Room Temperature Weyl Fermion Transport in Tubulin Microtubules or Biomimetic Materials?

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Abstract

Research should be focused on the possibility that dissipation-less room temperature *Weyl* fermion transport in tubulin microtubules is responsible for the ability of living creatures to storage and process the known huge amount of information. The importance of ordered chiral water chains confined in tubules in emphasized. An array of opposed chiral *Fibonacci* carbon nanotubules as housing for *Weyl* fermions could be the template for modern decoherence protected quantum computers effectively working at room temperature.

Keywords: Consciousness, Tubulin Microtubules, Ordered Water Chains, Superconductivity, Weyl Fermions, Fibonacci Carbon Nanotubules, Quantum Computing, Geometrical Frustration, Golden Mean.

1. Introduction

How can we explain the ability of living creatures to store and process big amounts of information with extremely high speed, over long periods of time and at room temperature? For such processes the possibility of superfluid hole pairing at room temperature could be responsible, but the research on *Weyl* fermions [1] [2] [3] [4] suggests that chiral *Weyl* fermionic excitations are more likely to explain such room temperature processes of information handling. The question is whether pairs of chiral *Weyl* fermions can house in homo-chiral organic or inorganic materials or does such material accept single fermions. However, artificially constructed material can easily be made of domains having opposite chirality.

In the end we will not be surprised to find out that processes of *Weyl* fermion excitation and superconductivity have a common hole-governed basis. We will learn to use this knowledge in constructing organic respectively biomimetic inorganic materials such as topologically protected *Fibonacci* carbon nanotubules for quantum computers being extremely stable against unwanted deletion of information [5].

Nature's beauty lies in simplicity. Therefore, we avoid complicated mathematics and physics, especially the misleading *BCS* construct [6] and any *QED* assumptions [7]. Chirality is a leading construction scheme of nature. Helices with 13 protofilaments and helices with 13 turns are the queens among nature's geometric creations and as *Fibonacci* helices very important for any elaborated research. We are step by step approaching one of the great puzzles of mankind.

The first researcher who suggested the possibility of ambient superconductivity in quasi-one-dimensional organic chains of biological significance with low configuration entropy was *Little* in 1964 [8]. *Mikheenko* observed hints for superconducting response in self-assembled microtubules [9]. We followed his research and ask the question, based of the work about water helices by *Lozynski* [10], whether one-dimensionally ordered water helices in a supporting tube scaffold can become superconducting at room temperature [11] [12]. However, with the knowledge about dissipation-less *Weyl* fermionic transport at room temperature it is suggested that such processes are responsible for information handling in helical microtubules of living creatures, and the observation of superconductivity may be coupled to fermion transport properties as a surface effect.

In the following we explain the importance of *Fibonacci* helix structures as nature's most effectively working information processing tool due to its geometric uniqueness, which is connected to fundamental numbers and constants of physics including *Sommerfeld*'s structure constant α. New insights about the very beginning of magnetically induced homo-chirality in nature [13] can be helpful in constructing artificial helical arrays for quantum computer application. The dominance of golden mean governed paired entities under nature's creations it worked out [14].

2. Chiral Fibonacci Helices

Pisano, named *Fibonacci*, is known by its famous F_n number series, which is important in life as well as physics [15]

$$F_n = F_{n-1} + F_{n-1} = \{0,1,1,2,3,5,8,\mathbf{13},21,33,54,\dots\} \tag{1}$$

It is for increasingly high *n* connected to the golden mean $\varphi = \frac{\sqrt{5}-1}{2} = 0.6180339887\dots$ by

$$\varphi = \frac{F_{n-1}}{F_n} \tag{2}$$

The golden mean shows the simplest infinitely continued fraction representation of all numbers [16]. Its secret is to mediate stability resulting from its most irrational character, which causes only 'particles' as the center of gravity of vibrations with most irrational winding to survive.

