

# The Superluminal Interpretation of Quantum Mechanics

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**Abstract:** Here, within the Scale-Symmetric Physics (S-SP), we present a new interpretation of the Quantum Mechanics i.e. the superluminal interpretation (SIQM). Werner Heisenberg used term “the ideological superstructures” to the hidden-variables theory. All known mainstream interpretations of quantum mechanics deserve such a term. It follows from the fact that all mainstream interpretations neglect physical consistency of the 3-dimensional wave functions. A wave function which fills up the Universe cannot be a coherent physical object when distant points of the wave function cannot communicate with superluminal speed. Just period of a local change in the wave function (due to a luminal Standard-Model interaction) cannot be shorter than size of the wave function divided by superluminal speed. The Planck length is the lower limit for size of gravitating particles. Objects with sizes smaller than the Planck length must be non-gravitating so non-relativistic and they must be superluminal. The S-SP, due to the succeeding phase transitions, leads from the objects with sizes smaller than the Planck length (so superluminal) to objects with sizes close to the Planck length (so luminal) and larger. The question is not whether there are in existence some superluminal entanglons responsible for quantum entanglement but why we cannot see their motion directly. And the answer is very simple - just they are not the Standard-Model objects, their size is much smaller than the Planck length and the degree of filling of spacetime is very low.

Here, within the Scale-Symmetric Physics (S-SP), [1], we present a new interpretation of the Quantum Mechanics i.e. the superluminal interpretation (SIQM). More details concerning the quantum mechanics in the S-SP we can find in following papers [1] – [10].

Werner Heisenberg used term “the ideological superstructures” to the hidden-variables theory. All known interpretations of quantum mechanics deserve such a term. It follows from the fact that all mainstream interpretations neglect physical consistency of the 3-dimensional wave functions. A wave function which fills up the Universe cannot be a coherent physical object when distant points of the wave function cannot communicate with superluminal speed. Just period of a local change in the wave function (due to a luminal Standard-Model interaction) cannot be shorter than size of the wave function divided by superluminal speed. The shortest luminal lifetimes are about  $10^{-25}$  s whereas the present-day size of the Universe is about  $10^{26}$  m – it leads to conclusion that there must be in existence a fifth interaction with speed of interaction higher than about  $10^{51}$  m/s. Only then the quantum mechanics can be

physically a coherent theory. Emphasize once more that we must show why lifetime of the local changes in a wave function is shorter than the time of communication between the outermost points of it. Since quantum mechanics is non-local so there must be in existence some superluminal entanglons responsible for the quantum entanglement.

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And the answer is very simple. The Planck length is the lower limit for size of gravitating particles. Objects with sizes smaller than the Planck length must be non-gravitating so non-relativistic and they must be superluminal.

The Scale-Symmetric Physics (S-SP), [1], is based on the succeeding phase transitions of the Higgs field composed of the non-gravitating superluminal pieces of space. Their size is about  $10^{-64}$  m. During the inflation, some of them transformed into the superluminal entanglons responsible for the quantum entanglement (their speed is about  $10^{68}$  m/s, size is about  $10^{-45}$  m and they carry the non-gravitating unitary spin). We can see that sizes of the pieces of space and entanglons are smaller than the Planck length so they are the superluminal objects. We can see as well that the speed of entanglons (about  $10^{68}$  m/s) is much higher than the calculated threshold (about  $10^{51}$  m/s) so in S-SP the wavefunctions are the physically coherent objects. Entanglons are not the Standard-Model objects, their size is much smaller than the Planck length and the degree of filling of spacetime is very low so we cannot see their motion directly (CFD: yes).

In the Einstein General Theory of Relativity we apply formula for the total energy  $E$  of the Standard-Model particles in which mass  $M$  is for inertial mass equal to gravitational mass. Assume that the word 'imaginary' concerns physical quantities characteristic for objects that have broken contact with the wave function that describes state of the Universe. This means that such objects cannot emit some particles. Assume that the pieces of space are the internally structureless objects so they cannot emit some objects. From this follows that the pieces of space have only the inertial mass  $m$ . Substitute  $i c$  instead  $c$ ,  $i v$  instead  $v$  and  $i m$  instead  $M$ , where  $i = \sqrt{-1}$ . Then the formula for the total energy  $E$  of a gas composed of the pieces of space is:

$$E = M c^2 / \sqrt{1 - v^2 / c^2} = - i m c^2 / \sqrt{1 - v^2 / c^2} = m c^2 / \sqrt{v^2 / c^2 - 1}. \quad (1)$$

We can see that now the pieces of space must be superluminal.

The luminal gravitating neutrinos appeared during the inflation as well and are built of the entanglons. The luminal Einstein-spacetime components are the neutrino-antineutrino pairs and they can be free or entangled (then between them are exchanged the superluminal entanglons). It causes that the quantum mechanics which follows from the S-SP is the coherent theory.

In 2005 scientists noticed that a droplet of silicone oil bouncing and surfing (i.e. walking) on the surface of the same liquid which is vibrated vertically, produces ripples on the liquid [11]. It suggests that walking droplets on a bath of vibrating oil mimic many phenomena previously thought unique to the quantum particles.

