Spring 4-13-2021

Magnetic vector potential manipulation of Majorana fermions in DNA quantum logic

F. Matthew Mihelic
University of Tennessee Health Science Center

PROCEEDINGS OF SPIE

SPIEDigitalLibrary.org/conference-proceedings-of-spie

Magnetic vector potential manipulation of Majorana fermions in DNA quantum logic

Mihelic, F. Matthew

F. Matthew Mihelic M.D., "Magnetic vector potential manipulation of Majorana fermions in DNA quantum logic," Proc. SPIE 11726, Quantum Information Science, Sensing, and Computation XIII, 1172606 (12 April 2021); doi: 10.1117/12.2584951

SPIE.

Event: SPIE Defense + Commercial Sensing, 2021, Online Only

Magnetic vector potential manipulation of Majorana fermions in DNA quantum logic

F. Matthew Mihelic
University of Tennessee Graduate School of Medicine
fmihelic@utmck.edu

Abstract

In the quantum logic of the DNA molecule, electrons are held and conducted coherently as spinless Cooper pairs and are shielded from electromagnetic energy by a Faraday cage effect of the double lipid bilayer of the nuclear membrane. The magnetic vector potential generated by cellular depolarization can synchronize logical activity in portions of the DNA molecule by affecting spin directions of appropriately oriented spinless electrons via the Aharonov-Bohm effect, but is not blocked by that Faraday cage effect. Within the logically and thermodynamically reversible chiral enantiomeric symmetry of the deoxyribose moieties the decoherent transition of Cooper pair to Dirac pair in a p-orbital of the C2-C3 covalent bond effects chiral selection between the C2-endo and C3-endo conformations. Such a spin-1/2 chiral collective movement of particles can be considered as a quasiparticle excitation that is its own antiparticle (C2-endo vs. C3-endo), meeting the definition of a Majorana fermion.

Keywords: quantum DNA, magnetic vector potential, Majorana fermions

Introduction

This paper will explore the theoretical concept of Majorana fermions functioning within the quantum DNA model, and how those Majorana fermions can be affected by a time-dependent magnetic vector potential (TDMVP) generated by cellular depolarization. This paper will also examine how certain biological phenomena might be explained through such concepts, along with implications for potential biomedical and man-made quantum computing scientific applications.

The DNA molecule can be modeled as a quantum logic processor in which coherent electron spin states are conducted along the pi-stacking of aromatic base pairs, subject to spin filtering effects of the helicity of the DNA molecule's interaction with the electron spin state, and held in a topologically insulated chiral enantiomeric quantum symmetry in the deoxyribose nucleotide moieties. [1] Within the quantum DNA model electrons that are involved in the quantum logic of the DNA molecule are held and conducted coherently as spinless Cooper pairs. The coherence of this quantum logic system is theoretically shielded from the disruptive effect of electromagnetic energy by the double lipid bilayer of the nuclear membrane that forms a type of Faraday cage around the DNA of the nucleus. The magnetic vector potential that is generated by cellular depolarization can synchronize quantum logical activity in portions of the DNA molecule by affecting the spin directions of appropriately oriented spinless electrons via the

Quantum Information Science, Sensing, and Computation XIII, edited by Eric Donkor, Michael Hayduk, Proc. of SPIE Vol. 11726, 1172606 · © 2021 SPIE
CCC code: 0277-786X/21/$21 · doi: 10.1117/12.2584951

Aharonov-Bohm effect, which can induce a spin direction in a spinless electron but would not be limited by the Faraday cage effect of the nuclear membrane. Within the electron spin states that are coherently conducted along the pi-stacking interactions of the aromatic nucleotide bases of the DNA molecule to the quantum gate effect of the logically and thermodynamically reversible chiral enantiomeric symmetry of the deoxyribose moieties, the decoherent transition of a Cooper pair of electrons to a Dirac pair of electrons in a p-orbital of the C2-C3 deoxyribose covalent bond effects enantiomeric selection between the C2-endo and C3-endo conformations of the deoxyribose moiety. Such a spin-1/2 chiral collective movement of particles can be considered as a quasiparticle excitation that is its own antiparticle (C2-endo vs. C3-endo) and meets the definition of a Majorana fermion. Some previously unexplainable biological anomalies are consistent with such modeling of the effect of the magnetic vector potential on Majorana fermions in the DNA molecule, and these aspects of quantum DNA modeling have important implications for the design of manmade quantum computing.

The magnetic vector potential (MVP) was first theorized as an important aspect of magnetic theory by Maxwell in the 1850's, who characterized the MVP "A-vector" as fundamental to the "B-vector" of the magnetic field. The MVP could not be detected at the turn of that century, which led Heaviside and Hertz to consider the MVP A-vector to be a completely theoretical concept and to marginalize its importance in favor of the magnetic field B-vector. In 1959, Aharonov and Bohm theorized that the MVP was not just a theoretical concept, but that it has a quantum mechanical effect on electron spin phase. Because this Aharonov-Bohm effect (AB effect) is purely quantum mechanical it is very difficult to detect, and it has only been experimentally demonstrated a few times since 1959 with varying degrees of accuracy. The magnetic vector potential is not a force or an electromagnetic wave, and therefore is able to pass through a Faraday cage unaffected.

