Ontological Quantum Mechanics as the Principal Branch of Quantum Theory and the Ontological Source of Fundamental Quantum Physics

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Abstract

Due to its statistical nature, the Standard Model runs into fundamental limitations: it denies the objectivity of a particle's location and velocity at the same time, is unable to provide three-dimensional visualization of the inner structures of particles and their three-dimensional spacetime dynamics, and cannot describe and visualize the process of decay and the formation of new inner structures.

It is shown here that Statistical Quantum Mechanics (SQM) and Ontological Quantum Mechanics (OQM) are two branches of the overall quantum theory, where OQM is the principal and deeper branch.

The ontological branch of quantum theory overcomes the limitations of the statistical branch with elegancy, intuition, and basic mathematical formalism.

OQM has opened the floodgate of ontological quantum physics far beyond the Standard Model, bringing back intuition and dramatic simplification of mathematical formalism at least on initial stage of its development. It leads to fundamental scientific discoveries at every turn in particle physics.

OQM represents an initial effort at the explanation of causality in quantum processes and particle-particle interactions.

OQM has expanded our fundamental understanding of quantum reality by including two new fundamental categories, the aphysical matter and the universal elementary consciousness. It offers three-dimensional inner structure design with perfect geometry for each class of elementary particles, provides visualization of individual particle dynamics in spacetime, describes the process of decay and the formation of new inner structures. It explains the origin of self-mass and explains the fundamental role of spin as the generator of self-mass for each class of elementary particles. It solves all known quantum enigmas, including the collapse of the wavefunction, the double-slit experiment, and the non-radiating orbiting electron. It provides an ontological explanation for the anomaly in the electron magnetic moment. Quantum mechanics is no longer enigmatic.

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Keywords

Keywords: quantum reality, ontology, aphysical matter, charged c-ring, energy c-ring, c-link, host, a-fraction, aphysical cylinder, universal elementary consciousness, proto-consciousness, inner structures, position parameter, fundamental constant U, self-mass, spin, self-entanglement, inverted electromagnetism

1. Introduction

Quantum Mechanics stands as a remarkable scientific achievement of the 20th century, opening a window into quantum reality. At the 5th Solvay Conference (1927), the Copenhagen Group declared that Quantum Mechanics is complete. Albert Einstein disagreed, stating repeatedly over many years that (1) Quantum Mechanics is certainly imposing but is not a complete theory; (2) as a statistical theory, quantum mechanics does not provide a complete description of the individual system; (3) and if the statistical quantum theory does not pretend to describe the individual system (and its development in time) completely, then it is unavoidable to look elsewhere for a complete theory (see Einstein quotations in Appendix 2).

2. Ontological Quantum Mechanics is the Principal Brunch of Quantum Theory

As our research shows, there is a strong indication that the most important branch of quantum theory and quantum physics is the ontological branch. It has been missing from the time of the 5th Solvay Conference (1927).

It is our view that Ontological Quantum Mechanics (OQM, previously called Aphysical Quantum Mechanics [1,2,3,4,5], is the principal and deeper branch of the overall quantum theory, and Statistical Quantum Mechanics (SQM) is its minor but valuable branch.

In Newtonian traditions, the introduction of OQM is intuitive and requires only basic mathematical formalism at least in the initial stage of its development.

OQM has opened the floodgate of new physics—ontological quantum physics far beyond the Standard Model, resulting in new fundamental scientific discoveries. Some examples presented in this study include inner structures of perfect geometry for the fundamental electron and the photon. The electron we know as a fundamental fermion—it is not. The electron is a composite fermion consisting of a fundamental (intrinsic) electron and an electron neutrino [3].

3. Quantum Mechanics at Crossroads

At the onset of the 20th century, prior to the 5th Solvay Conference, quantum mechanics had faced a pivotal crossroads—it could have advanced along either the statistical or the ontological path or both. By then, Einstein's special relativity and classical electrodynamics were firmly established and well understood. Various electron models had been proposed and studied. As Einstein stated, "You know, it would be sufficient to really understand the electron" (see Q.1 in Appendix 2).

