Journal of Applied Mathematics and Physics, 2023, 11, 377-386
https://www.scirp.org/journal/jamp
ISSN Online: 2327-4379
ISSN Print: 2327-4352

New Superionic Memory Devices Can Provide Clues to the Human Memory Structure and to Consciousness

Hans Hermann Otto

Materialwissenschaftliche Kristallographie, Clausthal University of Technology, Clausthal-Zellerfeld, Lower Saxony, Germany
Email: hhermann.otto@web.de

How to cite this paper: Hans Hermann Otto (2023) New Superionic Memory Devices Can Provide Clues to the Human Memory Structure and to Consciousness. *Journal of Applied Mathematics and Physics*, **11**, 377-386.
https://doi.org/10.4236/jamp.2023.112021

Received: January 2, 2023
Accepted: February 4, 2023
Published: February 7, 2023

Copyright © 2023 by author(s) and Scientific Research Publishing Inc.
This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).
http://creativecommons.org/licenses/by/4.0/
Open Access

Abstract

Since the work of *Penrose and Hameroff* the possibility is discussed that the location of human memory and consciousness could be connected with tubulin microtubules. If one would use superionic nano-materials rolled up to microtubules with an electrolyte inside the formed channels mediating fast ionic exchange of protons respectively lithium ions, it seems to be possible to write into such materials whole image arrays (pictures) under the action of the complex electromagnetic spectrum that composes these images. The same material and architecture may be recommended for super-computers. Especially microtubules with a protofilament number of 13 are the most important to note. We connected such microtubules before with *Fibonacci* nets composed of 13 sub-cells that were helically rolled up to deliver suitable channels. Our recent *Fibonacci* analysis of *Wadsley-Roth* shear phases such as niobium tungsten oxide $Nb_{16}^{5+}W_5^{6+}O_{55}$, exhibiting channels for ultra-fast lithium-ion diffusion, suggests to use these materials, besides super-battery main application, in form of nanorods or microtubules as effectively working superionic memory devices for computers that work ultra-fast with the complex effectiveness of human brains. Finally, we pose the question, whether dark matter, ever connected with ultrafast movement of ordinary matter, may be responsible for synchronization between interactions of human brains and consciousness.

Keywords

Memory Device, Niobium Tungsten Oxide, Crystallographic Shear, Lithium Intercalation, Superionicity, Super Battery, Fibonacci Nets, Fibonacci Stoichiometry, Tubulin Microtubules

1. Introduction

It is one of nature's greatest secrets how such a huge amount of pictures can be saved by a non-volatile write operation into the human memory and can be read out ever and ever again during the long life of a human being. While philosophers have tried to give an early answer, *Penrose and Hameroff* offered a more scientific approach for a possible mechanism, where tubulin microtubules are proposed to be the location of memory and consciousness [1] [2]. Tubulin microtubules are non-covalent mesoscale polymers, first described concurrently in 1963 by *Slautterback* [3] and by *Ledbetter and Porter* [4]. The interested reader may also study a review recently written by *Roll-Mecak* [5].

In a previous contribution the present author had designed a microtubule from a helically twisted *Fibonacci* net composed of even 13 subcells imitating a tubulin microtubule with the same dominant protofilament number of $\langle \mathbf{N}_{pf} \rangle$ = 13 [6]. It was obvious that carbon nanotubes could be used for such a design. Recently, carbon nanotubes as biomimetic carrier design have been intensively investigated by *Barcelos and Alasaraie* [7]. However, despite of the immense scientific effort in the last years, the understanding of the tubulin microtubule contribution to the human memory writing and reading processes and consciousness "is still in its infancy" [7].