While the magnetic vector potential (MVP) is difficult to detect, it is relatively easy to calculate, generate, and direct. The magnetic vector potential (a.k.a. simply "vector potential") is not blocked or affected by physical objects such as earth, water, or a Faraday cage. Biological systems can be theoretically very sensitive to a pulsed MVP because the coherent electrons held in the quantum logic mechanism of the DNA molecule are naturally responsive to a pulsed MVP that theoretically will phase shift coherently held electron spin states via the Aharonov-Bohm effect. Within the quantum DNA model [1], the pulsed MVP generated by electron movement during cellular depolarization is theorized to naturally influence the phase synchronization of the DNA quantum logic system that controls cellular processes.

Experiments by Pizzi, et al. from 2004 to 2009, showed unexplained anomalies involving the response of neuronal cell cultures to a laser, and raised some possibility of MVP involvement. [2] Related experiments by Mihelic demonstrated non-local communication between separated neuronal cell cultures in a manner that empirically supports modeling of the DNA molecule as a quantum logic processor that can topologically insulate coherent entangled electron spin states at biological temperatures. [3] Certain anomalies in the experimental observations of both Pizzi, et al. and (previously unpublished by) Mihelic imply that the biological effect of the laser was not limited solely to the coherent photons from a pulsed laser, but that there may also be some spin-related quantum mechanical biological effect from the MVP generated by the pulsing of the laser, and/or its cabling, and/or its power supply.

Majorana Fermions

In 1937 Ettore Majorana hypothesized a quantum mechanical entity that has the quality of being describable by spin-½ statistics, and also the quality of being its own antiparticle because its creation and annihilation operator matrices are antisymmetric. This entity later became known as the "Majorana fermion", and a search for a "particle" that exhibited those two qualities was prompted by the concept of wave-particle duality. That search for such a "Majorana state" (perhaps a better term) has led to its further characterizations, such as being neutral in charge, describable by a real wave equation, and a of chiral nature that can enable an envisioned non-Abelian "braiding" with other such Majorana states. Majorana fermions can be characterized in quasiparticle excitations of collective particles. [4]

The Majorana state and its qualities have been demonstrated in topological superconductors and can also be theoretically understood in the quantum mechanical function of the DNA molecule, wherein a resonant triple state in the deoxyribose pseudorotation of each nucleotide provides superposition of opposing (i.e., antisymmetric) deoxyribose chiral enantiomers (C2-endo and C3-endo) separated by an intermediate deoxyribose conformation (O1-endo). [5] There are indications in experimental anomalies that selection between the C2-endo and C3-endo chiral enantiomers in DNA can be induced by a magnetic vector potential operating through the Aharonov-Bohm effect, in a manner analogous to the Majorana states that have been experimentally demonstrated in topological superconductors.

Quantum DNA Modeling

Three properties come together to theoretically allow the DNA molecule to function as a quantum logic processor. The first such property is that there is coherent conduction of electron spin states along the pi-stacking interaction of the aromatic nucleotide bases of the DNA molecule. [6] The second such property is that the helicity of the DNA molecule interacts with electron spin which allows it to act as a very efficient electron spin filter. [7] The third such property is that there is a theoretical quantum gate formed in a logically and thermodynamically reversible enantiomeric symmetry of the deoxyribose moiety of each nucleotide that allows for the interaction of coherently held electron spin states. [8] [1]

As electron spin states are coherently conducted and spin filtered by the DNA molecule, they are simultaneously read into the triple state that exists in the pseudorotation of the nucleotide deoxyribose moiety (C2-endo ↔ O1-endo ↔ C3-endo). [5] More specifically, the C2-C3 covalent bond in the deoxyribose moiety of DNA is located between two chiral centers (C3 is an obvious chiral center and C2 is an atropisomeric chiral center) and can be determinative of the deoxyribose chiral enantiomeric selection between the C2-endo and C3-endo configurations. The C2-endo and C3-endo enantiomers are separated by an energy barrier that is very appropriate to the Landauer limit, and the flip-flop between those two conformations can lead to significant topological changes in the geometry of the DNA molecule. [9]

The deoxyribose moiety of each nucleotide in the DNA molecule is strategically placed between the nucleotide base pairs that can theoretically conduct quantum information coherently

along the pi-stacking of those aromatic base pairs, and the deterministic classical information contained in the geometry of the DNA phosphate backbone, so quantum-to-classical information transition can occur across the theoretical quantum gate function of the deoxyribose moiety. [10] If all of the deoxyribose moieties in both strands of a segment of DNA are in the C2-endo conformation (i.e. B-DNA), the nucleotide base pairs are geometrically stacked (like pancakes) and the pi-stacking interaction of their electron clouds can take place. However, if the deoxyribose moieties on both sides of a particular nucleotide base pair simultaneously transition from the C2-endo conformation to the C3-endo conformation there would be a "roll" of that particular base pair and the geometry of the pi-stacking would be broken, leading to an interruption of the coherent conduction along the DNA segment. In order to roll a particular base pair there must be a simultaneous transition of the deoxyribose enantiomers on both sides of the base pair, and such a simultaneous transition between the C2-endo and C3-endo deoxyribose conformations requires simultaneous energetic changes to the deoxyribose moieties on both sides of the base pair that are each appropriate to the Landauer limit.

