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Reduction of the Quantum State in Unitary Quantum Theory

S.I. Konstantinov[1]*, Leo G. Sapogin[2]

[1]*Department of Physical Electronics, Herzen State Pedagogical University of Russia, St. Petersburg , RSC "Energy", Russian Federation.*

[2]*Department of Physics, Technical University (MADI), Moscow, Russia*

Corresponding Author:** ***Stanislav Konstantinov, *Department of Physical Electronics, Herzen State Pedagogical University, Saint Petersburg RSC"Energy", Russia*

Abstract: *The article discusses the Penrose-Diosi model and experiments of underground tests of the collapse of particles of the gravitational wave function, carried out in the mine of the Gran Sasso National Laboratory in central Italy. It is indicated that it is not possible to draw a definite conclusion on the results of the experiment from the standpoint of the Penrose-Diosi model. However, the Unitary Quantum Theory allows to solve in a new way the problem of the collapse of the wave function of particles and to explain the results of the experiment.*

Keywords: *wave function, gravity, wave packet, particle*

PACS Number: *01.10.Fv, 04.50.-h, 12.10.Kt, 95.36. + X, 98.80.-k*

1. Introduction

The experiment of underground tests of the collapse of the gravitational wave function, carried out in August-September 2020 in the mine of the Gran Sasso National Laboratory in central Italy, was intended to confirm the Penrose-Diosi gravitational hypothesis of the resolution of the quantum paradox of a particle capable of being located in two places at once [1]. At the same time, the renowned mathematician of the University of Oxford, Roger Penrose, hoped to eliminate the anthropocentric idea that observation itself somehow leads to the collapse of the wave function [2]. After the experiment, the co-author of the Diosi-Penrose model Catalina Curcianu, an employee of the National Institute for Nuclear Physics in Rome, said: "We should have seen the consequences of quantum collapse in the experiment with germanium, but we do not see them. Gravity, apparently, does not push particles out of their quantum superpositions (the experiment also limited, although did not exclude, collapse mechanisms not related to gravity) "[1]. The question of the collapse of the wave function has long been solved in the Unitary Quantum Theory of Lev Sapogin, and gravity really has nothing to do with it [3].