The charged spinning sphere, a promising model of the electron, was proposed by Abraham in 1902 and studied for many years. The charged spherical model produces electro-magnetostatic energy (self-mass), spin, and magnetic moment, although with values substantially below experimental data. Moreover, the model is unstable—it would explode in the direction of the poles. The only stable portion of the model is a small region around the equator (see Figure 1). Had the fundamental importance of this stability region been recognized prior to the 5th Solvay Conference, it could have led to the discovery of *the charged c-ring*, the principal component of the electron inner structure [3,4,5] (also see Figures 2 and 3). A detailed description of *the charged c-ring* and its properties is presented in Appendix 1. It was just a purely historical contingency that this discovery had not been made in time for the 5th Solvay Conference.

The early discovery of the charged c-ring would have changed the historical trajectory of quantum mechanics. Its development would have proceeded along both statistical and ontological trajectories.

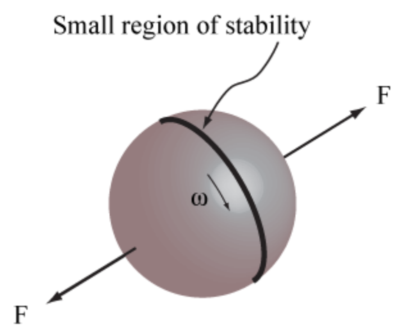

Figure 1. The charged spinning sphere studied by Abraham in 1902 and others.
The sphere explodes in the direction of the poles, where electrostatic repulsive force F is unopposed by magnetostatic force. The fundamental significance of the small region of stability in the equator area is overlooked.

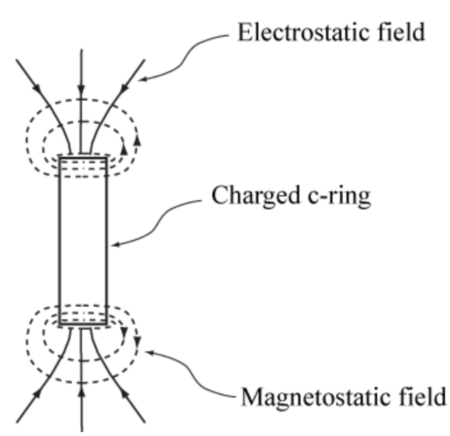

Figure 2. Side view of the charged c-ring and its electro-magnetostatic field configuration
(for detailed electrodynamic description of the charged c-ring, see Appendix 1).

4. Foundational Principles of Ontological Quantum Mechanics (OQM)

We are arriving at a surprising and mindboggling conclusion that the most important body of scientific knowledge in quantum physics has yet to be discovered. Same as Newtonian (ontological) classical mechanics, Ontological Quantum Mechanics in its introduction is more intuitive, requiring only basic mathematics. OQM promises to bring fundamental simplicity to quantum physics.

Here are some foundational principles of Ontological Quantum Mechanics (OQM):

A. Visualization

One of the core principles of OQM is three-dimensional visualization of individual particles and their individual quantum spacetime dynamics in the human mind, including visualization of the process of particle decay and the follow up the formation of new inner structures. Physics without three-dimensional visualization of individual quantum processes in the human mind has no future, or at the minimum cannot pretend on a premiere role.

B. Three Fundamental Categories of Quantum Reality

OQM expands dramatically the fundamental understanding of quantum reality. According to OQM, quantum reality consists of three fundamental categories: the physical matter, the aphysical matter (or the aphysical substance), and the universal elementary consciousness. Universal elementary consciousness always resides in the physical matter. The universal elementary consciousness is the lowest level of consciousness in Nature. It is the proto-consciousness.

C. Universal Constant U

The elementary particle has both physical matter (physical substance) and aphysical matter (aphysical substance) with ratio of $U = P/A$, where P and A represent physical matter and aphysical matter, respectively. U is the universal fundamental constant. Its value is to be determined in the future. The universal elementary consciousness resides always in the physical matter of every individual elementary particle, including charge-free electromagnetic waves.

D. Aphysical Matter Category

As with the physical matter category, the aphysical matter category has its own laws, fundamental constants, inner structures, and properties. The subject is only partially presented here (for complete presentation see [1,2,3]).

E. Conservation Law of Physical Matter and Aphysical Matter

The law of conservation of aphysical matter runs in parallel with the law of conservation of physical matter. In the interaction of two quantum entities, the transfer of aphysical matter is proportional to the transfer of physical matter. The ratio of physical matter to aphysical matter is always consistent with the universal constant U for primary and secondary quantum entities before and after the interaction.