Some years ago, the present author set out to demonstrate the intimate interconnection of fundamental numbers such as φ, φ^5, π, and *Sommerfeld*'s structure constant α [17]. An impressive example is the relation between φ and π

$$\varphi \approx \sqrt{\frac{6}{5\pi}} = 0.6180387\dots \tag{3}$$

We are here interested especially in *Fibonacci* number 13. In combination with the fifth power of the golden mean characterizing phase transitions we can get the circumference radius $r_{circ}$of an icosahedron with edge length *a* by [18] [19]

$$r_{circ} = \frac{\sqrt{3+\varphi}}{2}\, a = \frac{\sqrt[4]{\varphi^5+13}}{2}\, a \qquad (4)$$

Organic microtubules forming helices with just 13 protofilaments seem to play an outstanding role when considering the ability for storage and processing of information within living creatures, but today the mechanism can only be guessed at [20] [21].
We are dealing now with artificial *Fibonacci* nets consisting of 13 sub-cells that can be rolled up to chiral tubules of chosen handiness [22] [23]. Excitingly, this chiral geometry is connected to nature's most import fundamental number that describes rotating matter, *Sommerfeld*'s structure constant α [24] [25]. It may be the explanation, why *Fibonacci* helices are so successful in nature. It supports our holistic approach to explain questions of life, physics and cosmos the other way indicating that all things are connected more than thought.
A very simple approximation connects the fifth power of the golden mean with the relative galactic difference velocity β_g recently introduced by *Guynn* in his seminal contribution [7]

$$\varphi^5 \approx \sqrt[3]{\beta_g} \qquad (5)$$

The fifth power of the golden mean is a fundamental number that stands for phase transitions from particle scale to galactic scale [16], whereas the galactic velocity is related to *Sommerfeld*'s structure constant by a simple reciprocity relation [26]

$$\pi\beta_g = \frac{\alpha}{\pi} \qquad (6)$$

The fifth power of the golden mean is also related to the matter and energy constituents of the universe [27] [28] and certainly to superconductivity [29] [30]. In 1993 *Hardy* derived that the maximum of the quantum entanglement probability of two particles has exactly the value of φ^5 [31] [32].

Back to number 13 and its utmost significance, we consider a hexagonal net divided into 13 subcells as depicted in **Figure 1** together with its mirror image. These nets can be rolled up to tubules with opposed chirality. Between the lattice parameter of the big unit cell and the subcell exists the following relation

$$a = \sqrt{13} \cdot a_{sub} \qquad (7)$$

The subcell direction is offset by an angle of α_F = 13.898° with respect to the *a* axis, where α_F yields

$$\alpha_F = arctan\left(\frac{5}{3\sqrt{3}}\right) - 30° = 13.898° \approx \frac{180°}{13} = 13.846°. \qquad (8)$$

Surprisingly, the angle α_F seems to have a far-reaching importance, because we can connect it also to the inverse of *Sommerfeld*'s structure constant α^{-1} by the relation

$$\frac{\alpha^{-1}}{\pi^2} = 13.88465\ ... \tag{9}$$

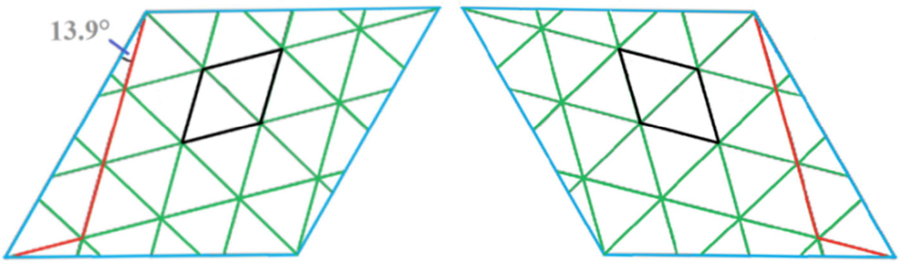

Figure 1. *Fibonacci* arrangement of a hexagonal net and its mirror image [22] [29] [30]
The light-blue outlined unit-cell contains 13 sub-cells, offset by an angle of α = 13.9°.

