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Towards Realism Interpretation of Wave Mechanics based on Maxwell Equations in Quaternion Space and some implications, including Smarandache's Hypothesis

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Abstract. From time to time, some eminent physicists commenced to ask: What is the reality behind quantum mechanical predictions? Is there a realism interpretation of Quantum Physics? This paper is intended to explore such a possibility of a realism interpretation of QM, based on a derivation of Maxwell equations in Quaternion Space. In this regards, we begin with Quaternion space and its respective Quaternion Relativity (it also may be called as Rotational Relativity) as it has been discussed in several papers including [1]. The purpose of the present paper is to review our previous derivation of Maxwell equations in Q-space [17], with discussion on some implications. First, we will review our previous results in deriving Maxwell equations using Dirac decomposition, introduced by Gersten (1999). Then we will shortly make a few remark on helical solutions of Maxwell equations, Smarandache's Hypothesis and possible cosmological entanglement. Further observations are of course recommended to refute or verify some implications of this proposition.

INTRODUCTION

From time to time, some eminent physicists began to ask: What is the reality behind quantum mechanical predictions? Is there a realism interpretation of Quantum Physics? For instance, in a recent paper Prof. G. 't Hooft asks questions which can be paraphrased as follows: "The creator has made his own analysis of the acknowledged facts, and got here to the conclusion that the Copenhagen doctrine, that is, the consensus reached by many of the world specialists at the beginning of the 20th century, partly for the duration of their numerous gatherings in the Danish capital, has it almost right: there is a wave function, or rather, something we name a quantum state, being a vector in Hilbert space, which obeys a Schrodinger equation. The absolute squares of the vector elements can also be used to describe possibilities every time we wish to predict or give an explanation for something. Powerful techniques had been developed, enabling one to bet the proper Schrodinger equation if one knows how things evolve classically, that is, in the ancient theories the place quantum mechanics had not but been incorporated. It all works magnificently well. According to Copenhagen, however, there is one question one no longer ask: "What does fact seem like of some thing moves round in our experimental settings?", or: what is actually going on? According to Copenhagen, such a question can never be addressed via capability of any experiment, so it has no reply within the set of logical statements we can make of the world. Period, schluss, fini. Those questions are senseless. It is this answer that we dispute. Even if this form of questions cannot be answered via experiments, we can nonetheless in idea try to construct credible models of reality." (see [16]) This paper is intended to explore such a possibility of realism interpretation of QM, especially based on a derivation of Maxwell equations in Quaternion Space. In this regards, we begin with Quaternion space and its respective Quaternion Relativity (it also may be called as Rotational Relativity) as it has been defined in a number of papers including [1], and it can be shown that this new theory is capable to describe relativistic motion in elegant and straightforward way. For instance, it can be shown that the Pioneer spacecraft's Doppler shift anomaly can be

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explained as a relativistic effect of Quaternion Space [11]. The Yang-Mills field also can be shown to be consistent with Quaternion Space [1]. Nonetheless there are subsequent theoretical developments which remains an open issue, for instance to derive Maxwell equations in Q-space [1].

Therefore the purpose of the present paper is to review our previous derivation of Maxwell equations in Q-space, also with a few remarks on helical solutions and the shape of electron. First, we will review a derivation of Maxwell equations using Dirac decomposition, introduced by Gersten (1999). Then we will shortly make a few remark on helical solutions of Maxwell equations and Smarandache's hypothesis. Further observations are of course recommended in order to refute or verify some implications of what. we discuss here.

Review of previous result: derivation of Maxwell equations in Quaternion Space by virtue of Dirac-Gersten decomposition.

In this section we review our previous derivation of Maxwell equations in Quaternion space based on Gersten's method to derive Maxwell equations from one photon equation by virtue of Dirac decomposition [4]. It can be noted here that there are other methods to derive such a 'quantum Maxwell equations' (i.e. to find link between photon equation and Maxwell equations), for instance by Asim Barut quite a long time ago (see ICTP preprint no. IC/91/255).

As a short review of our previous paper [17], we started with remark that Maxwell equations [9] will be obtained by substitution of E and p with the ordinary quantum operators (see for instance Bethe, *Field Theory*):

$$E \to i\hbar \frac{\partial}{\partial t} \quad , \tag{1}$$

and

$$p \to -ih\nabla, \tag{2}$$

and the wavefunction substitution:

$$\vec{\Psi} = \vec{E} - i\vec{B}, \tag{3}$$

where E and B are electric and magnetic fields, respectively. With the identity:

$$(\vec{p} \cdot \vec{S})\vec{\Psi} = \hbar\nabla \times \vec{\Psi}. \tag{4}$$

Then one will obtain:

$$i\frac{\hbar}{c}\frac{\partial(\vec{E} - i\vec{B})}{\partial t} = -\hbar\nabla \times (\vec{E} - i\vec{B}), \tag{5}$$

$$\nabla \cdot (\vec{E} - i\vec{B}) = 0, \tag{6}$$

Which are the Maxwell equations if the electric and magnetic fields are real [4,5].