Turning back to *Fibonacci* number 13, a stoichiometric *Fibonacci* analysis of *Wadsley-Roth* shear phases such as niobium tungsten oxide $Nb_{16}^{5+}W_5^{6+}O_{55}$, exhibiting channels for ultra-fast lithium-ion diffusion, suggests to use these materials, besides super-battery main application, in form of nanorods or microtubules as effectively working superionic memory devices [8]. Superionic transport of charge carriers is, besides ballistic electron transport, superconducting transport or holography of biophotonic processes, a very rapid way of transmitting and storing a huge amount of information. Most likely the information is stored via diffraction patterns, and this is how holographic recording comes into play. When we think about holography, we have to ask how and where the needed reference beam is created to generate a storable diffraction pattern. Probably a combination of the above listed processes takes place in our brain. It is the essential topic of this short contribution to present some new ideas slowly approaching the fundamental solutions that nature has given us. Different chapters deal with *Fibonacci* helices, such helices as carbon nanotubes, artificial microtubules form *Wadsley-Roth* shear phases, holographic information processing, the possibility of a combined space-reciprocal space approach for information storage and processing, and the question, whether dark matter (energy) is responsible for synchronization between interactions of human brains and eventually consciousness.

2. Fibonacci Helices as Biomimetic Devices

Tubulin protein molecules form linear chains which are able to self-assemble into $2D$ sheets that can roll up to microtubules (**Figure 1**) [9].

Especially interesting for our approach is the dominance of tubulin microtubules with a *Fibonacci* protofilament number of $\langle \mathbf{N}_{pf} \rangle$ = 13 [6].

We want to create a simplified model for such microtubule with $\langle \mathbf{N}_{pf} \rangle = 13$, starting with a *Fibonacci* arrangement of a hexagonal net consisting of 13 subcells, offset by an angle of $\delta_{13} = 13.898^\circ$ (**Figure 2**).

The starting small cell is then helically wound at the twist angle *α*. It needs 13-times the small cell lattice parameter a_{sub} to reach again identity with a large cell lattice point. It exists between *a* and a_{sub} the relation

$$a_{sub} = \frac{a}{\sqrt{13}} \tag{1}$$

The angle *α* between sub-cell direction and *a*-axis can be calculated as

$$\delta_{13} = \arctan\left(\frac{5}{3\sqrt{3}}\right) - 30 = 13.898^\circ . \tag{2}$$

By a full turn one gains a height in filament direction of

$$h_{13} = \frac{\sqrt{3}}{2} a = \frac{\sqrt{39}}{2} a_{sub} \approx \pi \cdot a_{sub} \tag{3}$$

If you look through the microtubule perpendicular to the filament direction, you will see the mirror image on the back somewhat offset.

From a geometrical viewpoint the importance of protofilament number 13 may be manifested as a sort of frustration due to the almost identical angles between the *Fibonacci* net offset angle *α* and the angle *α'* = 180˚/13 of the base circle

$$\alpha = 13.898^\circ \approx \alpha' = \frac{180^\circ}{13} = 13.846^\circ \tag{4}$$

Furthermore it yields

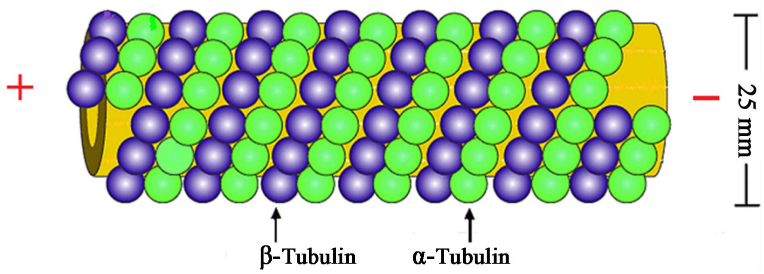

Figure 1. Sketch of a microtubule dipole of helically rolled up tubulin protein subunit chains, consisting of *α* and *β*-tubulin. The inner diameter of the hollow cylinder is about 15 nm.

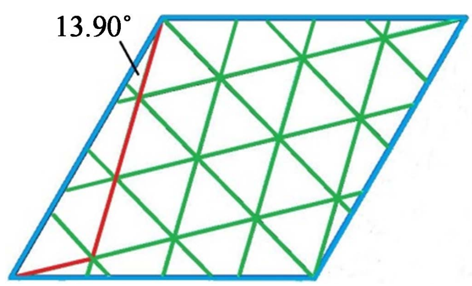

Figure 2. Fibonacci arrangement of a hexagonal net consisting of 13 subcells, offset by an angle of 13.9˚ in comparison to the blue outlined "unit cell" [10] [11].

$$\frac{\sin(\alpha)}{\pi} = 0.0764561 \approx \frac{1}{13 + \frac{1}{13}} = 0.076470 \quad (5)$$

Interestingly, we connected the term $\frac{1}{13 + \frac{1}{13}}$ with icosahedron mathematics and used it in our approach of the *Moebius*-ball electron and in the formula for the gyromagnetic factor of the electron [12].