Recently, the present author has shown, based on results of *Traill* [33] that α^{-1} can be put into a purely π-based equation [34]

$$\alpha^{-1} = 4\pi^3 + \pi(\pi + 1) = 137.03630\ ... \tag{10}$$

Using relation (10) we obtain for α_F also a purely π-based relation

$$\alpha_F \approx \frac{\alpha^{-1}}{\pi^2} = 4\pi + \frac{\pi+1}{\pi} = 13.88468° \tag{11}$$

For the angle α_F other relations underline the outstanding topology of this net

$$\frac{\sin(\alpha_F)}{\pi} = 0.0764561 \approx \frac{1}{13+\frac{1}{13}} = 0.076470 \tag{12}$$

$$\frac{72°}{\arcsin(\varphi^5)} = 13.91739° \tag{13}$$

Most interestingly is also another relation to the fifth power of the golden mean

$$\sin(13.886) = 0.2399908 \approx \frac{\pi}{13+\varphi^5} = 0.239996 \tag{14}$$

The term $13 + \frac{1}{13}$ is related to coefficients of the icosahedron equation, connecting the icosahedron with the mathematics of helices and again with α^{-1}

$$171 \approx \left(13 + \frac{1}{13}\right)^2 \qquad 228 \approx \frac{4}{3}\left(13 + \frac{1}{13}\right)^2 \qquad 494 \approx \frac{2}{9}\cdot 13\left(13 + \frac{1}{13}\right)^2 \tag{15}$$

$$\alpha^{-1} \approx \frac{4}{5}\left(13 + \frac{1}{13}\right)^2 + \varphi^3 \tag{16}$$

In this way our *Fibonacci* net seem to be a geometric object of upmost importance for life and physics and technological applications.

Two other *Fibonacci* nets consisting of 3 respectively 21 hexagonal sub-cells can be constructed. The number of sub-cells can be obtained from the *Miller* indices *hki0* of the sub-cell atomic plane according to [22]

$$n_{subcell} = h^2 + k^2 + hk \tag{17}$$

Figure 2 shows the 21 sub-cell net. We derive the angle between sub-cell and unit-cell as difference angle $\Delta\delta$ between the planes with (hki0) *Miller* indices ($5\bar{1}\bar{1}0$) and ($3\bar{1}\bar{1}0$) using the following formula [5]

$$\tan(\delta) = \frac{1}{\sqrt{3}}\frac{h-k}{h+k} \tag{18}$$

We then obtain
$$\alpha_{21} = \arctan\left(\frac{1}{\sqrt{3}} \cdot \frac{5+1}{5-1}\right) - \arctan\left(\frac{1}{\sqrt{3}} \cdot \frac{3+1}{3-1}\right) \tag{19}$$

$$= 40.89339° - 30° = 10.89339° \tag{20}$$

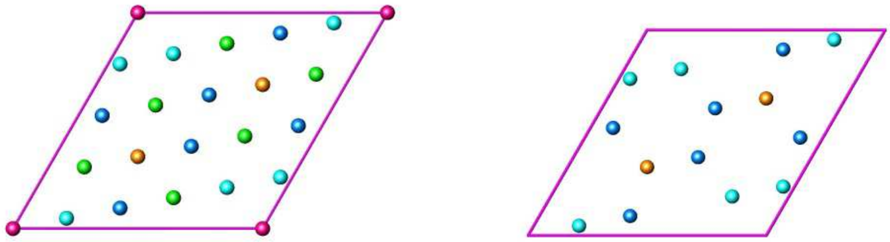

Figure 2. *Fibonacci* cell with 21 atoms (left) respectively downsized to 14 atoms, simulating the graphene structure (right). Symmetry-equivalent positions have given a common color [25].

For the simplest 3 sub-cell *Fibonacci* net representing a rhombohedral lattice projected down the *c* axis we obtain

$$\alpha_3 = \arctan\left(\frac{1}{\sqrt{3}} \cdot \frac{2+1}{2-1}\right) - \arctan\left(\frac{1}{\sqrt{3}} \cdot \frac{3+1}{3-1}\right) = 60° - 30° = 30° \tag{21}$$

A non-*Fibonacci* case is given for the plan $3\bar{2}\bar{1}0$ with $n_{subcell} = 7$ and $\alpha_7 = 19.1066°$.