For example, in the collision of two high energy particles resulting in the production of secondary particles, aphysical matter A is transferred and distributed proportionally to the transfer and distribution of physical matter P among primary and secondary particles. Consequently, the total amount of A and the total amount of P, before and after the interaction, remain unchanged in accordance with the law of matter (energy) conservation.

F. Some Properties of Aphysical Matter

Aphysical matter has no intrinsic inertial, gravitational, and relativistic properties. In its "outward" mode, an aphysical entity travels with the speed of its host never exceeding the speed of light. In the case of self-entanglement (see Section M) in its "inward" or reconstruction mode, an aphysical entity travels instantaneously towards its host, regardless of how vast a distance separates the individual aphysical fraction and the host (see Figure 6 and for more explanation, see Section M).

G. Aphysical Matter as the Origin of Interference and Diffraction

An aphysical-aphysical energy interaction of a particle with periodic structures such as multi-slits or ideal crystals can produce, under certain conditions, self-entanglement (see below M.) and interference or diffraction patterns. In such a process, the physical matter of the particle plays no role. The physical matter of the particle allows for statistical physical detection of interference and diffraction patterns on the detection screen. Physical matter, by itself, has no wave properties.

H. Particles Have Trajectories

All elementary particles traveling in free space have absolutely defined trajectories. A full-fledged particle has a single trajectory. A self-entangled particle has several trajectories, but only the host carries both physical and aphysical entities. All other trajectories carry only aphysical entities, called a-fractions.

I. Complete Definition of Particle in Spacetime

An elementary particle has complete definition, physical and aphysical, in spacetime. A particle, with all its attributes and intrinsic properties, exists objectively in spacetime, whether it is observed or not, measured or not.

At any given moment, a particle has a defined location and a defined velocity. As a quantum statistical principle, Heisenberg's uncertainty principle is not ontologically applicable.

The total definition of location and velocity is ontological quantum reality. It cannot be experimentally proven using a physical interaction. However, aphysical energy has some potential as a measuring tool for experimental demonstration of such reality. The interaction of an aphysical entity with a physical entity has no influence on the physical entity. At the moment of such a physical-aphysical interaction, the aphysical entity instantaneously returns to its host regardless of distance (see Section 6). In the case of a self-entangled photon, this distance could span several hundred light years or even much more, for there is no limit.

The development of aphysical technology and aphysical detectors is required for such experiments, a challenging task for physicists in the future.

J. General Statement on Inner Structures of Elementary Particles

All elementary particles have non-zero size. All elementary particles have three-dimensional inner structures of perfect geometry.

Fermion inner structure consists of the physical charged c-ring(s), the aphysical cylinder(s), and the universal elementary consciousness residing in the physical charged c-ring(s).

Boson inner structure consists of the single physical energy c-ring, the aphysical cylinder and the universal elementary consciousness residing in the energy c-ring. Bosons do not carry charge. Only the charged c-ring carries charge. The charged c-ring is the principal component of the fermionic structure. Energy c-ring and charged c-ring do not mix. W-boson is a fundamental misconception in the Standard Model.

K. Inner Structure of Fundamental Electron

The inner structure of the fundamental (intrinsic) electron consists of a single charged c-ring and a single aphysical cylinder. The intrinsic electron is a fundamental fermion (see Figure 3).

The inner structure of the composite fermion consists of two or more charged c-rings, each matched with its own aphysical cylinder. Universal consciousness resides in each charged c-ring.

The electron, the one we know, is not a fundamental fermion—it is a composite electron [3].

L. Inner Structure of Photon

The photon is a genuine boson. The inner structure of the photon consists of one physical energy c-ring and one aphysical cylinder (see Figure 4). The physical energy c-ring has zero cross-section. It is an absolute requirement of relativity. The photon travels always in space with the speed of light.

The photon-photon cross-section of interaction is zero. The photon is stable. It does not decay and has no path to a transformation into other inner structures. The photon is not a quantum of electromagnetism as claimed by the

Standard Model.

The photon is a quantum of “inverted” electromagnetism (for explanation see Section 7). The photon is not massless. In its energy c-ring, the photon carries energy which is the equivalent of its mass. Its trajectory in space is subject to gravitational force. The photon does not decay—it has no pathway to any transformation.