Majorana Fermions in Topological Superconductors and in DNA

The existence of Majorana states has been demonstrated in condensed matter systems [11] [12] [13] [14] and there are analogous parallels between the generation of Majorana states in a solid-state system and the generation of Majorana states in a biologically active DNA system. Majorana states can be shown to theoretically exist in the DNA molecule, and retrospective evaluation of unreported anomalies in some of the experimental data that was generated in quantum DNA experimentation support this theoretical concept. The generation of Majorana fermions in both a solid-state system and in DNA involves pairs of electrons induced to alternate between a Cooper pair state and a Dirac pair state. Such an alternation of electron pair states can be considered as a "seesaw mechanism" of eigenvalues that is similar to what has been theoretically described with regard to neutrinos. [15] While the mechanism of the generation/transition of/between Cooper pairs/Dirac pairs differs between a solid state electronic system and a biological DNA spintronic system, in both systems a degeneracy is created between two electrons, and a magnetic vector potential can break the degeneracy by opening the band gap between the two electrons. An important difference between a solid state topological superconducting system and a biologically active DNA system is that, while in the solid-state system a chiral change in spin-orbit coupling is manifested in an emission of electromagnetic energy, in a biologically active DNA system a chiral change in spin-orbit coupling is manifested as a geometric molecular change.

Majorana fermions have been demonstrated to arise via Abrikosov vortices at the one-dimensional interface of an s-wave superconductor and a spin-orbit coupled semiconductor, where the application of an electromagnetic field to induce Zeeman splitting suppresses conventional electron pairing and opens a band gap inducing a re-entrant superconducting phase that supports Majorana fermions. [16] Zero-energy Majorana modes are produced at the ends of a one-dimensional version of the spin-orbit coupled semiconductor system. [17] Theoretically, it would take only an "infinitesimal perturbation" to "lift the degeneracy of the two zero modes at some value of phase difference…" [18] A Cooper pair of electrons that is established within such a topological superconductor system is shielded by the Meissner effect from electromagnetic fields. While an electromagnetic field cannot penetrate that Meissner effect

shielding to affect the electrons of the Cooper pair, by the Aharonov-Bohm effect a magnetic vector potential can impart a momentum to the electrons of the Cooper pair, opening the band gap between them by breaking their relative degeneracy.

Majorana fermionic states have been demonstrated in solid state systems experimentally and can also be theorized to occur naturally in DNA as a collective movement of particles that is a quasiparticle excitation. Majorana fermionic states form when a "spinless" Cooper pair of electrons in a degenerate state is converted into a Dirac pair of electrons with differential spins and an energy band gap between them. This has been shown to occur experimentally in a solid-state topological superconducting electronic system, but an analogous mechanism can be theorized to occur in DNA. Majorana fermions can be affected in both topological superconductors and in DNA by a phase transition imparted to spinless electrons by a magnetic vector potential.

The electrons that are held and conducted coherently within the quantum DNA model are theoretically held as a spinless Cooper pair, and Majorana fermionic states can theoretically form as a band gap is opened as a Dirac pair of electrons forms from the degenerate Cooper pair of electrons being held coherently in an enantiomeric symmetry of the deoxyribose moiety. In DNA the theoretical quantum gate in the deoxyribose moiety, in which a Pauli pair of electrons within a p-orbital of the C2-C3 covalent bond is held coherently in a spinless state, can be represented by the O1-endo deoxyribose conformation. The O1-endo conformation is an intermediate state that separates the C2-endo and C3-endo conformations. [5] This resonant state has been theoretically shown to be both logically and thermodynamically reversible, thus providing for electrons to be coherently held in a resonant "triple state" of the deoxyribose pseudorotation. [8] [1]

In DNA the Majorana bound state (MBS) or Majorana zero mode (MZM) represents an intermediate state between the two chiral states. This intermediate state is manifested as a resonant situation in the pseudorotation of the deoxyribose moiety of the nucleotide that exists between the C2-endo enantiomer and the C3-endo enantiomer, the intermediate conformation being considered as the O1-endo conformation. The Majorana state in DNA can thus be considered either as a "two-state" system (MBS vs. chiral) or as a "triple state" system (MBS vs. right-handed chirality vs. left-handed chirality).

In DNA, the coherently held Cooper pair of electrons can theoretically be transformed into a Dirac pair in two ways. One way that a Cooper pair of electrons can be transformed into a Dirac pair of electrons in DNA is by the quantum spin Hall effect (QSHE) [19], whereby the spin angular momentum and spin direction of electron spin states that are being coherently conducted along the pi-stacking interaction of the aromatic nucleotide bases, are converted through spin-orbit coupling into the orbital angular momentum and chiral selection at a chiral center. [1] [10] The second way that a Cooper pair of electrons can be transformed into a Dirac pair of electrons in DNA is by the quantum anomalous Hall effect (QAHE) [20] [21], whereby a time-dependent magnetic vector potential (TDVP) will impart a differential momentum to the degenerate or spinless electrons held coherently in the O1-endo intermediate enantiomeric state of the deoxyribose moiety, effecting a decision as to which electron (electron number one or electron number two) spins which way (spin-up or spin-down) in which chiral center (C2 or C3).