We can remark here that the combination of E and B as introduced in (3) is quite well known in literature [6,7]. For instance, if we use positive signature, then it is known as Bateman's representation of Maxwell equations ($div\vec{\varepsilon} = 0; rot\vec{\varepsilon} = \frac{1}{c}\frac{\partial\vec{\varepsilon}}{\partial t}; \varepsilon = \vec{E} + i\vec{B}$). But the equation (3) with negative signature represents the *complex nature* of Electromagnetic fields [6], which indicates that these fields can also be represented in quaternion form.

Then after some steps, one will obtain *the Maxwell equations in Quaternion-space* as follows [17]:

$$i\frac{\hbar}{c}\frac{\partial\vec{\varepsilon}_q k}{\partial t} = -\hbar\nabla_k \times \vec{\varepsilon}_{qk} \quad , \tag{7}$$

$$\nabla_k \cdot \vec{\varepsilon}_{qk} = 0. \tag{8}$$

Now the remaining question is to define quaternion differential operators in the right hand side of (7) and left hand side of (8).

In this regards one can choose some definitions of quaternion differential operator, for instance the so-called 'Moisil-Theodoresco operator'[8].

As with cross product, we can note here that there could be more rigorous approach to define such a quaternionic curl operator.[7]

In the present paper we only discuss derivation of Maxwell equations in Quaternion Space using the decomposition method described by Gersten [4,5].

In the next section we will discuss three physical implications of this new derivation of Maxwell equations in Quaternion Space.

Implication 1: Helical solutions of Maxwell equations; one-to-one correspondence with Wave Mechanics; and limitations of this paper.

In the foregoing section we derived a consistent description of Maxwell equations in Q-Space by virtue of Dirac-Gersten's decomposition. Now we discuss some plausible implications of the new proposition.

First, in accordance with Gersten, we submit the viewpoint that the Maxwell equations yield wavefunctions which can be used as guideline for interpretation of quantum mechanics [4,5]. We shall emphasize here: "The one-to-one correspondence between classical and quantum wave interpretation actually can be expected not only in the context of Feynman's derivation of Maxwell equations from Lorentz force, but also from known exact correspondence between commutation relation and Poisson bracket." See also [3,4].

Secondly, the above expressions of Maxwelll equations in Q-space are still missing the A term. Provided we include A term as defined by R.W. Bass [2], as follows:

$$A = \nabla x(\psi u) + (1/\lambda)\nabla x(\nabla x(\psi u)) \tag{9}$$

then we got helical solutions of Maxwell eq., which are more consistent with many experimental results, instead of the well-known "sinusoidal" solutions.[2]

A few more remark deserves further attention, as follows: "This helical form of EM ties into the KH electron, during photon capture events. The captured photon causes an energetic imbalance in the desired and required stability of the electron, which causes the photon to be ejected in a short while. We're still trying to discover what is the cause of the form of the electron being as stable as it is, and why it has such a strong surface boundary." (KH=Kelvin-Helmholtz)

Further implications of this new proposition of helical solutions of Maxwell equations require further study, and therefore they are excluded from the present paper; see also Bass [2].

Before we close this paper, allow us to point out two limitations of the procedure as outlined above: (a) It begins with Gersten decomposition and Dirac equation, which assumes that mass-energy equivalence holds true. Whenever one can show that such an equivalence does not hold true, then our procedure should be revised. (b) Our model assumes orthogonality. Some authors have argued that orthogonality of Dirac equation prevents it to predict fractional states of hydrogen (hydrino, cf. R.L. Mills [15]). However, the majority of interactions and appearances in Nature are not orthogonal, but are comprised of acute and oblique angles, usually far from orthogonality. This fact is covered by dot products and cross products, as required by engineering applications of the Maxwell equations. Quaternion solutions may be not capable of doing dot products, to our knowledge (although it may be possible to define "quaternionic curl," as we mentioned in previous section). Perhaps it is better to use the graded Grassmann algebra as the foundational basis, since projective Grassmann solutions are easy to obtain. Furthermore, the graded Grassmann algebras do not require a metric, nor do they need to know which way is "up" as the Clifford algebras require. Thus, the Grassmann algebras are better suited for cosmological considerations, which the Clifford algebras are incapable of handling, due to the limitations and shortcomings of the Clifford algebras. But we reserve such an extension to Grassmann algebra for future investigation.

