What is The Reason to Use Clifford Algebra in Quantum Cognition?
Part I: “It from Qubit”
On The Possibility That the Amino Acids Can Discern Between Two Quantum Spin States

Elio Conte

ABSTRACT
Starting with 1985, we discovered the possible existence of electrons with net helicity in biomolecules as amino acids and their possibility to discern between the two quantum spin states. It is well known that the question of a possible fundamental role of quantum mechanics in biological matter constitutes still a long debate. In the last ten years we have given a rather complete quantum mechanical elaboration entirely based on Clifford algebra whose basic entities are isomorphic to the well-known spin Pauli matrices. A number of our recent results indicate the possible logical origin of quantum mechanics and the direct admission of quantum mechanics in the field of cognitive sciences. In February 2011, Gohler et al. published their important discovery on Science about Spin Selectivity in Electron Transmission Through Self-Assembled Monolayers of Double-Stranded DNA confirming in such manner that the principles of quantum mechanics apply to biological systems.

Key Words: Clifford algebra, quantum cognition, quantum mechanics, discrimination of spin states from amino acids

Introduction
Chirality is the property of an object to exist as distinguishable mirror image forms that are known as enantiomers. The chemistry of life is intrinsically homochiral. Biological molecules such as sugars, amino acids and DNA exist almost exclusively as only one enantiomer.

The identification of the mechanisms for such asymmetry is of tremendous interest, first to explain the manner as they acted at the origin of life but also because understanding such mechanisms may allow valuable applications as, in principle, more efficient asymmetric synthesis of pharmaceuticals.

In information mechanics a problem is related to understand the transmission of the information message at the different levels of the given biological organism. Generally speaking, the filtration and the enrichment effects accompany both local direction of transmission information. Biologic information, using some preferential channels, may cross several structural levels overcoming filtering and buffering effects. As example, the genetic information starts from the microscopic gene level and arrives at the macroscopic body level without errors. In the reverse direction of transmission information, the basic psychological functions of the body as the “will”, the cognitive performances or other mental activities are conveyed for a prompt execution into the cellular level. We have given a number of scientific results on the possibility of quantum mechanics to have a role at the human perceptive-cognitive level.

Our investigations have outlined the possible significant roles of the basic Clifford algebraic unities. In the standard language of quantum mechanics they are isomorphic to spin Pauli matrices and thus to the spin. In several papers, see www.saistmp.com, we have
shown the logical origin of quantum mechanics by using such algebraic Clifford formulation and thus such algebraic unities.

Substantially, living matter has developed special means in the course of its evolution in order to avoid the filtering or blurring effects in information message dynamics. A very powerful mechanism of information filtration is due to symmetry effects (Ciplea, 1976) which should annihilate the symmetrical directed parameters of an information message. The living matter structures should have learned the manner to avoid such filtering effects due to symmetry by using highly asymmetric components. Because of these fundamental questions, chirality is so important in biomolecules.

The role of the abstract Clifford entities could have had and still should have a basic and fundamental role. It is important to evidence the nature of such problem having previously shown, as said, the possible role of quantum mechanics, and, in particular, of our Clifford algebraic quantum mechanical formulation at the human level of perceptive-cognitive performance.

In 1957 Vester (1959) and Ulbricht postulated a causal relationship between the parity-non conserving aspect of weak interactions and the observed asymmetry of the molecules in living organisms. The universal chirality involved in the weak interaction could have influenced the selection of exclusively D-sugars and DNA and L-amino acids for proteins. The assumption was that the weak interactions, violating parity, prospected an inherent dissymmetric influence in physical world. Parity violating effects should have provided an unequivocal and determinate account of dominant handedness of the basic biomolecules. Asymmetry should have been developed during chemical evolution or during biological evolution assuming that the molecules synthesized abiologically were racemic but that such physical agent depleted one of the enantiomers before the first reproductive biological units existed.