Consider an electron which is the quantum particle. According to the S-SP, there is the bare electron and the radiation field produced by the created and annihilated virtual electron-positron pair [1]. The bare electron is not a mathematical point. There is the pure electric charge which is the surface of a torus composed of the entangled Einstein-spacetime components. The torus is only a spin-polarized local Einstein spacetime with the external radius equal to the reduced Compton length of the electron – it causes that it is very difficult to detect such torus (just its mass is equal to zero). The torus/pure-electric-charge, due to the

exchanges of the polarized Einstein-spacetime components, produces two masses i.e. the ring overlapping with the equator of the torus and the condensate in the centre of the torus. Such model leads to the precise value of the anomalous magnetic moment [1]. The quantum behaviour of such electron is as follows. Due to the superluminal quantum entanglement, the torus/pure-electric-charge disappears in one place and appears in another one, and so on. In each place in which appears the torus, is produced the ring and condensate which are moving with a mean dynamic velocity  $v$  and expand when torus disappears. The speed  $v$  depends on mean “speed” of the torus (the torus appears and disappears so there are the inverted commas). We can see that distribution of the mass density, energy density and momentum in the field composed of the moving and expanding rings and condensates depends on behaviour of the torus/pure-electric-charge. The torus/pure-electric-charge is the real particle whereas the field composed of the rings and condensates is the real wavefunction of the electron. The moving and expanding rings and condensates produce regions with mass density lower and higher than the mean mass density of the Einstein spacetime – it is the real wavefunction so the square of the absolute value of the wavefunction is a probability density. Can you see the particle-wavefunction duality? An observation of the torus/pure-electric-charge does not cause an instantaneous collapse of the wavefunction concerning the gravitational-mass distribution, in the place of observation of the pure electric charge but due to the superluminal quantum entanglement, the rotational energies of entangled photons can collapse in the point of observation. Emphasize once more that in the S-SP, both the particle/pure-electric-charge and the associated wavefunction are the real objects. The whole object, i.e. the pure electric charge and real wavefunction, can be both mathematical and physical coherent object only due to the superluminal quantum entanglement.

Appearance and disappearance of the torus/pure-electric-charge has higher frequency for its higher mean “velocity” – then, the relativistic mass of electron is greater i.e. the number density of the moving and expanding rings and condensates is higher. The moving and expanding rings and condensates are the non-relativistic objects.

We can assume that the walking oil droplet represents the real pure electric charge whereas the ripples on the liquid represent the real wavefunction. But we can see that there are the big differences i.e. the droplet does not appear and disappear and there is lack of same analog to the superluminal entanglons which are responsible for the cohesion of the whole particle-wave object and responsible for the superluminal quantum entanglement.

We can see that the superluminal interpretation of the quantum mechanics (SIQM) differs from the Copenhagen interpretation (wavefunction is not real), from the de Broglie-Bohm theory (particle plus “pilot” waves (hidden variables); wavefunction never collapses whereas in S-SP, gravitational mass of the real wavefunction does not collapse instantaneously whereas entangled rotational energies can collapse) and from many-worlds interpretation (observation causes that state splits into parallel copies; wavefunction does not collapse).

The wavefunctions of an electron depend on the coordinates and on the z-component of spin but the total spin is fixed. Due to the superluminal entanglons, the resultant spin of all spinning and expanding rings (the rings carry the spin) is fixed (more expanding rings means their lower spin speed and higher radial speed) – it follows from the fact that information about the partial spin speeds is carried by the superluminal entanglons. We can see that due to the superluminal entanglons, the spin part of wavefunction can collapse whereas the part of wavefunction describing distribution of gravitating mass cannot collapse – it follows from the fact that such information is luminal.

We know that the quantized theory of electromagnetic field describes correctly wave-mechanical properties of photons. The question is as follows. Can we describe properties of photons without field quantization i.e. can we replace the quantized field for the photon wavefunction? According to the S-SP, the photons are the rotational energies of the luminal

Einstein-spacetime components which are the carriers of photons. It leads to conclusion that the quantization of electromagnetic field is the very good idea. Moreover, the carriers of photons are not the quantum objects i.e. due to the tremendous non-gravitating energy frozen inside the carriers of photons (about  $10^{119}$  times higher than their gravitational energy [1]), they cannot disappear in one place and appear in another one, and so on. Notice as well that the carriers of photons are the luminal but non-relativistic objects [1]. But we can say about distribution of energy of entangled photons i.e. we can say about wavefunction of entangled photons. With time, due to the superluminal entanglons, distribution of energy in an entangled photon can change so we can say about evolution of entangled-photon wavefunction. Such wavefunction can collapse. The theory of photon wavefunction we can find here [12].

In S-SP, the superluminal quantum entanglement follows from exchanges of the superluminal entanglons.

More detailed considerations show that the superluminal interpretation of Quantum Mechanics (SIQM) is non-deterministic (an object-antioobject pair can transform into physical.object-cosmological.hologram pair), the wavefunctions are real, history is unique, there are not hidden variables, wavefunctions for non-gravitating energy can collapse whereas for gravitational mass cannot, observers are not needed, on assumption that the speed of light is the upper limit the theory is non-local, there are in existence objects which cannot be observed directly i.e. the superluminal pieces of space and entanglons (counterfactual definiteness (CFD): yes), and universal wavefunction does not exist because there are the non-quantum objects.

Notice that the same conclusions appear in the transactional interpretation of quantum mechanics (TIQM) formulated by John G. Cramer in 1986 but the lack of the superluminal entanglons causes that this theory is physically incoherent.

To send superluminal information between entangled particles, at first we must separate them with luminal or subluminal speed.

The superluminal entanglons are, as well, the dark photons which entangle the dark matter particles and which entangle the visible matter with dark matter.

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