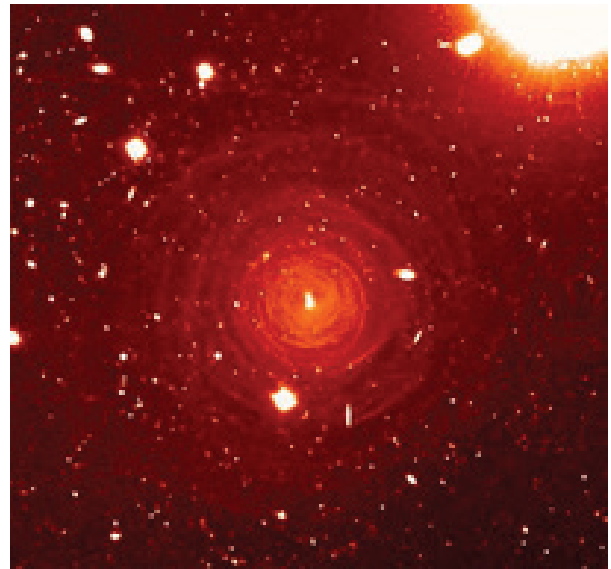


Figure 8 (left) Becklin et al. discover the Red Giant Star IRC+10216 (*Astrophysical Journal* 158: L133); (right) The in space is ionized by stars because the ultraviolet light from stars strips an electron from the C_{60} .

History of sexagesimal (base 60) system: Icosahedron and C₆₀

Year	The first time	By who or what	Reference
Pre-historical period of C₆₀ (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. <i>Astrophysical Journal Letters</i> 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	Albrecht 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, <i>Zeitschrift für Physik</i> , 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”, <i>J. Cell Biol.</i> 42:202-220, 1969
1970	Theoretical prediction of C ₆₀	Eiji Osawa	Eiji Osawa, <i>Cornannulene</i> , <i>Kagaku</i> , 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 synthesis of Corannulene, <i>Journal of the Am Chem Soc</i> 93(7):1730, 1971
1972	Dual form of C ₆₀ : Synthesis of dodecahedron	Philip Eaton and Richard Mueller	Eaton, PE and Mueller, RH, The Peristylane system, <i>Journal of the Am Chem Soc</i> 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, <i>Proc. Acad. Science</i> 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, <i>Nature Physical Science</i> , 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, <i>J. Chem. Phys</i> 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 : Buckminsterfullerene, <i>Nature</i> , 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. <i>J. Chem Phys</i> 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 C₆₀: a new form of carbon , <i>Nature</i> , 347 :354–358, 1990.
1990	Isolation, separation and characterization C ₆₀	Taylor, R, hare, J.P., Abdul-Sada, A.K	<i>J. Chem Soc Chem Commune</i> 20:1423-5, 1990
1991	C ₆₀ Rotation 1.8-3.0×10 ⁻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)	<i>Science</i> , 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, <i>Fullerene Science and Technology</i> , 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., <i>Fullerene C₆₀: History, Physics, Nanobiology, Nanotechnology</i> , 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	Markus Arndt, Olaf Nairz, Julian Vos-Andreae, Claudia Keller, <u>Gerbrand van der Zouw</u> & Anton Zeilinger , Wave-particle duality of C ₆₀ molecules , <i>Nature</i> , 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.
ZEPTEK NanoWorld based on C₆₀			
2016	BIOPTRON Hyperpolarized filter based on C ₆₀	Koruga, Đ ZEPTEK GROUP	Koruga, Dj., 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. ZEPTEK GROUP	Koruga, Đ. Hyperpolarized light: Fundamentals of nanobiomedical photonics, ZEPTEK BOOK WORD, 2018.
2019	Quantum cosmetics based on C ₆₀	Koruga, Đ. ZEPTEK GROUP	Koruga, Đ., Compositions comprising hyper harmonized hydroxyl modified fullerene substance, PCT/EP2019/083307
2019	Quantum cavity optics based on C ₆₀	Koruga, Đ. ZEPTEK GROUP	Koruga, Đ. Optical filter based on light-matter coupling in quantum-confined cavity spaces, Patent PCT/EP2019/065365



Figure 9 TFT (Thales-Fibonacci-Tesla) Nano Center (ZEPTEK GROUP) where researchers make new ZEPTEK products according to the light properties of C₆₀.