Geometrical frustration may also be responsible for the matter-antimatter asymmetry [13]. Also interesting is that water is able to form helices of pentagonal or hexagonal symmetry [14]. Such water helices could have served as a scaffold mediating the first assembling of a double-helix of nuclear acids [15]. The bonding angle of water being 104.30˚ can be found by subtracting the angle of arcsin (φ^5) = 5.17˚ from the regular tetrahedron angle of 109.47˚ [15].

About the curious angle arcsin (φ^5) = 5.17˚ see also a contribution by *Fang et al.* [16]. Remarkably, the exterior angle of a pentagon of 360˚/5 = 72˚ connects both arcsin (φ^5) and the angle α (Equation (4))

$$\frac{72^\circ}{5.17} = 13.9265^\circ \approx 13.898^\circ \approx \frac{180^\circ}{13} = 13.846^\circ \quad (6)$$

Now, noting the projection of the subcell length a_{sub} onto the base circle as b, one gets

$$b = \frac{7}{2 \cdot \sqrt{13}} a_{sub} \quad (7)$$

Finally radius and diameter of the helix are determined to be

$$r_{13} = \frac{7}{4 \cdot \sqrt{13} \cdot \sin(\alpha')} a_{sub} = 2.02813 \cdot a_{sub} = \frac{7}{4 \cdot 13 \cdot \sin(\alpha')} a = 0.5625 \cdot a \quad (8)$$

$$d_{13} \approx \frac{9}{8} a \quad (9)$$

The aspect ratio for one full turn is then given as

$$\frac{h_{13}}{d_{13}} = \frac{\sqrt{3} \cdot 13}{7} \sin\left(\frac{180}{13}\right) = 0.76985 \approx \frac{4}{3 \cdot \sqrt{3}} \quad (10)$$

Figure 3 displays a projection of the constructed <$\mathbf{N}_{pf}$> = 13 microtubule down its filament axis.

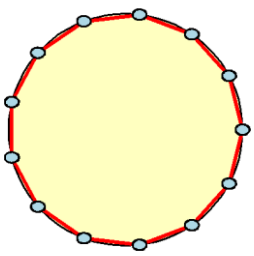

Figure 3. Helically twisted microtubule projected down the filament direction with 13 light-blue atoms or atom groups on sub-lattice positions.

The length l_0 of a single turn of a helix having height z_0 and radius r_0 can be calculated by unrolling the helix to a plane and then applying the *Pythagorean* theorem

$$l_0 = \sqrt{z_0^2 + 4\pi^2 r_0^2} \tag{11}$$

3. Fibonacci Carbon Nanotubes

When turning now to an actual example of chiral carbon nanotubes, our subcell must be replaced by the hexagon net of graphene. Let us begin with a *Fibonacci* net with 21 subcells, displayed in the left side of **Figure 4**. Then remove magenta atoms at the cell origin and the green colored sites to form hexagons. A reduced number of 14 atoms remain as displayed in the right side of **Figure 4**. Now we rotate the axes and enlarge the cell to create a *Fibonacci* graphene cell (grafibon), given with a blue unit-cell outlining in **Figure 5**. It contains the wanted 13 connected hexagons and 26 carbon atoms. Rolling up such a net to a microtubule would deliver a diameter d_{13g} having twice the value of the simple 13-*Fibonacci* helix, where $a'_{sub} = 1.42$ Å is the C-C distance within a graphene sheet

$$d_{13g} = \frac{7}{2 \cdot \sqrt{13} \cdot \sin\left(\frac{180}{13}\right)} a'_{sub} = 4.05626 \cdot a'_{sub} = 11.52 \text{ Å} \tag{12}$$