Magnetic Vector Potential Generation in Biological Systems

Why would the controlling quantum logic source code of a cell (i.e. the DNA) respond to a time-dependent magnetic vector potential? Theoretically, when a cell (e.g. a neuron) depolarizes and sodium ions rush across the cell membrane into the cytoplasm, there is a concomitant preceding rush of electrons out of the cell, the movement of which generates both a magnetic field and a magnetic vector potential. Both the magnetic field and the magnetic vector potential could theoretically affect the coherently held electrons of the DNA quantum logic processor in the depolarizing cell, and also affect the coherently held electrons of DNA in cells closely surrounding the depolarizing cell. It is known that a magnetic field can cause a loss of coherence across a quantum logic system, but a magnetic vector potential could theoretically determine spin states of spinless electrons in appropriate topological alignment while not effecting a decoherence of the entire system, and a time-dependent magnetic vector potential generated by cellular depolarization might thus effect local time synchronization of appropriately aligned DNA segments, both intracellularly and intercellularly. The DNA inside a nucleus would be theoretically protected from electromagnetic interference and resultant decoherence by a theoretical Faraday cage effect of the nuclear membrane, which is a double lipid bilayer that is separated by a conductive ionic solution. Interestingly, DNA inside the mitochondria is also protected by a double lipid bilayer that is separated by a conductive ionic solution that can theoretically function as a Faraday cage as well, so the only two places in a eukaryotic cell that contain DNA (the nucleus and the mitochondria) are bounded by such a double lipid bilayer. The time-dependent magnetic vector potential generated by cellular depolarization would not be blocked by the Faraday cage formed by the conductive ionic solution inside the double lipid bilayer of the nuclear membrane, but the magnetic field generated by that cellular depolarization would be blocked by it.

Cooper Pairs and Dirac Pairs

A Cooper pair of electrons is a pair of electrons with no energy band gap between them. Such a “gapless” pair can be described as “degenerate”, and also as “spinless”. The state of a Cooper pair has also been characterized as the “Majorana zero mode” (MZM). Experiments in solid state electronic systems have shown that an MZM state can form in a (chiral) p-wave topological superconductor through the superconductor proximity effect by which a condensate is formed that breaks particle number conservation and emits a Cooper pair. Through the Meissner effect the superconductor shields the electric field so that particles conducted along the superconductor are invariant to charge conjugation, confining or “expelling” the magnetic field so that magnetic flux is quantized.

In biologically active DNA an analogous mechanism theoretically generates a Cooper pair. By the quantum DNA model, the spin states of a coherent Pauli pair of electrons in the C2-C3 bond of the deoxyribose moiety in a DNA nucleotide can be conducted and held coherently in the pi-stacking interaction of the aromatic nucleotide bases, while being simultaneously split by the spin filtering effect caused by interaction of electron spin with the helicity of the DNA molecule. The time-independent coherent conduction of entangled coherent electron states along

the pi-stacking interaction of the aromatic nucleotide bases is analogous to chiral topological p-wave superconduction in solid state electronic systems.

In solid state electronic systems, a Majorana excitation is produced when a band gap is opened between a Cooper pair of electrons by Zeeman splitting, thus breaking the degeneracy between the two electrons. This Zeeman splitting is accomplished by application of an external magnetic field to the topological superconductor system, and is perhaps better described as an anomalous Zeeman effect because the application of a Zeeman splitting to suppress the conventional pairing potential in the topological superconductor opens a re-entrant superconducting phase that is shielded by the Meissner effect from electromagnetic fields that are of a strength below the band gap, but will still be responsive to chirality determination by the magnetic vector potential. Within this topologically insulated situation, momentum-dependent spin-orbit coupling then can take place via the Rashba effect, thus transforming what was a Cooper pair of electrons into a Dirac pair of electrons.

In biologically active DNA an analogous mechanism transforms a Cooper pair of electrons into a Dirac pair of electrons. By the quantum DNA model, electron pairs can be held coherently in the C2-C3 covalent bond of the deoxyribose moiety in each nucleotide. This is an interesting topologically insulated bond that sits between two chiral centers (C3 is an obvious chiral center, and C2 is an atropisomeric chiral center), and because it is theoretically both logically and thermodynamically reversible [1] [8], it would be considered to be at or near the "degeneracy" of the Hamiltonian of the system. Berry shows that any physicality capable of a geometric phase change, and at or near the "degeneracy" of the Hamiltonian of its system, would be induced into such quantum topological changes. [22]

The two electrons that are held coherently in the theoretical degeneracy of a C2-C3 deoxyribose covalent bond must determine (upon decoherence) which electron goes spin-up and which electron goes spin-down within the orbital that they both inhabit. That determination between them can theoretically be induced via the Aharonov-Bohm effect when conditions are topologically and geometrically appropriate. [23] It is the chiral effect of the magnetic vector potential on the spinless electrons that determines which electron of the pair is selected to spin which way, thus determining the phase of the system through the quantum anomalous Hall effect [20] [21] within the special situation of DNA quantum logic.

The two electrons that are being held coherently in the C2-C3 covalent bond of the deoxyribose moiety in DNA essentially have "undecided" spin directions. By the Pauli exclusion principle, one must be spin-up and one must be spin-down once a deterministic decision as to spin direction is made. Electron spin direction determines chirality and chiral centers have an affinity for electron spin. Upon decoherence of the system, each electron will affect a chiral center, either C2 or C3. Theoretically, the chirality of which electron goes where can be decided topologically by the magnetic vector potential via the Aharonov-Bohm effect and the quantum anomalous Hall effect, breaking the Cooper pair degeneracy and transforming it into a Dirac pair in a manner analogous to that which occurs as described in a solid state topological superconducting system.