Implication 2: Smarandache's Hypothesis

As we discussed above, Maxwell equations in Quaternion Space are formally equivalent with Dirac equations, this result brings to a mathematical support of Smarandache's hypothesis. So in this section we will review shortly what Smarandache's hypothesis is. Smarandache's Hypothesis states that there is no speed limit of anything, including light and particles [18]. Eric Weisstein also wrote implications of Smarandache's Hypothesis [18a], which can be paraphrased as follows: "...the velocity of light c is no longer a maximum at which statistics can be transmitted and that arbitrary speeds of data or mass switch can occur. These assertions fly in the face of each idea and experiment, as they violate both Einstein's exceptional principle of relativity and causality and lack any experimental support. It is authentic that modern-day experiments have confirmed the existence of positive sorts of measurable superluminal phenomena. However, none of these experiments are in conflict with causality or distinct relativity, because no statistics or bodily object absolutely travels at speeds v large than c to produce the located phenomena." (see [18a]) While the idea is quite simple and based on known hypothesis of quantum mechanics, called Einstein-Podolski-Rosen paradox, in reality such a superluminal physics seems still hard to accept by majority of physicists. Since 2011, there was an apparent surprising result as announced by OPERA team. Nonetheless, few months later it was renounced, on the ground of errors in handling the measurement. The story was retold by Lukasz Glinka [20], which can be paraphrased as follows: "On September 22, 2011, the human world overloaded at some point of the various paradigms and dogmas had experienced without a doubt innovative excitations. Namely, on this day the OPERA Collaboration, an global experimental undertaking of the European Organization for Nuclear Research - CERN, announced that their results, which arose from the high-statistics experimental data, naturally display existence of the superluminal neutrinos... During the subsequent 5 months, the public opinion was once a witness of many a variety of speculations about faster-then-light motion, but already on February 22, 2012, OPERA pointed out the two issues, based totally on the technology of the Global Positioning System whose construction in itself makes use of the arguments of Special Relativity, which ought to at once have an effect on on the dimension process... The first trouble was once linked to the oscillator producing the occasions time-stamps in between the GPS synchronizations, whereas the 2d one used to be the cable of the optical fiber bringing the external GPS sign to the OPERA grasp clock. Both these probabilities probably could supply the anomaly regarded as an experimental error which led to registration of the faster-than-light neutrino. In February 2012, the 2nd cause was once regarded extra seriously than the first one, and the CERN experimentalists announced that the state of affairs will be demonstrated as soon as once more but in 2012. In March 2012, the ICARUS experiment, another CERN experimental collaboration initiated in 1977 via Carlo Rubbia, who shared the 1984 Nobel Prize in Physics for discovery of the weak gauge bosons W and Z, confirmed the absolutism of the pace of light in the dimension of the neutrino motion. Already in June 2012, the CERN Research Director Sergio Bertolucci, at the twenty fifth International Conference on Neutrino Physics and Astrophysics held in Kyoto, established the fallacious size due to the OPERA Collaboration… Moreover, it is worth stressing that the superluminal kingdom of affairs is regular in current astronomy when you consider that the early 1980s, when the faster-than-light movement had been advised in order to contradict the quasars having the cosmological distances. In the present-day situation, the experimental information exhibit that the superluminal travels are the phenomena which are very regularly met in radio galaxies, quasars and microquasars."

Allow us to make few comments on such an apparent failure to detect faster than light speed as follows: Despite those debates over OPERA results, we thought that a more convincing experiment has been done by Alain Aspect etc., who were able to show that quantum non-locality interaction is real. In 1980 Alain Aspect performed the first EPR experiment (Einstein-Podolski-Rosen) which proved the existence of space nonlocality (Aspect 1982). Alain Aspect and his team at Orsay, Paris, conducted three Bell tests using calcium cascade sources. The first and last used the CH74 inequality. The second was the first application of the CHSH inequality [24]. The third (and most famous) was arranged such that the choice between the two settings on each side was made during the flight of the photons (as originally suggested by John Bell). Some experimenters have repeated this experiment and prove similar result until distance of more than 90 km. So the notion of "spooky action at a distance" is a real physical phenomenon. Moreover, action at a distance was already mentioned in Newton's Principia Mathematica. Despite, apparently Einstein was trying to make all of Newton's expressions into nothing, our result suggests that the Maxwell equations in classical electrodynamics have "spooky interaction at a distance" type of interactions (as it has also been proven for Coulomb potential), which may be observed both at small scale experiments as well as in cosmological scale, as recent evidences show. The latter will be discussed in next section.