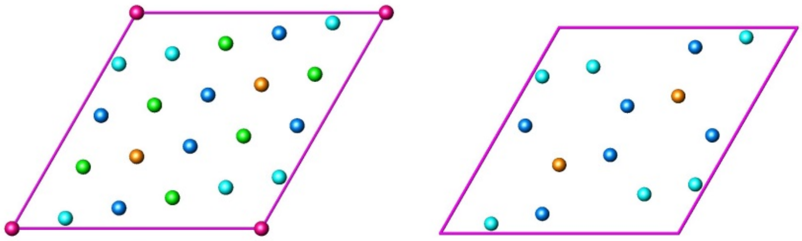

Figure 4. *Fibonacci* cell with 21 atoms (left) respectively downsized to 14 atoms (right). Symmetry equivalent positions have given a common color.

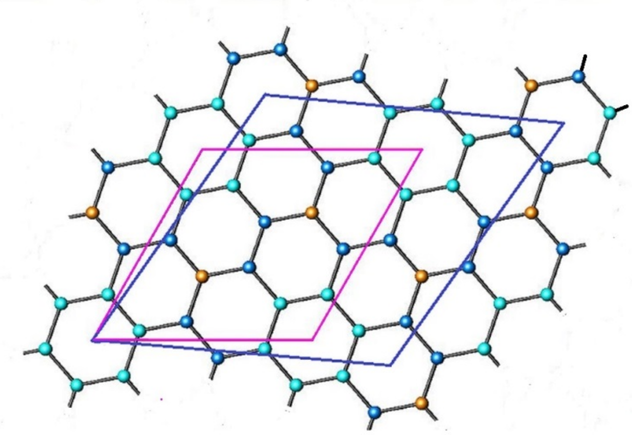

Figure 5. Chiral graphene net composed of 13 hexagons within the blue outlined "unit-cell".

Such a microtubele with an effective hollow cylinder diameter of about 10 Å can take up a lithium ion bearing respectively proton bearing "electrolyte" to mediate electrochemical exchange processes with the microtubule inner surface under the action of electric current or electromagnetic radiation, emitted by biophotons. In this way, interference patterns can be written in and stored via microtubule as biophysical medium.

If one compares for instance the diameter of d_{13g} with that of a buckyball d_{bb} [17] [18] [19], a chiral convex body consisting of 60 carbon atoms, one finds for the last mentioned body a diameter, which is by a factor of about $(4/3)^2$ smaller than d_{13g}

$$d_{bb} \approx 2\sqrt{2}\varphi^{-1} \approx 4.576 \cdot a \approx 6.50\ \text{Å} \tag{13}$$

where $\varphi = \frac{\sqrt{5}-1}{2}$ is the golden mean.

4. Artificial Microtubules from *Wadsley-Roth* Shear Phases

Wadsley-Roth shear phases ($Nb_{16}W_5O_{55}$ and related super-battery materials) exhibit besides *Fibonacci* stoichiometry a *Fibonacci*-like atomic arrangement [8].

The lack of centrosymmetry is connected with a dipole moment. We suggest the possibility to use these phases in form of dipolar microtubules to mimetic tubulin helices with $\langle \mathbf{N}_{pf} \rangle = 13$. Such nanotubes could be produces for instance by electro-spinning. Intercalated lithium ions or protons of the material may be thought locally moved out of position by the action of electromagnetic radiation, in this way storing the information of the original electromagnetic field. As proposed for the tubulin microtubules [20], also our inorganic model material could contain ordered water molecules in the channels, which would generate an enhanced electric dipole moment and an electric field.

Figure 6 depicts a projection of the monoclinic crystal structure of $Nb_{12}WO_{33}$ down [010] [8]. The monoclinic angle of $\beta = 123.6^\circ$ is near 120˚.