Table 1.

A Comparison of Majorana State Characteristics Expressed in Topological Superconductors and in DNA

Majorana State* Characteristic	Expression in Topological Superconductor	Expression in DNA
Spin-½ wave statistics	electrons in electrical current	electrons in spin current
Conduction medium	chiral p-wave topological superconductor	aromatic pi-stacking interactions
Majorana zero mode**	edge state in condensate	deoxyribose enantiomeric triple state
Vector potential source	external parallel magnetic field	cellular depolarization
Electromagnetic shielding	Meissner Effect	double lipid bilayer Faraday cage effect
Zeeman splitting***	electromagnetic field interaction	helical spin filtering
Chirality manifestation	heterostructure vortex formation	deoxyribose enantiomeric selection
Antiparticle antisymmetry	annihilation operator matrices	opposing chiral enantiomers

*Majorana state / Majorana fermion / Majorana particle

** Majorana zero mode / degenerate state / spinless state / Majorana bound state / Cooper pair

***Zeeman splitting / opening of band gap / Dirac pair

Biological Anomalies Consistent with Effects of a Time-Dependent Magnetic Vector Potential

Unanticipated anomalies observed in the experiments conducted by Pizzi, et al. and by Mihelic might be explained through the biological effects of a time-dependent magnetic vector potential (TDMVP). Part of the experimental work of Pizzi, et al., conducted from 2004 through 2009 described an effect on the depolarizations of neurological cells that seemed to have been induced by a laser power supply, despite extensive efforts to shield the neurological cells from any electromagnetic radiation emitted from the laser power supply. [24] The experimental work of Mihelic [3] demonstrated that a series of laser pulses of applied to a target neuronal cell culture (A) induced sustained oscillatory depolarizations in cells of that target neuronal cell culture (A), and also induced phase correlated sustained oscillatory depolarizations in cells of a second neuronal cell culture (B) that was a clone of the first culture. A previously unreported anomalous finding by Mihelic was that covering the laser so that no laser light actually struck the target neuronal cell culture (A), was found to induce sustained oscillatory depolarizations in cells of the target neuronal cell culture (A) that were of a different quality than those induced when the laser light directly struck the culture, but no oscillatory depolarizations were found to be induced in the cells of the second neuronal cell culture (B) when the laser was covered. These experimental findings can be explained through the quantum DNA model as an effect caused by the magnetic vector potential that was generated by the laser power supply, upon the degenerate state of a Cooper pair of electrons, transforming it into a Dirac pair of electrons with resultant molecular change in the DNA molecule that affected the depolarization pattern of the cell.

The anomalous and previously unexplainable experimental results of Pizzi, et al. can be explained by the effect of pulsed magnetic vector potential generated by the power supply of the laser being used in the experiments. The experimental results of Mihelic 2019 [3] are supportive of the quantum DNA model, but related to that research and not previously published, an experimental run was done with the laser pointed at the local culture (A) but with the laser covered so that no photons from the laser could hit the culture, and this resulted in some responses that differed significantly from those induced by the noncovered laser (see Figure 1). Some iterations of this experimental run recorded cells in the local culture (A) that exhibited oscillatory depolarizations, and analysis of the wave forms of those depolarizations showed them to be of a much more regular (almost sinusoidal) quality that the depolarizations induced by exposure to the laser photons in other experimental runs (see comparative examples in Figure 2). In this experimental run no oscillatory depolarizations were found to be induced in the non-local culture (B) in any of the iterations. The induction of oscillatory depolarizations in the local culture (A) is a biological phenomenon that is different from, but related to, the depolarizations induced by the laser photons of the uncovered laser, and is likely related to the same unexplained effect that was described by Pizzi, et al.

Figure 1. The top three tracings are neuronal depolarization patterns from cells in the local culture (A), to which the covered laser was directed. The fourth tracing from the top is the timing of the laser pulses. The bottom four tracings are the depolarization patterns of cells in the non-local culture (B). Only the local culture (A) showed any response to the covered laser.