In 1968 A. S Garay obtained a number of positive experimental results in this direction and with Hrasko he also formulated a physical model of the interaction (Garay 1968; Garay et al., 1973). Researchers at an international level promptly investigated the problem following different theoretical and experimental approaches and methodologies. We press the reader to analyse in depth the obtained results also if we report here an absolutely incomplete list (see Special Issue, BioSystems, 1987). The studies covered a broad range and, in particular, the calculation of the energy difference between enantiomers due to weak interaction, scattering of electrons from enantiomers and production of asymmetry by weak interaction and possible amplification effects. Here are the basic points of our technical comment:

- The Vester-Ulbricht suggestion was that the chirality of the biomolecules originated from the $\beta$ - radiolysis of prebiotic racemic mixtures.

- All the experimental results still today remain inconclusiveness owing to the very restricted differences that were experimentally observed. A datum was certainly established: actually the $\beta$ - particles, because of their helicity, radiolyse $D$- and $L$- enantiomers at slightly different rates. The obtained asymmetric values were and are not evaluated to be sufficient to completely assign a definitive role to weak interactions in order to accept that biomolecules originated from $\beta$ - radiolysis of the prebiotic racemic mixture.

- In brief, the original Vester and Ulbricht hypothesis remains suspended under the profile of the problem of prebiotic-biotic chemical evolution but remains ascertained that asymmetry is produced by the asymmetric decomposition of the chiral monomers by spin polarized $\beta$ - particles. This last statement is the essential point of the present comment. The verification of such existing effect induces obviously the possibility to formulate a model of biomolecules. We performed three kinds of experiments.

The first investigation aimed to investigate the asymmetrical interaction of polarized electrons from $^{89}\text{Sr} \rightarrow ^{90}\text{Y}$ beta decay with $D$- and $L$- alanine using ESR measurements and compared with decomposition induced from $^{60}\text{Co} \rightarrow ^{\gamma}$. Using a similar kind of investigation performed by Bernestein et al. and Bonner et al. (see Special
Conte E., What is the reason to use Clifford algebra in NeuroQuantology | electrons are polarized predominantly dispersion. Here, in one isomer the electrons of different helicity and have a different law of enantiomer as a kind of non-Garay the previous formulations in (previous experimentation also in accord with of course the conclusion arising from our conceptually that the electrons in optically spectroscopy and differences between D and L-Alanine. The results of the experimentation are exposed in such papers. It was obtained that asymmetrical yields induced in $^{90}$Sr -- $^{90}$Y --beta --irradiated alanine are 10% more in D- respect to L-alanine.

The second experiment related investigation on the chirality of positrons emitted from $^{22}$Na decay and their asymmetrical interaction with D-, L-, and DL-Alanine. In condensed materials, positrons slow down within $10^{-12}$ sec to energies of about 10 eV before annihilation. We consider two ways: by annihilation on free electrons which takes place in $2 \times 10^{-16}$ sec or by formation of positron. In the last mode Ps atoms are formed in singlet (spin = 0) or triplet (spin = 1) states, in the relative proportion of 1:3, but different lifetimes. A number of experiments have shown that positrons emitted in radioactive decay partly retain their longitudinal polarization during slowing down and Ps formation. Since the singlet annihilation of positron results in two 0.511 MeV gamma rays while the triplet annihilation of positron occurs with the emission of three coplanar gamma rays having total energy of 1.022 MeV, we estimated the differences in the singlet (triplet) formation and annihilation of positron in D-, L-, DL-Alanine by counting the effective number of 0.511 MeV emitted gamma rays from equal samples of D-, L-DL-Alanine bombarded by the same number of positrons. The experiment was performed by using sophisticated Canberra-gamma spectrometry apparatus. The results of the experimentation are reported in (Conte et al., 1987) with a detailed Table of the results. As expected, three main peaks were recorded by gamma ray spectroscopy and differences between D- and L-Alanine were ascertained with a statistical significance of 99.5%.