A rolling up of such an inorganic structure to polar artificial helical microtubules would provide channels of about 16Å diameter. For simplicity, we will

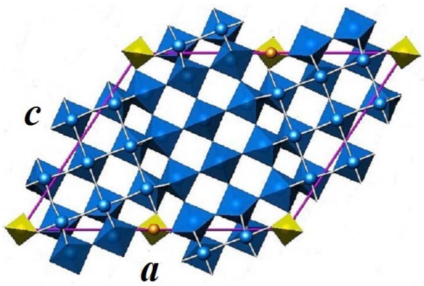

Figure 6. Crystal structure of $Nb_{12}WO_{33}$ projected down [010]. Space group *C*2, a = 22.37 Å, b = 3.825 Å, c = 17.87 Å, β = 123.6˚, Z = 2, D_x = 4.76 Mg·m^{-3} [8] [21]. Tungsten (yellow tetrahedra, brownish sphere) joins four neighboring 3 × 4 octahedron blocks. The atomic arrangement highlighted by red lines can be compared with that on the *Fibonacci* net in **Figure 4**.

work with a hexagonal lattice with lattice parameter of $a \approx 14.5$Å, which is the mean of a and $c/2$ for monoclinic $Nb_{12}WO_{33}$ (see **Figure 6**). Using the approximate relation (8) for a *Fibonacci* 13-cell we get for the diameter

$$d \approx \frac{9}{8} a = 16.3 \text{ Å} \quad (14)$$

There is enough space for taking up a Li^+ ion or H^+ ion bearing electrolyte. Could we store information in such microtubules creating memory devices? Electromagnetic radiation is thought to be able to shift these Li^+ respectively H^+ ions within the channels of the structure locally out of position via the action of photons (biophotons) of different energy, in this way storing very fast the entire information of an image by using the superionic property of the structure.

5. Holographic Quiddity of Information Processing

Storing of information as a diffraction pattern (holography) is most effective, because the loss of some information of this pattern is not critical when the pattern is retranslated into the true image by *Fourier* transform. However, holographic recording and reconstruction of information needs a reference beam to generate such interference patterns. We may ask, whether the special form of a helically twisted microtubule provides inherently such a bio-photonic reference beam? As we know, when we look perpendicularly to the filament direction through the helical microtubule, then we see on the backside the mirrored front side picture, where the reference beam could be generated [15]. It is suggested to think up an optical experiment to verify such conjecture. Biophotonic information transport [22] [23] may be superimposed and supplemented by dissipation-free energy and information transport via chiral solitons associated with microtubule [24]. It points towards the very complex but most effective information processing in our brain. It is highly interesting why *Fibonacci* number 13 is so often involved in nature's creations [15].

6. Combined Space - Reciprocal Space Approach

In 1921 *P. P. Ewald* introduced an approach to determine quite convergent electrostatic lattice potentials (*Madelung* potentials) by a method that used real space besides reciprocal space calculations [25]. We should check whether our brain could profitably use such a method of information processing by combining direct pictures and diffracted ones. In this way, data loss by termination effects could be avoided quite effectively. Such an approach is also conceivable for computer applications.

7. Ultrafast Speed of Matter Causes Dark Energy Signature

One component that has little considered until now is the effect of dark energy, which is always accompanied with ultrafast movement of matter. We cannot grasp the true magnitude of such biological options, if we ignore this new exciting black dimension. Black energy as a result of strong thought processes may be always around us and is sometimes accused as human charisma or even halo effect. It is an effect that we perceive as entanglement. It is by no means metaphysics, but should be taken seriously as a research object. The relation between matter energy and dark matter energy is quantitatively formulated in the *IRT* theory, which is actually a local-realistic theory [26], contrary to intrinsically nonlocal interactions [27] [28] [29]. Can dark matter respectively energy be responsible for the synchronization between brains, when musicians play duets, precisely aligned in time [29] [30]? The reader is invited to study also the recent contribution about the mass constituents of the Universe to understand that matter and dark matter are always intimately connected [13].