Now we roll up this net to a helix. By a full turn one gains a height in filament direction of

$$h_{13} = \frac{\sqrt{3}}{2}a = \frac{\sqrt{39}}{2}a_{sub} \approx \pi \cdot a_{sub} \tag{22}$$

Then the pitch angle α' yields

$$\sin(\alpha') = \frac{h_{13}}{13 \cdot a_{sub}} = \frac{\sqrt{3}}{2 \cdot \sqrt{13}} \tag{23}$$

$$\alpha' = 13.89788° \tag{24}$$

The projected sub-cell length a'_{sub} is

$$a'_{sub} = a_{sub}\sqrt{1-\frac{3}{4\cdot 13}} = 0.97725 \cdot a_{sub} \tag{25}$$

and for the radius of the helix we obtain

$$r_{helix} = \frac{a'_{sub}}{2\cdot\sin(\frac{360}{2\cdot 13})} = \frac{0.97725}{0.47863}a_{sub} = 2.0417 \cdot a_{sub} \tag{26}$$

The aspect ratio can be gotten as

$$\frac{h_{13}}{2r_{helix}} = \frac{\sqrt{39}}{4\cdot 2.0417} = 0.76468 \tag{27}$$

Interestingly, the following approximation holds (see relation 22) pointing again to geometrical frustration

$$\frac{\sqrt{39}}{2} \approx \pi \tag{28}$$

Finally, in view of technological applications, we have constructed a *Fibonacci* graphene net, composed of 13 hexagons, which can be twisted to a helical tubule (**Figure 3**). Details can be studied in reference [11]. For this net we introduced the name *grafibon*. The *grafibon* net can be simply obtained by placing carbon hexagons at the 13-net positions and enlarging the cell accordingly.

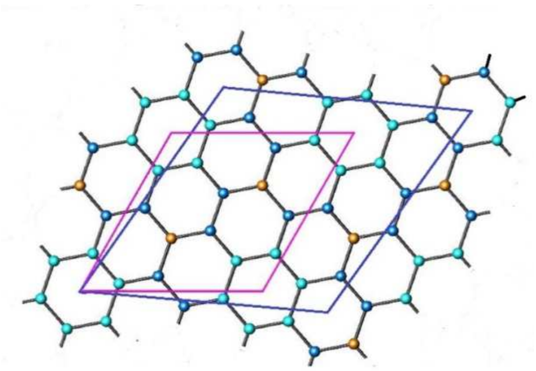

Figure 3. Chiral graphene net composed of 13 hexagons within the blue outlined 'unit-cell'. The related sub-cell is generated by the hexagon centers. The magenta colored cell depicts the original *Fibonacci* cell.

If we take the mean distance between carbon atoms in graphene as $d_C \approx 2.46$ Å, and using relation (26) with $a_{sub} = \sqrt{3} \cdot d_C$ (see **Figure 3**), we get for the diameter of this special 13-helix a central diameter of

$$d_{13} \approx \sqrt{3} \cdot 2.46 \cdot 2.0417 \cdot 2 \text{ Å} \approx 17.40 \text{ Å} \tag{29}$$

The empty space within the tubule would allow the uptake of chiral chains of small molecules

$$d_{13} - d_{\mathrm{C}} = 14.94\ \text{Å} \approx 15\ \text{Å} \tag{30}$$

The existence of chiral chains of water molecules is also proposed for tubulin microtubules with larger inner diameters of their 'hollow' cylinders (**Figure 4**).

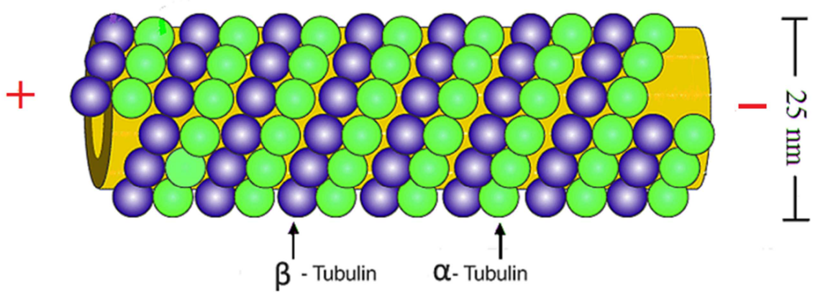

Figure 4. Sketch of a microtubule dipole of helically rolled up tubulin protein subunit chains, consisting of α and *ß*-tubulin. The inner diameter of the hollow cylinder is about 15 nm. It has a persistent length of about 6 mm and a helical repeat period of 8 nm [11].