M. Self-Entanglement Versus Entanglement

A particle, prior to its interaction with periodic structure, such as a multi-slit or ideal crystal, is called “the full-fledged particle”. After interaction with a periodic structure, the particle becomes “self-entangled”, splitting on several aphysical fractions (called a-fractions) and the host, that carries both physical matter and the balance of aphysical matter. The host is connected to each aphysical fraction by a “c-link” (for more explanation see Figures 5 and 6).

A self-entangled particle can be in several different locations at the same time, physically is always in one and aphysically in all the others. Just prior to a physical-physical interaction with a physical entity such as a measuring device, the particle is instantaneously reconstructed to the full-fledged quantum state regardless of distances separating the host from a-fractions, with no violation of special relativity. That explains the quantum enigma—“the collapse” of the wavefunction (for details see Section 6).

N. Spin and its Principal Role

Spin is the actual rotation of an inner structure around a cylindrical axis in three-dimensional space at the Compton angular velocity and the circumferential speed of light. Spin is the mode of existence of elementary particles and is eternal over their lifetimes. Spin is the generator of self-mass. There are no elementary particles without spin. Spin can be visualized in a classical way and can be either obvious or hidden. A particle with spin zero (“hidden spin”) has an inner structure with two equal but opposing spins. The origin of self-mass does not require the Higgs mechanism.

The speed of light has a special significance in the world of elementary particles. It is incorporated into the inner structure of each elementary particle.

The fundamental (intrinsic) electron has spin $\hbar/2$ because only one half of its self-mass (magnetostatic) contributes to spin, whereas the spin of the photon is $\hbar$ because its total self-mass (self-energy) contributes to spin. That is an ontological explanation in its fundamental simplicity.

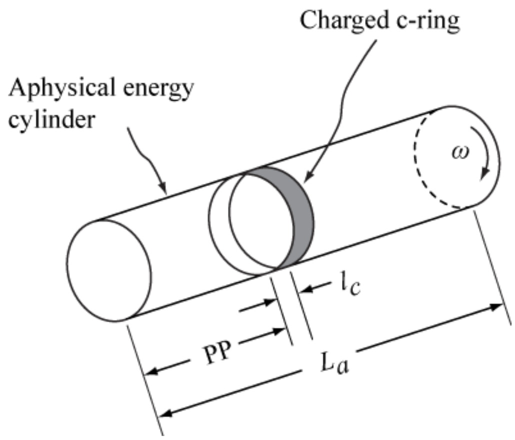

Figure 3. The inner structure of the fundamental (intrinsic) electron.
PP is position parameter of the charged c-ring.

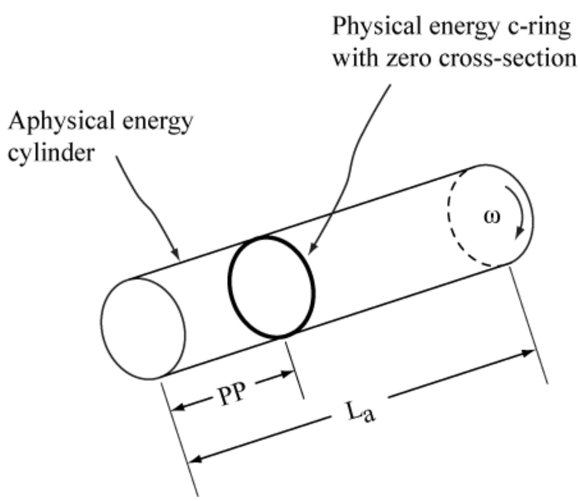

Figure 4. The inner structure of the photon. PP is position parameter of the energy c-ring.

5. Fundamental View: Entanglement versus Self-Entanglement

The phenomenon of entanglement has been studied and is well-known in quantum physics. There are several forms of entanglement such as a pair of entangled particles, condensate of Cooper pairs, Bose-Einstein condensate and Superfluid helium-4 and -3. Entanglement is not a topic of this article and we limit ourselves to its simplest form such as a pair of entangled photons.