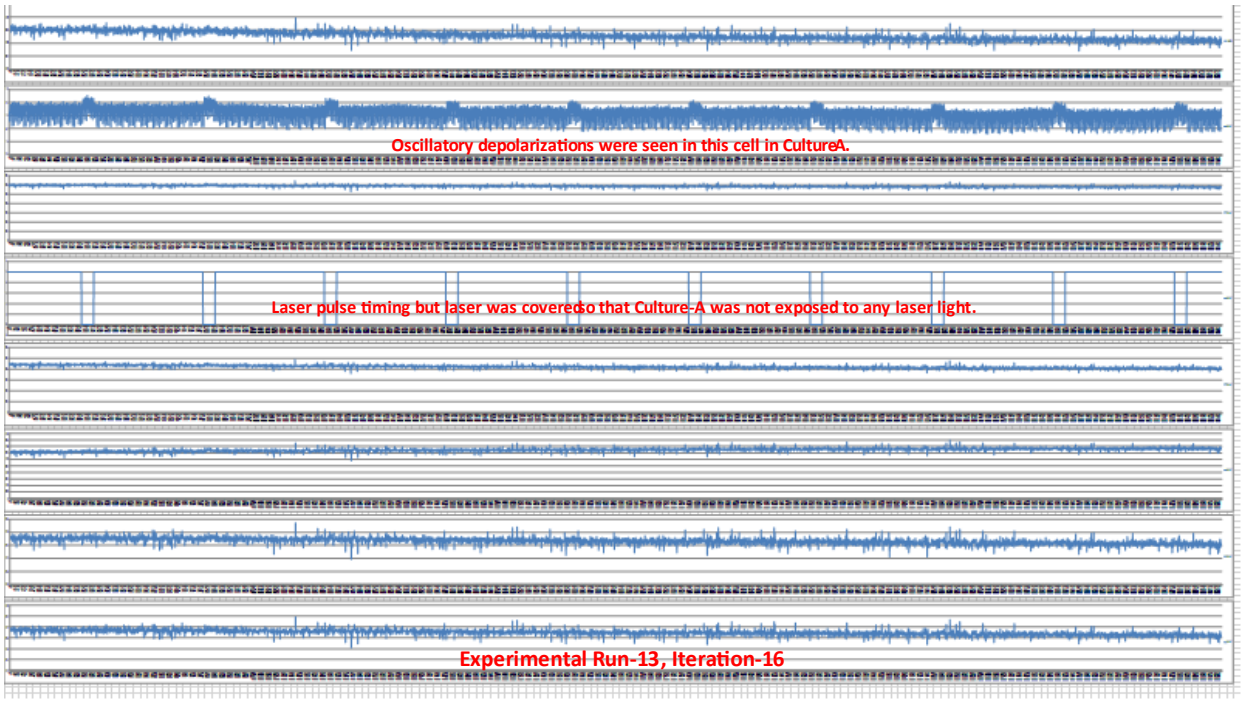
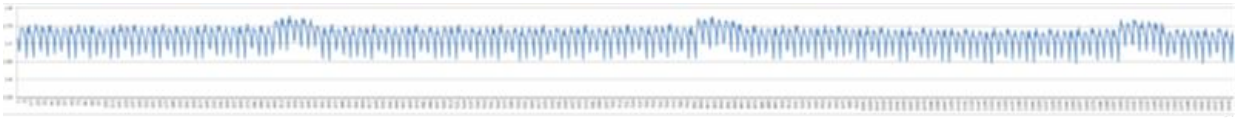
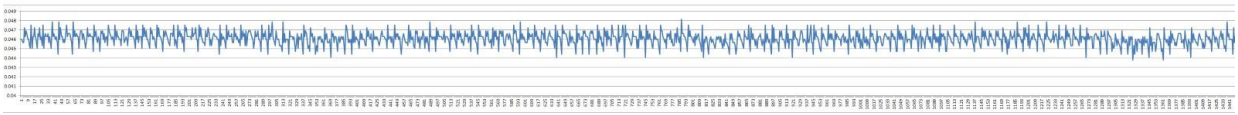


Figure 2. Comparison of the types of depolarizations observed.

Below is an expanded view of the first portion of the second tracing of Experimental Run-13, Iteration-16:



For comparison, below is a tracing from Experimental Run-15, Iteration-15 of a cell in Culture-A that had oscillatory depolarizations of phase lock induced by (uncovered) pulsed laser stimulation:



Also for comparison, below is a tracing of random asynchronous (i.e.not phase locked) neuronal cell depolarizations:

There is certainly a different quality of the oscillatory depolarizations seen between the top two tracings, in that the oscillatory depolarizations seen in Experimental Run-13 seem much "cleaner" and without as much "interference" as the oscillatory depolarizations seen in Experimental Run-15.

Although the experiments of Pizzi, et al. and Mihelic were investigations into the quantum mechanics of biological systems, they were not controlled experiments designed to investigate the biological efffect of the magnetic vector potential, however, the unexpected anomalies in the results of those experiments might be explained as the result of the effect of the magnetic vector potential. Theoretically this could indicate that there are two separate mechanisms by which a pulsed laser can affect DNA quantum mechanics. The first such theoretical mechanism is by the effect of the laser photons causing spin pumping of electron spin states that are coherently conducted and spin filtered along the DNA molecule to affect chiral selection in the deoxyribose moiety (via the QSHE). The second such theoretical mechanism is by direct TDMVP manipulation of the spin of Cooper pair electrons in the C2-C3 bond to affect chiral selection in the deoxyribose moiety (via the QAHE).

Potential Biomedical Implications

There are significant potential biological implications of the effect of a magnetic vector potential on the quantum logic of the DNA molecule. While there has been inconsistent data regarding the association between electromagnetic radiation and cancer, it has been experimentally demonstrated that radio frequency radiation in a range similar to that emitted from 2G and 3G cellphones is associated with certain tumors in rats. [25] [26] If indeed a Faraday cage effect of the double lipid bilayer nuclear membrane can shield the DNA quantum logical functions taking place within it from electromagnetic interference, then perhaps this tumorigenic effect of cell phone-range electromagnetic radiation is less a result of an electromagnetic field and more a result of the time-dependent magnetic vector potential (which is induced by the source of the electromagnetic field) that can theoretically interfere with the

quantum logic of cellular DNA. Such an understanding might lead to the development of safer cell phones.