8. Conclusion

This contribution summarizes some ideas about artificial microtubules (*AMT*'s) that may pave the way to better understand human consciousness based onto the effective processing of an uncountable amount of stored information. The author takes nature as model and works with the golden section and with the *Fibonacci* number series, preferring *AMT*'s with a protofilament number of 13, exemplified by carbon *AMT*'s respectively rolled up *Fibonacci* shear phases of the superionic $Nb_{12}WO_{33}$ prototype. The concept of a special arrangement of microtubules into a "heavy" hexagonal lattice with numbers that follow the *Fibonacci* number sequence and with vertices that minimize frequency collisions to protect the system from de-coherence, has been effectively refined again and again in nature by evolution. We should produce such structures to gain technological progress besides understanding how awareness of human existence works. Dark matter or energy, ever accompanied by ultrafast movement of ordinary matter, may be responsible for synchronization and teleportation processes of our brains and for consciousness. The presented new ideas may also serve as example for new computers that work ultrafast with the complex effectiveness of our brains.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

[1] Penrose, R. and Hameroff, S.R. (1995) Quantum Computing in Microtubules: Self-Collapse as a Possible Mechanism for Consciousness. Toward a Science of Consciousness. MIT Press, Cambridge.

[2] Penrose, R. and Hameroff, S.R. (2011) Consciousness in the Universe: Neuroscience, Quantum Space-Time Geometry and Orch OR Theory. *Journal of Cosmology*, **14**, 1-50.

[3] Slautterback, D.B. (1963) Cytoplasmic Microtubules. I. Hydra. *Journal of Cell Biology*, **18**, 367-388. https://doi.org/10.1083/jcb.18.2.367

[4] Ledbetter, K.F. and Porter, K.R. (1963) A "Microtubule" in Plant Cell Fine Struc-

ture. *Journal of Cell Biology*, **19**, 239-250. https://doi.org/10.1083/jcb.19.1.239

[5] Roll-Mecak, A. (2020) The Tubulin Code in Microtubule Dynamics and Information Encoding. *Development Cell*, **54**, 7-20. https://doi.org/10.1016/j.devcel.2020.06.008

[6] Otto, H.H. (2020) Phase Transitions Governed by the Fifth Power of the Golden Mean and Beyond. *World Journal of Condensed Matter Physics*, **10**, 135-159. https://doi.org/10.4236/wjcmp.2020.103009

[7] Barcelos, K. and Alisaraie, L. (2022) Microtubule-Inspired Functionalization of Carbon Nanotubes: A Biomimetic Carrier Design. *Molecular Systems Design & Engineering*, **7**, 330-349. https://doi.org/10.1039/D1ME00190F

[8] Otto, H.H. (2022) Fibonacci Stoichiometry and Superb Performance of $Nb_{16}W_5O_{55}$ and Related Super-Battery Materials. *Journal of Applied Mathematics and Physics*, **10**, 1936-1950. https://doi.org/10.4236/jamp.2022.106133

[9] Sahu, S., Ghosh, S., Fujita, D. and Bandyopadhyay, A. (2014) Live Visualization of Single Isolated Tubulin Protein Self-Assembly via Tunneling Current Effect of Electromagnetic Pumping during Spontaneous Growth of Microtubule. *Scientific Reports*, **4**, Article No. 7303. https://doi.org/10.1038/srep07303

[10] Otto, H.H. (1965) Zur Kristallchemie synthetischer Blei-Wismut-Spießglanze. Diploma Thesis, TU, Berlin, 1-65.

[11] Otto, H.H. (2015) Pyroelectric $Bi_{5-x}(Bi_2S_3)_{39}I_{12}S$: Fibonacci Superstructure, Synthesis Options and Solar Cell Potential. *World Journal of Condensed Matter Physics*, **5**, 66-77. https://doi.org/10.4236/wjcmp.2015.52010

[12] Otto, H.H. (2022) Golden Quartic Polynomial and Moebius-Ball Electron. *Journal of Applied Mathematics and Physics*, **10**, 1785-1812. https://doi.org/10.4236/jamp.2022.105124

[13] Otto, H.H. (2022) Galactic Route to the Strong Coupling Constant $\alpha_s(m_z)$ and Its Implication on the Mass Constituents of the Universe. *Journal of Applied Mathematics and Physics*, **10**, 3572-3585. https://doi.org/10.4236/jamp.2022.1012237

[14] Lozynski, M. (2015) Liquid Water: The Helical Perspective of Structure. *Chemical Physics*, **455**, 1-6. https://doi.org/10.1016/j.chemphys.2015.03.013

[15] Otto, H.H. (2021) Beyond a Quartic Polynomial Modeling of the DNA Double-Helix Genetic Code. *Journal of Applied Mathematics and Physics*, **9**, 2558-2577. https://doi.org/10.4236/jamp.2021.910165

[16] Fang, F., Irvin, K., Kovacs, J. and Sadler, G. (2013) Cabinet of Curiosities: The Interesting Geometry of the Angle β.