Figure 5(a) shows a pair of entangled photons. The splitting of a primary photon into two entangled secondary photons is accomplished by using a non-linear crystal, a technique known in quantum optics as ”spontaneous parametric down-conversion” or SPDC [6,7].

The pair of entangled photons can travel in space over vast distance while preserving their entanglement. Measurement (physical interaction) of one photon instantaneously affects the quantum state of both photons and entanglement is disrupted even if both photons are separated by millions of light years. Both photons are no longer entangled.

Here we introduce a concept of self-entanglement. It is a quite different fundamental situation as compared with entanglement. Let us consider a simple case of self-entanglement as shown in Figure 5(b). Here, a primary photon, called "a full-fledged photon", passes through a double slit. The photon is split into an aphysical fraction ("a-fraction") and "the host", consisting of a physical energy c-ring and the balance of the aphysical substance. The a-fraction is connected to the host with the c-link. The self-entangled system, the host and the a-fraction, can travel in space over vast distance. The cross-section of photon-photon interaction is zero. Therefore, both the host and the a-fraction are not influenced by the cosmic microwave background radiation and remain self-entangled.

The universal constant U remains intact for the system consisting of the a-fraction and host. An attempt to disrupt the c-link by physical interaction with one of the participants leads to instantaneous recovery ("resetting") of the system to the full-fledged state.

That is the fundamental difference between "entanglement" and "self-entanglement". In the case of entanglement, participants can be separated and become independent. In the case of self-entanglement, the participants cannot be separated, and the universal constant U remains intact. The a-fraction cannot be cut off from its host or acquired by another physical entity.

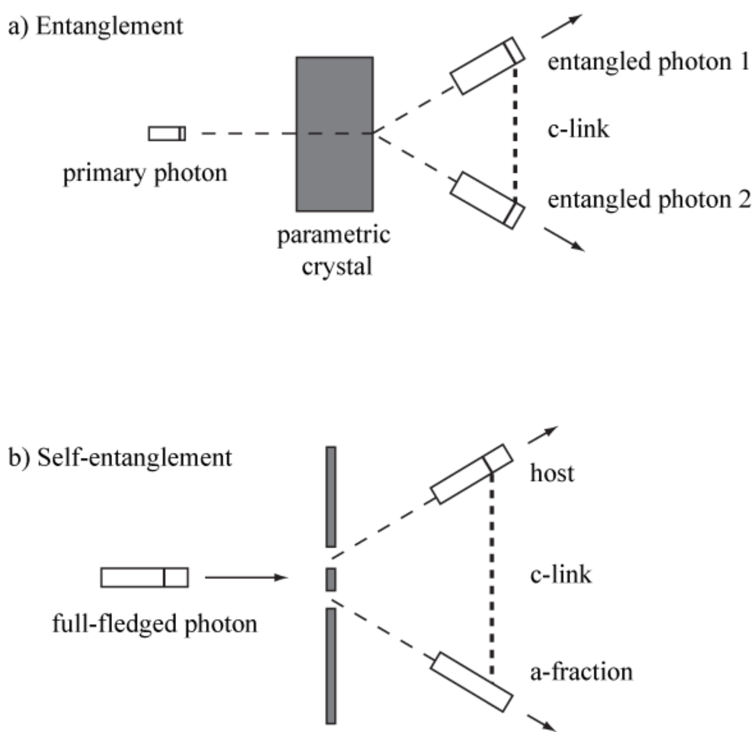

Figure 5. Entanglement (a) versus Self-Entanglement (b).

6. The Ontological Explanation of “the Collapse” of Wavefunction

In Figure 6(a), we present a self-entangled photon traveling in space and consisting of a host and four a-fractions connected to the host by c-links, resulting from the interaction of the full-fledged photon with the five-slit structure in space. The host is on a direct collision with an unknown physical entity (fermion, atom, piece of rock, or measuring device). Just before the host interacts with the physical entity, it recalls in an instant all four a-fractions (as shown in Figure 6(b)), instantaneously transforming itself into a full-fledged photon (as shown in Figure 6(c)). Now the full-fledged photon is ready to proceed toward a physical-physical interaction with the physical entity. It is important to mention, as this spacetime dynamics shows, the universal constant U is preserved. That is the ontological explanation of “the collapse” of the wavefunction, the issue which had been debated for many decades by the founders of quantum mechanics and others with no solution found. This is also an explanation of another quantum enigma such as a particle in several places at the same time.