Implication 3: Possibility of Cosmological Entanglement

In the present paper, we argued in favor of mathematical correspondence which is more known as Dirac-Maxwell isomorphism. Its implications include Smarandache's Hypothesis and also quantum entanglement both as small scale experiments and also at cosmological scale. Interestingly, there is a recent report from MIT suggesting that ancient quasars support such quantum entanglement at large scale phenomena. In an article it is reported about possibility of cosmological entanglement [21], which can be paraphrased as follows: "In 2014, Kaiser and two individuals of the contemporary team, Jason Gallicchio and Andrew Friedman, proposed an test to produce entangled photons on Earth — a method that is pretty fashionable in research of quantum mechanics. They planned to shoot every member of the entangled pair in contrary directions, towards mild detectors that would additionally make a measurement of every photon the use of a polarizer. Researchers would measure the polarization, or orientation, of every incoming photon's electric powered field, with the aid of putting the polarizer at quite a number angles and watching whether or not the photons surpassed thru — an outcome for each photon that researchers should compare to decide whether the particles confirmed the hallmark correlations expected by using quantum mechanics. The team delivered a special step to the proposed experiment, which used to be to use mild from ancient, far away astronomical sources, such as stars and quasars, to decide the attitude at which to set each respective polarizer. As each entangled photon was once in flight, heading towards its detector at the velocity of light, researchers would use a telescope placed at every detector site to measure the wavelength of a quasar's incoming light. If that light used to be redder than some reference wavelength, the polarizer would tilt at a certain perspective to make a particular size of the incoming entangled photon — a size desire that was once determined by means of the quasar. If the quasar's mild was once bluer than the reference wavelength, the polarizer would tilt at a special angle, performing a one of a kind measurement of the entangled photon. In their preceding experiment, the team used small outdoor telescopes to measure the light from stars as shut as 600 light years away. In their new study, the researchers used a good deal larger, greater effective telescopes to seize the incoming mild from even greater ancient, far away astrophysical sources: quasars whose light has been travelling towards the Earth for at least 7.8 billion years — objects that are relatively a ways away and yet are so luminous that their mild can be located from Earth. On Jan. 11, 2018, "the clock had just ticked past nighttime neighborhood time," as Kaiser recalls, when about a dozen individuals of the crew gathered on a mountaintop in the Canary Islands and started amassing information from two large, 4-meter-wide telescopes: the William Herschel Telescope and the Telescopio Nazionale Galileo, both located on the equal mountain and separated via about a kilometer. One telescope focused on a particular quasar, whilst the different telescope appeared at every other quasar in a specific patch of the night time sky. Meanwhile, researchers at a station located between the two telescopes created pairs of entangled photons and beamed particles from each pair in contrary directions toward every telescope. In the fraction of a 2nd before each entangled photon reached its detector, the instrumentation determined whether or not a single photon arriving from the quasar used to be extra pink or blue, a dimension that then mechanically adjusted the angle of a polarizer that finally received and detected the incoming entangled photon." (see [21]) Therefore such a discovery has opened up a new way to look at the Universe: an entangled Cosmos.[22,23]

Concluding remarks

In the present paper we review our previous result on consistent derivation of Maxwell equations in Q-space. In accordance with Gersten, we submit the viewpoint that the Maxwell equations yield wavefunctions which can be used as guideline for interpretation of quantum mechanics. The one-to-one correspondence between classical and quantum wave interpretation here actually can be expected not only in the context of Feynman's derivation of Maxwell equations from Lorentz force, but also from known exact correspondence between commutation relation and Poisson bracket [2,4].

A somewhat unique implication obtained from the above results of Maxwell equations in Quaternion Space, is that it suggests that the helical solutions, especially if we consider the real physical meaning of A vector from R. Bass. Further implications, include possibility of faster than light entities, which seem to have been supported by a recent experiment of (quantum) cosmological entanglement.

In the present paper we only discuss our result on derivation of Maxwell equations in Quaternion Space using the decomposition method, and its implications [4,5]. Further extension to Proca equations in Quaternion Space seems possible too using the same method [5], but it will not be discussed here.

This proposition, however, deserves further theoretical considerations. Further observation is of course recommended in order to refute or verify some implications of this result.

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