In the third experiment we considered conceptually that the electrons in optically active biomolecules possess net helicity. This is of course the conclusion arising from our previous experimentation also in accord with the previous formulations in (Garay, 1968; Garay et al., 1973). We may consider each enantiomer as a kind of non-interacting electron gas in each of which the electrons are of different helicity and have a different law of dispersion. Here, in one isomer the electrons are indeed polarized predominantly parallel to their motion and in the other isomer the electrons are polarized predominantly antiparallel to their motion. Let us consider the interaction $\gamma + e^- \rightarrow \gamma + e^-$ (Compton scattering). Considering the usual Klein-Nishima expression for cross section, corrected for accounting for acting polarizations, we will have different expressions for one enantiomer respect to the other. In brief, assuming that the two enantiomers of biomolecules are polarized predominantly parallel and, respectively, antiparallel to their motion, the interaction with circularly polarized photons will give maximum of the interaction peaked, respectively, at different energies, $k_1$ and $k_2$ (for details Conte et al., 1989). The existence of such predicted difference was confirmed during our experimentation. During the slowdown in matter of free positrons to thermal energies, a significant number of Ps was formed combining their electron binding. From positron annihilation in singlet state if one photon of 0.511 MeV was emitted with left circular polarization, the other 0.511 MeV photon was emitted with right circular polarization. Assuming that a net correlation between the direction of the motion and the spin of the electrons in the optically active materials exists, a Compton effect should arise between the 0.511 MeV polarized annihilation) (singlet state of the positron) and the electrons with net helicity in the two enantiomers respectively. Consequently, different values of the energies $k_1$ and $k_2$, previously detailed, should be observed. This is precisely the result that we obtained using the chirality of positrons from $^{22}$Na decay and their asymmetrical interactions with D and L-Alanine. We used the same Canberra experimental apparatus and the statistical significance of the results was obtained with 99.5%. The results are reported in detail in (Conte, 1989). We gave demonstration on the existence of electrons with net helicity in biomolecules.

The results of the whole set of experimentation here reported, seem to indicate that the amino acids discern between the two quantum spin states.

The conclusion seems to be that we have basic biological unities, biomolecules as the amino acids, whose interfaced counterpart may be represented by the basic Clifford mathematical and thus computational entities that of course enable us to represent the basic foundations of quantum mechanics, also if in a
rough bare bone skeleton, and qubit. It from qubit was the title of David Deutsch (Deutsch, 2002), a paper due to the celebrations of John Wheeler’s 90th birthday. Let us consider his illuminating words of John Wheeler’s: “Really Big Questions”, the one on which the most progress has been made is It from Bit?—does information play a significant role at the foundations of physics? It is perhaps less ambitious than some of the other Questions, such as How Come Existence? Because it does not necessarily require a metaphysical answer. And unlike, say, Why the Quantum?, it does not require the discovery of new laws of nature: there was room for hope that it might be answered through a better understanding of the laws as we currently know them, particularly those of quantum physics. And this is what has happened: the better understanding is the quantum theory of information and computation.

How might our conception of the quantum physical world have been different if it from Bit had been a motivation from the outset? No one knows how to derive it (the nature of the physical world) from bit (the idea that information plays a significant role at the foundations of physics), and I shall argue that this will never be possible. But we can do the next best thing: we can start from the qubit.

When investigating the foundations of quantum theory, and especially the role of the information, it is best to use the Heisenberg picture, in which quantum observables change with time, and the quantum state is constant. Apart from the trivial observables that are multiplies of the unit observable, and hence have only a value, the simplest type of quantum observable is a Boolean observable – defined as one with exactly two eigenvalues. This is the closest thing that quantum physics has to the classical programmer’s idea of a Boolean variable. The simplest quantum system that contains a Boolean observable is a qubit. We can describe a qubit $Q$ at time $t$ elegantly in the Heisenberg picture, following Gottesman, using a triple $q(t) = (q_x(t), q_y(t), q_z(t))$ of Boolean observables of $Q$, satisfying $q_x(t)q_y(t) = i q_z(t)$, and cyclic permutations over $(x,y,z)$, and $q_{x,y,z}(t) = 1$. All observables of $Q$ are linear combinations, with constant coefficients, of the unit observable 1 and the three components of $q(t)$.