7. Electromagnetism versus Inverted Electromagnetism

According to the Standard Model the terms “photon field” and “electromagnetic field” are interchangeable [8]. Such statement is a fundamental misconception.

According to OQM, the photon is the quantum of inverted electromagnetism with zero cross-section of its energy c-ring. In fact, electromagnetism and photons are two opposites. Electromagnetism has no space restrictions whereas the photon energy c-ring has zero physical space.

An example of the transformation of the electromagnetism into the inverted electromagnetism is the annihilation of electron-positron pair and production of two gamma-photons:

$$e^- + e^+ \rightarrow \gamma + \overline{\gamma}.$$

Electro-magnetostatic energy of electron-positron pair is transformed into the inverted electromagnetic energy of photon-photon pair called “the inverted electromagnetism”.

In future, quantum physics may show that the cross-section of the photon energy c-ring is extremely small but still not zero. In such case, one should expect a new stage in development of theory of relativity and in upgrading of our understanding of fundamental structure of space and time.

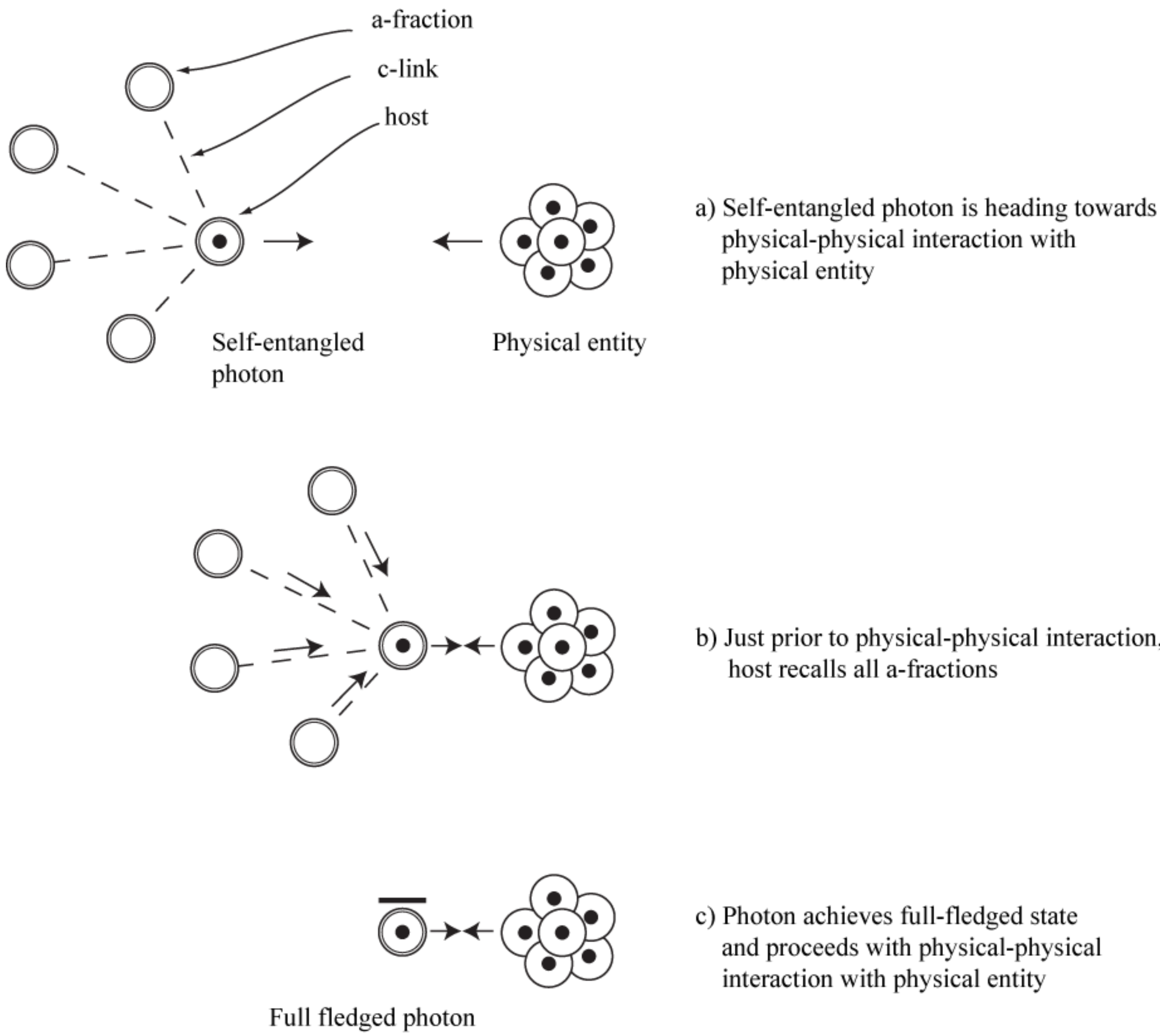

Figure 6. The ontological explanation of "the collapse" of the wavefunction.

Appendix 1. Properties of Charged C-Ring

- The charged c-ring is an infinitely thin, short section of a cylinder made of electrical charge with uniform charge density. The charged c-ring rotates around its axis with Compton angular velocity ω_c and peripheral speed of light *c.*
- The charged c-ring is the principal component of the fundamental electron.
- The charged c-ring is made of a single elementary unit of negative electric charge (-*e*) with uniform charge density distribution. Electric charge is a special state of matter, not yet recognized by science. By itself, electric charge has no self-energy, no gravitational properties, and no inertia.
- The charged c-ring produces two fields: electrostatic and magnetostatic. The fields are described by classical electrodynamics. The repulsive electrostatic force is balanced by the magnetostatic pinch force over the entire

c-ring surface.

- Electrostatic self-energy is equal to magnetostatic self-energy.

  Total self-energy: $E_p = \hbar\omega_c \times 2$,

  Self-mass: $m_{\hat{e}} = 2\hbar\omega_c/c^2$,

  Magnetic moment: $M_{\hat{e}} = e\hbar/4m_H$, where $m_H = \frac{1}{2}m_{\hat{e}}$.