3. Beyond Weyl Fermion Quasiparticle Excitations

The main focus of this article is the most likely physical process to explain the ability of living beings to store and process information. The most likely physical process is certainly, besides superconductivity, the dissipation-less transport via *Weyl* fermions at room temperature. *Weyl* fermions are peculiar helical pairs of quasi-particle excitations, existing side by side in different domains of acentric inorganic crystals, separated by twin boundaries. The author is surprised why *Weyl* fermion research is as yet not extended to organic compounds. Historically, the early theory for such fermions was worked out by *Hermann Weyl* already in 1929 [35]. In 1937, *Conyers Herring* supposed the existence of *Weyl* fermions in condensed matter [36]. Finally in 2015, *Weyl* fermions have been discovered in semimetals independently by different research teams [37] [38]. Since then even more acentric compounds have been found that can serve as host for such excitations. We may ask, whether separated *Weyl* fermions can survive also in single domains of acentric crystals or helical organic compounds like tubulin microtubules. Indeed, *Kaplan* recently has presented an alternative *d*-dimensional chiral gauge theory with a manifold having only single boundary and consequently no mirror fermions [39]. Experiments to indicate the intimate connection between *Weyl* fermion physics and superconductivity have been performed by *O'Brien, Beenakker and Adagideli* [40] opening the pathway to single-cone physics where fermion doubling is cancelled.

4. Superfluid Hole Superconductivity Compared to Weyl Fermion Transport

In the case of superconductivity, we should finally say goodbye to the picture of electron pairing via phonon exchange, as proposed by the *BCS* theory [6] [41]. Both conventional and

non-conventional superconductivity is exclusively caused by superfluid hole interaction [42] [43] [44]. Thereby holes like to nest near domain walls.
Turning to unconventional superconductivity of the high-T_c cuprates, an optimum number of holes resulted in the unique number σ_o = 0.229. This number can also be confirmed for the family of FeAs-based superconductors. Some time ago, the present author connected this optimum with *Hardy*'s quantum entanglement probability φ^5 [18] [29] [31]

$$\sigma_0 \approx \frac{8}{\pi}\varphi^5 = 0.2296, \tag{29}$$

The golden mean involvement can be explained by a quartic polynomial representation of the superconductor potential function, because each quartic is golden. If $\Psi(r) = |\Psi(r)| \cdot \exp(i\Theta(r))$ represents the wave function, a depressed quartic in $|\Psi(r)|$ can be derived for the potential [45]

$$V(|\Psi(r)|) = k\left(\frac{T-T_c}{2T_c}\right)|\Psi(r)|^2 + \frac{U}{4!}|\Psi(r)|^4 \tag{31}$$

If we now connect ambient superconductivity with quasi-one-dimensionally ordered water molecules, the question comes along, where this physical property has been developed first on Earth. We should turn our attention to world's oceans and the myriad thread-like hollow structures created by nature there, which consist almost entirely of water.
The anomalously high static permittivity of water ($\varepsilon_0 \approx 80$) was traced back to the *Coulomb* interaction of H_3O^+ and OH^- ions in a remarkable concentration in pure water, reported previously by *Artemov et al.* [46]. However, an anomalously low dielectric constant of confined water was observed [47] and attributed to anti-parallel alignment of the water dipoles in the perpendicular direction to the surface indicating a net ferroelectric ordering [48].
The role of ordered water in helical channels of living matter is of great interest [5] [11] [12]. The helical structure of water was recently comprehensively studied by *Lozynski* [10]. He reported about helices with different space-curved arrangements revealing optimal hydrogen bond and oxygen atom connectivity: 3_6, 4_8, 5_{10} and 6_{12} polymerized water molecules. One can assume that one-dimensionally ordered water inside the tubulin microtubule channels is also helically connected. This special alignment of water molecules with strongly different properties in contrast to normal water may be responsible for superfluid hole superconductivity at room temperature, where photo-generated holes can effectively be paired. But also water helices with a higher protofilament number than 6 should be considered, thought of as residing in tubulin microtubules or in artificial designed helical materials like *grafibon*. The empty space of this helical tubule is enough for the uptake of one-dimensionally ordered water chains (see relation 30).
However, could one-dimensionally ordered chiral water chains in a suitable non-chiral tubule be oriented with reversed chirality by the influence of a magnetic field? An experiment is proposed, where this reorientation is provoked by the *RNA* precursor *RAO* (ribose-aminooxazoline) as a chiral agent used by *Blackmond* and coworkers in their superb explanation of how molecular handedness emerges in early biology [13]. They investigated the spin coupling between *RAO* and Fe_3O_4, a frequently occurring magnetic spinel-type