Here are the central points of our comment.
a) Each Boolean observable of $Q$ changes continuously with time, and yet, because of the central relations before mentioned, retains its fixed pair of eigenvalues which are the only two possible outcomes of measuring it.

If we regard a flight, as example, as consisting of a literally infinite number of infinitesimal steps, what exactly is the effect of such step? Since there is no such thing as a real number infinitesimally greater than another, the continuum is and remains a very natural idea but we cannot characterise the effect of this infinitesimal operation as the transformation of one real number in another, and so we cannot characterise it as an elementary computation performed on what we are trying to regard as information. For this sort of reason, It from Bit would be a non-starter in classical physics. In quantum theory, it is continuous observables that do not fit naturally into the formalism.

According to the previous rules, as said, each Boolean observable of $Q$ changes continuously with time, and yet, because of the central relations before mentioned, retains its fixed pair of eigenvalues which are the only two possible outcomes of measuring it. Although this means that the classical information storage capacity of a qubit is exactly one bit, there is no elementary entity in nature corresponding to a bit. Therefore, Deutsch’s conclusion is that it is qubits that occur in nature. Bits, Boolean variables, and classical computation are all emergent or approximate properties of qubits, manifested mainly when they undergo decoherence.

b) Here is a central question. According also to Gottesman and Chuang, the previous basic rules of a qubit pertain to the basic unities of the Clifford algebraic formulation that we have used in such years to reformulate the whole body of quantum mechanics, arriving to formulate a bare bone skeleton of such theory.

c) There are several results that we have obtained and that evidence their importance in this context. By using the Clifford algebraic formulation of quantum mechanics we have given mathematical proof of the potentiality-actualization transition that in quantum mechanics is admitted instead as postulate. This is the so called postulate of wave function reduction or psi collapse. We have given proof

www.neuroquantology.com
of von Neumann’s postulate on quantum measurement. Still, we have shown the logical origins of quantum mechanics: *It from qubit* seems to reappear. It is not logic that may be derived from quantum mechanics and its basic conceptual foundations as von Neumann showed. It is possible to demonstrate the vice versa. The quantum mechanical foundations derive from logic.

Therefore, quantum mechanics relates logic, mental entities. Finally, we have shown the important role of quantum mechanics at perceptive and cognitive level and the possibility that we think in a quantum mechanical manner.

There is still another result that appears of interest to us. We have shown that there are stages of our reality in which it results impossible to unconditionally defining the truth. Logic, language and thus cognition enter with a so fundamental role in quantum mechanics because there are levels of our reality in which the fundamental features of cognition and thus of logic and language, and thus the conceptual entities, acquire the same importance as the features of what is being described. At this level of reality we no more may separate the features of matter per se from the features of the cognition, of the logic and of the language that we use to describe it. Conceptual entities non more are separated from the object of cognitive performance. As correctly Yuri Orlov outlined in his several papers, the truths of logical statements about dynamic variables relating matter structure become dynamic variables themselves in quantum mechanics, and thus the cognition becomes in itself an immanent feature that operates symbiotically with the matter phenomenology that traditional physics aims to represent.

This is the basic conclusion of our studies. It seems to close the circle “it from qubit”. Amino acids are basic unities of the life and are represented by the basic Clifford unities as experimentally shown. Of course a Clifford algebraic formulation of quantum mechanics may be developed, and a qubit is given by the Clifford basic unities. *It is from qubit* as supported on the intrinsic logical origins of quantum mechanics.

References

Ciplea A, Ciplea LJ. The Information Mechanics in Biology, Cybernetica, 1976; 2: 141.