There have also been reports of occupational health problems affecting some who work in close proximity to MRI machines. [27] [28] It had always been assumed that such symptoms in MRI healthcare workers were related to the magnetic field generated by the MRI machines, but the pilot experimental anomalies and theoretical modeling at the University of Tennessee supports the hypothesis that such symptoms in healthcare MRI workers, may instead be a consequence of the magnetic vector potential generated by the strong electromagnets used in MRI machines, rather than by the magnetic field itself. A better understanding of the biological effects of the MVP generated by such strong electromagnets might lead to safer occupational practices for those who work around such equipment.

There are some significant similarities between the symptoms reported by those who work in close proximity to MRI machines and the symptoms of those affected by the so-called "embassy illness syndrome". Reports of a syndrome of mysterious illness involving directional auditory sensations, dizziness, sleep disturbances, and other neuro-cognitive symptoms in diplomatic workers at the US embassy in Havana, Cuba, and at the US Consulate in Guangzhou, China, have led to reductions in embassy staffing, with a resultant reduction in mission effectiveness. [29] No definite cause of this mysterious "Havana syndrome" (a.k.a. "embassy illness") has yet been established, but most speculation as to cause has centered on some sort of intentional and malevolent microwave or ultrasonic emissions being directed toward diplomatic facilities and workers. There has been no definite detection of microwaves or of ultrasonic vibrations, and countermeasures against such have not provided any useful benefit. Physicians who examined the affected diplomatic workers from Havana found that definite physiological/organic damage was done to those diplomatic workers which seemed consistent with the damage that is seen in concussion (a.k.a. "mild traumatic brain injury"). [30] Reasonable rationale has been provided as to why such symptoms are not related to microwave exposure [31], and at this time there is no general medical consensus as to the cause of the embassy illness syndrome, with conventional biomedical understanding being unable to provide a reasonable etiology to explain the problem. Could these mysterious symptoms be instead related to the direction of a significant magnetic vector potential toward the embassy and/or its personnel in a deliberate attempt to degrade mission effectiveness?

The Quantum Computing Initialization Problem

A major concern in the development of man-made quantum computing has been called the "initialization problem", which is essentially the question of how to "set to zero" all of the coherently held quantum gates in the system without causing a decoherence of the entire system. [32] The theoretically successful strategy of biological systems that puts the coherent quantum logic system within the Faraday cage effect of the nuclear membrane, and then can synchronize segments of that quantum logic system that are in appropriate geometric/topological orientation via a time-dependent magnetic vector potential generated by cellular depolarization, might be emulated in a non-biological manner.

Conclusion

All information is physical, so any valid physical concept that can be conceptualized must have a corresponding physicality within the system conceptualizing it, otherwise it could not be conceptualized. There must be a corresponding physicality by which quantum logic and Majorana fermions can be conceptualized in the human brain. The quantum logic processes that take place in the human brain are thus arguably fundamental to the man-made quantum logic processes that take place in a dilution refrigerator. In order to build a truly functional quantum computer we should examine the quantum logic taking place in DNA and emulate it.

There is reasonable theory toward explanation of significant biological phenomena indicating that a magnetic vector potential can affect Majorana fermions in the mechanics of the quantum logic taking place in the DNA molecule. Because of the major potential implications that such concepts present, controlled experimental studies should be done to definitively explore them.

Acknowledgment

A special thanks to Sam Brown of Averoses, Inc., who provided multiple invaluable discussions regarding the subject of this paper, and who first recognized that the effect of the magnetic vector potential was responsible for certain anomalies in the data that was reported by Pizzi, et al.

References

[1] Mihelic, F.M., “Model of Biological Quantum Logic in DNA”, *Life*. Vol. 3: No. 3, pp 474-481, (2013).

[2] Baer, W. and Pizzi, R., “The case for biological quantum computer elements”, *Quantum Information and Computation VII, SPIE Proceedings*. Vol. 734204-1 (2009).

[3] Mihelic, F.M. “Experimental Evidence Supportive of the Quantum DNA Model”, *Proceedings Volume 10984, Quantum Information Science, Sensing, and Computation XI;* 1098404 (2019).

[4] Banerjee, A.; Bridges, C. A.; Yan, J.-Q.; et al. (4 April 2016). "Proximate Kitaev quantum spin liquid behaviour in a honeycomb magnet". Nature Materials. April 4, 2016, 15 (7): 733–740.

[5] Olson, WK, “Three-state models of furanose pseudorotation”, *Nucleic Acids Research.* 1981, 9:5, pp. 1251-1262.

[6] Rieper, E.; Anders, J.; Vedral, V. “Quantum entanglement between the electron clouds of nucleic acids in DNA”, arXiv:1006.4053v2, (2011).

[7] Göhler, B., et al., “Spin selectivity in electron transmission through self-assembled monolayers of double-stranded DNA”, *Science*. Vol. 331, pp. 894–897 (2011).

[8] Mihelic, F.M. “Szilard engine reversibility as quantum gate function”, *SPIE Proceedings*. Vol. 8400 (2012).