- The charged c-ring spin is equal to $\hbar/2$. Only its magnetostatic self-energy E_H or one half of its total self-energy $E_{\hat{e}}$ contributes to spin. This is the ontological explanation why fundamental fermion has spin ½.
- The length of the c-ring l_c is a fundamental constant.
- The physical charged c-ring model is mathematically accurate, requiring no approximation.

Appendix 2. Relevant Einstein Quotations

Q.1. "You know, it would be sufficient to really understand electron", quoted by Hans G. Dehmelt in his 1989 Nobel lecture.

Q.2. "Within the framework of statistical quantum theory there is no such thing as a complete description of the individual system." Schilpp, P. A., ed. Albrt Einstein: Philosopher-Scientist, The Library Living Philosophers, Evanston, IL,1949, p. 671.

Q.3. "…If the statistical quantum theory does not pretend to describe the individual system (and its development in time) completely, it appears unavoidable to look elsewhere for a complete description of the individual system…". Schilpp, P. A., ed. p. 672.

Q.4. "I am, in fact, firmly convinced that the essentially statistical character of contemporary quantum theory is solely to be ascribed to the fact that this (theory) operates with an incomplete description of physical systems." Schilpp, P. A,. ed. p.666.

Q.5. "Assuming the success of effort to accomplish a complete physical description, the statistical quantum theory would, within the framework of future physics, take an approximately analogous position to the statistical mechanics within the framework of classical mechanics. I am rather of the opinion that the development of theoretical physics will be of this type, but the path will be long and difficult." Schilpp, P. A., ed. p.675

Q.6. "I am therefore inclined to believe that the description of quantum mechanics… has to be regarded as an incomplete and indirect description of reality, to be replaced at some later date by more complete and direct one."- Einstein quoted by John S. Bell, Speakable and Unspeakable in Quantum Mechanics, Cambridge University Press, 1997, page 145.

Q.7. On December 4, 1926, Einstein wrote his famous words: "Quantum mechanics is certainly imposing. But an inner voice tells me that it is not yet the real thing. The theory says a lot, but does not really bring us any closer to the secret of “old one.” I, at any rate, am convinced that He is not playing dice.” – Abraham Pais, Subtle is the Lord: The Science and the Life of Albert Einstein, Oxford University Press, 1982, page 443.

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