mineral. By a sufficiently large magnetic field a reorientation of chiral water chains should be possible in our experiment.
When considering geometric frustration, we are faced with the bonding angle of H_2O being about 104.5°. It deviates from the regular tetrahedron angle of 109.47° some degrees. In recent publications the present author described an intriguing connection between the difference angle and the golden mean [11]. When subtracting from the regular tetrahedron angle of 109.47° the angle of $arcsin(\varphi^5) = 5.17°$, where φ is the golden mean, then the bonding angle of H_2O is quite well adapted giving 104.30°. About the curious angle arcsin(φ^5) = 5.17° see also relation (13) and contributions by *Fang et al.* [50] and by the present author [11] [14].

However, superconductivity at room temperature as proposed by *Little* [8] may be only observed as a side effect of another dominating transport effect caused by *Weyl* fermions. We are working on the unification of superconductivity and *Weyl* fermion physics and will confirm their golden mean based origin.

5. Fibonacci Helix Arrays for Quantum Computing

If one wants confined water to be one-dimensionally connected in the form of a helix, then a helical scaffold is needed. Earlier, we proposed inorganic *Fibonacci* nanotubules as housing for such water chains [18] [19]. Chiral graphene nets can be curled to such tubules (**Figures 2** and **3**), and the loading of helically ordered water in the otherwise empty channels should be easily possible. Could it be possible to manipulate such aggregates, representing a sort of 3*D* graphene, through doping or by laser light stimulation that superconducting transport properties results? Furthermore, if we create an artificial network of nanotubules consisting of opposed chiral tubules of the same sort, could therein pairs of *Weyl* fermions be observed also with dissipation-less transport properties? Because the present author no longer works experimentally, interested researcher groups may follow these ideas and decide to cooperate. We suggest that *Mikheenko* [8] should extend his work on self-assembled microtubules in direction of *Weyl* fermion research, because we suppose such dissipation-less room temperature transport properties in these organic aggregates. In a quasi-crystalline array of nanotubules of opposed chirality it should be able to store information self-protected against decoherence by holographic-like wave interference.

6. Towards Consciousness

Awareness depends of the ability to steadily recollect information in an ordered way from a big memory by rapid read and write processes at ambient conditions. Living creations consist mainly of water. Therefore, water should be the first considered compound to be connected with such processes. However, a special chiral ordering of water could be the key for a deeper understanding. Hollow chiral tubules exist even in the least developed living beings. Superfluid holes on the water chains can be produces by electromagnetic radiation or transition metal oxide (first *d*-block series) mediated redox processes. The pairing of superfluid hole can cause superconductivity, but another competing possibility to be investigated timely is the dissipation-less room temperature transport via chiral *Weyl* fermions. It is our favoring explanation.

7. Conclusion

A proposition is suggested considering dissipation-less *Weyl* fermionic transport properties at room temperature as the source for the storage capability and ability of information processing in microtubules like tubulin. The fermionic transport may be accompanied by superconducting response at surfaces. A special view should be taken on the properties of confined water in the form of quasi-one-dimensional chiral chains. From such models we can learn to tailor combined arrays of chiral carbon nanotubes with distinct handiness for quantum computer applications. These biomimetic arrays can also be tailored exhibiting a quasi-crystal lattice. Helical *Fibonacci* structures should be given a special attention.

Conflicts of Interest

The author declares no conflict of interests regarding the publication of this contribution.

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