[17] Otto, H.H. (1986) Lecture about Quasicrystals. TU Berlin.

[18] Otto, H.H. (2021) Ratio of In-Sphere Volume to Polyhedron Volume of the Great Pyramid Compared to Selected Convex Polyhedral Solids. *Journal of Applied Mathematics and Physics*, **9**, 41-56. https://doi.org/10.4236/jamp.2021.91005

[19] Peng, H.Y., Wang, N., Zheng, Y., Lifshitz, Y., Kulik, J., Zhang, R.Q., Lee, C.S. and Lee, S.T. (2000) Smallest Diameter Carbon Nanotubes. *Applied Physics Letters*, **77**, 1-3. https://doi.org/10.1063/1.1320869

[20] Mavromatos, N.E., Mershin, A. and Nanopoulos, D.V. (2002) QED-Cavity Model of Microtubules Implies Dissipationless Energy Transfer and Biological Quantum Teleportation. *International Journal of Modern Physics B*, **16**, 3623-3642. https://doi.org/10.1142/S0217979202011512

[21] Roth, R.S. and Wadsley, A.D. (1965) Multiple Phase Formation in the Binary System Nb_2O_5-WO_3. II. The Structure of the Monoclinic Phases $WNb_{12}O_{33}$ and

$W_5Nb_{16}O_{55}$. *Acta Crystallographica*, **19**, 32-38.
https://doi.org/10.1107/S0365110X65002724

[22] Rahmana, M., *et al*. (2011) Emission of Mitochondrial Biophotons and Their Effect on Electrical Activity of Membrane via Microtubule. *Journal of Integrative Neuroscience*, **10**, 65-88. https://doi.org/10.1142/S0219635211002622

[23] Grass, F., Klima, H., Kasper, S. (2004) Biophotons, Microtubules and CNS, Is Our Brain a Holographic Computer? *Medical Hypotheses*, **62**, 169-172.
https://doi.org/10.1016/S0306-9877(03)00308-6

[24] Mavromatos, N.E. (2017) Nonlinear Dynamics in Biological Microtubules: Solitons and Dissipation-Free Energy Transport. *IOP Conference Series*: *Journal of Physics Conference Series*, **880**, Article ID: 012010.
https://doi.org/10.1088/1742-6596/880/1/012010

[25] Ewald, P. (1921) Die Berechnung Optischer und Elektrostatischer Gitterpotentiale. *Annalen der Physik*, **64**, 253-287. https://doi.org/10.1002/andp.19213690304

[26] Suleiman, R. (2019) Relativizing Newton. Nova Scientific Publisher, New York, 1-207.

[27] Bell, J.J. (1964) On the Einstein Podolsky Rosen Paradox. *Physics Physique Fizika*, **1**, 195-200. https://doi.org/10.1103/PhysicsPhysiqueFizika.1.195

[28] Buoninfante, L. (2021) Maximal Acceleration, Reciprocity and Nonlocality. *International Journal of Modern Physics D*, **30**, Article ID: 2142012.
https://doi.org/10.1142/S0218271821420128

[29] Schwartz, S. (2021) A Reality Based on Consciousness. 1-217.
https://www.dialogo-conf.com/dialogo-journal
https://doi.org/10.51917/dialogo.2021.8.1.19

[30] Sänger, J., Müller, V. and Lindenberger, U. (2012) Intra- and Interbrain Synchronization and Network Properties When Playing Guitar in Duets. *Frontiers of Human Neuroscience*, **6**, Article No. 312.
https://doi.org/10.3389/fnhum.2012.00312