[9] Levitt, M.; Warshel, A. “Extreme conformational flexibility of the furanose ring in DNA and RNA”. *Journal of the American Chemical Society*. Vol. 100, pp. 2607–2613, (1978).

[10] Mihelic, F.M. “Implications of the Landauer limit for quantum logic”, *Quantum Information and Computation XII, SPIE Proceedings*. Vol. 91230B-1, (2014).

[11] Beenakker, C., “Search for Majorana Fermions in Superconductors”, *Annual Review of Condensed Matter Physics*, 2013, 4:113-136.

[12] Wang, et al., “Chiral topological superconductor and half-integer conductance plateau from quantum anomalous Hall plateau transition”, Physical Review B, 92, 064520 (2015).

[13] Dumitrescu, et al., “Majorana Fermions in Chiral Topological Ferromagnetic Nanowires”, Physics Review B, 91(9) (2014).

[14] Qing, et al., “Chiral Majorana edge state in a quantum anomalous Hall insulator-superconductor structure”, Science 357,294 (2017).

[15] Barr, S., “New Type of Seesaw Mechanism for Neutrino Masses”, *Physical Review Letters*, March 12, 2004, Vol. 92, No. 10.

[16] Jay D. Sau, Sumanta Tewari, Roman M. Lutchyn, Tudor D. Stanescu, and S. Das Sarma, “Non-Abelian quantum order in spin-orbit-coupled semiconductors: Search for topological Majorana particles in solid-state systems”, Phys. Rev. B **82**, 214509, 9 December 2010, p. 24.

[17] Jay D. Sau, Sumanta Tewari, Roman M. Lutchyn, Tudor D. Stanescu, and S. Das Sarma, “Non-Abelian quantum order in spin-orbit-coupled semiconductors: Search for topological Majorana particles in solid-state systems”, Phys. Rev. B 82, 214509, 9 December 2010, p. 43.

[18] Jay D. Sau, Sumanta Tewari, Roman M. Lutchyn, Tudor D. Stanescu, and S. Das Sarma, “Non-Abelian quantum order in spin-orbit-coupled semiconductors: Search for topological Majorana particles in solid-state systems”, Phys. Rev. B 82, 214509, 9 December 2010, p. 29.

[19] Bernevig, BA, Zhang, S-C, “Quantum Spin Hall Effect”, *Physical Review Letters*, March 17, 2006, Vol. 96, 106802.

[20] He, Qing Lin; Pan, Lei; Stern, Alexander L.; Burks, Edward C.; Che, Xiaoyu; Yin, Gen; Wang, Jing; Lian, Biao; Zhou, Quan (21 July 2017). "Chiral Majorana fermion modes in a quantum anomalous Hall insulator–superconductor structure". Science. 357 (6348): 294–299.

[21] Liu, C-X, Zhang, S-C, Qu, X-L, “The Quantum Anomalous Hall Effect: Theory and Experiment”, *Annual Review of Condensed Matter* Physics, Vol. 7:301-321 (March 2016)

[22] Berry, M.V, “Quantal phase factors accompanying adiabatic changes”, *Proc. R. Soc. Lond.* A 392, 45-57, 1984.

[23] Aharonov, Y; Bohm, D (1959). "Significance of electromagnetic potentials in quantum theory". Physical Review. 115 (3): 485–491.

[24] Baer, W. and Pizzi, R., “The case for biological quantum computer elements”, *Quantum Information and Computation VII, SPIE Proceedings*. Vol. 734204-1 (2009).

[25] National Toxicology Program, “Cellphone Radio Frequency Radiation Studies”, National Institute of Environmental, Health Sciences NIH-HHS, August 2020.

[26] Michael Wyde, Mark Cesta, Chad Blystone, Susan Elmore, Paul Foster, Michelle Hooth, Grace Kissling, David Malarkey, Robert Sills, Matthew Stout, Nigel Walker, Kristine Witt, Mary Wolfe, John Bucher, “Report of Partial findings from the National Toxicology Program Carcinogenesis Studies of Cell Phone Radiofrequency Radiation in Hsd: Sprague Dawley® SD rats (Whole Body Exposures)”, *bioRxiv*, February 1, 2018, doi: https://doi.org/10.1101/055699

[27] De Vocht, F., “Exposure, Health Complaints and Cognitive Performance Among Employees of an MRI Scanners Manufacturing Department”, *Journal of Magnetic Resonance Imaging*. 23:197–204 (2006).

[28] Van Nierop, LE, “Effects of magnetic stray fields from a 7 Tesla MRI scanner on neurocognition: a double-blind randomized crossover study”, *Occup Environ Med* 2012; 69:759–766.

[29] Entous, A and Anderson, JL, “The Mystery of the Havana Syndrome”, *The New Yorker*. November 19, 2018.

[30] Swanson, RL, et al., “Neurological Manifestations Among US Government Personnel Reporting Directional Audible and Sensory Phenomena in Havana, Cuba”, *JAMA*. February 15, 2018; 319(11):1125-1133.

[31] Foster, K, “Cuba's "Sonic Attack" on the U.S. Embassy Could Have Been Merely Sounds Emitted by a Listening Device”, *Scientific American.* September 7, 2018.

[32] Kak, S., “The Initialization Problem in Quantum Computing”, Foundations of Physics, February 1999, Vol. 29, pp. 267-279.