2. Unitary Quantum Theory and the Collapse of the Wave Function

In modern quantum theory, after the impressive success of Julian Schwinger, who calculated the exact value of the anomalous magnetic moment of an electron, which brilliantly coincided with experiment [4] more than 70 years ago, in our opinion, there are no serious physical successes. Perhaps this happened because specialists in the field of quantum field theory paid main attention to the mathematical formalism, and not to the physical essence of the problem, and because quantum field theory, apparently, is mainly engaged in mathematicians who are very far from physical Problems. In ordinary quantum theory, any microparticle is described by a wave function that has a probabilistic interpretation, which does not follow from the strictly mathematical formalism of nonrelativistic quantum theory, but is simply postulated. And, nevertheless, the mathematical description of a wide variety of quantum phenomena gave such an impressive result that physicists stopped thinking about the physical description of the phenomenon and concentrated all their efforts only on a mathematical description. However, the main problem of the structural representation of the particle remained unresolved. Apparently, the mistake of all attempts to present a particle as a wave function having only a probabilistic interpretation, without a causal component, be it resonance or gravity, was that the packet is built from de Broglie waves. In the Universal Quantum Theory (UQT), it proposes to build a packet of partial waves, and the de Broglie wave appears when, due to resonance, the oscillating amplitude and mass of a quantum object increase, as the envelope of a packet of partial waves. UQT is undoubtedly a new word in the theory of the microworld. Common sense was returned to physics, expelled from it by the principle of Complementarity, formulated by N. Bohr more than 100 years ago. Significant advances in quantum mechanics (especially in stationary cases) were based on simple relationships between the de Broglie wavelength and the geometric properties of potentials. In this case, the particle was formally considered a point, since otherwise it would be difficult to ascribe to the wave function the character of the probability amplitude. But the pinpoint, like the Complementarity principle, did not allow one to move inside the structure of elementary particles, and the further development of quantum field theory within the framework of the accepted paradigm slowed down and ultimately led to a complete fiasco. At present, the standard model does not even have a valid algorithm for calculating the mass spectrum of elementary particles. The CM contains from 20 to 60 arbitrary adjustable parameters (there are different versions of the CM) for calculating the particle mass.. All these bear strong resemblance to the situation with Ptolemaic models of Solar system before appearance of Kepler`s laws and Newton s mechanics. These earth-centered models of the planets movement in Solar system had required at first introduction of so called epicycles specially selected for the coordination of theoretical forecasts and observations. UQT allows calculating the mass spectrum of all still known or hypothetical elementary particles up to the Higgs Boson [3]. And also the solution of a simple scalar version of the basic equation of the UQT for a wave packet made it possible to give a theoretical calculation of the elementary electric charge and the fine structure constant (α) of elementary particles [3]. According to the UQT, particles as bunches (wave packets) of a real field are determined by the structure function and can be decomposed into plane sinusoidal waves using the Fourier series transformations. The structure is represented here as a harmonic amplitude-frequency function (spectral representation). Quantum packing becomes classical with increasing mass and quantizing mass in a delicate balance between dispersion and nonlinearity. The particle moves according to the classical laws of motion, and each packet is governed by quantum laws [3]. The physical meaning of this extremely fast oscillatory process lies in the fact that after external action on the quantum vacuum, which is a global field of superpositions of oscillators with a continuum of frequencies, a wave packet appears in it, oscillating like a membrane or a string. The frequency of these free vibrations is very high: it is proportional to the rest energy of the particle and is equal to the frequency of the so-called Schrödinger jitter ("zitter-bewegung") $\omega_S = \frac{mc^2}{\hbar\gamma}$, $\gamma=\sqrt{1-v^2/c^2}$. The calculations show that the envelope wavelength is exactly equal to the de Broglie wavelength, and the dependence of this wavelength on the packet speed is the same! Inside the movement, de Broglie oscillations occur with a frequency $\omega_B = \frac{mv^2}{\hbar\gamma}$ due to dispersion. At low energies $\omega_S >> \omega_B$ and the presence of fast natural vibrations, all quantum phenomena that arise as a result of de Broglie oscillations are not affected. In the case when $v \to c$, frequency $\omega_B \to \omega_S$, $\gamma \to 0$ (resonance frequency ω_r), the phenomenon of energy and resonance growth occurs, which leads to an increase in the oscillating amplitude and an increase in the mass of a quantum object $m_r = \hbar\ \omega_r / c^2$. The standard graph of the dependence of the particle's mass on its speed is now simply half the amplitude-frequency characteristic of the forced oscillations of a harmonic oscillator with no dissipation, and the mass growth is absolute [3]. With this approach, the mechanism of creation and decay of particles becomes completely natural, as is the fragmentation of wave packets. In this approach, all interactions and all processes occurring with microparticles are the result of a single process of diffraction and interference of packets on each other due to nonlinearity. Moreover, the operator description of matter in the standard approach of relativistic quantum theory is completely unsatisfactory. Let us describe the behavior of an electron in an atom (including the germanium atom participating in the experiment) from the standpoint of the Unitary Quantum Theory. In the new model of the atom, proposed by Professor Lev Sapogin, the electrons inside the atom do not fly in orbits, as in Rutherford's planetary model, but represent a standing electromagnetic wave that has no orbit and coordinates, but has a certain frequency and amplitude. In this case, the quantization of the energy levels (orbitals) of electrons in the atom is explained by the distribution of nodes and antinodes in the standing wave of the electron, and the integer number of de Broglie's wavelengths should be located in the diameter of the orbital, and not in the circumference of the electron orbital as de Broglie suggested. In the probabilistic description of the electron as a standing wave or as an electron cloud, spin has no classical analogies. Thus, for a complete characterization of the state of an electron in an atom, four quantum numbers are required. This idea was experimentally confirmed in 1927, when the phenomenon of electron diffraction was discovered. However, the discovery of the mysterious K-capture of an electron, when the nuclei of atoms of some isotopes of chemical elements somehow sometimes capture an electron from the inner (K- or L-) electron shell of the atom, raised new questions. Within the framework of quantum mechanics, it turned out to be impossible to explain the mechanism of such capture of an electron by the atomic nucleus, and Lev Sapogin's Unitary Quantum Theory (UQT) made it possible to solve this problem. allowing the tunneling of electrons through the nucleus of the atom [3]. Lev Sapogin explained tunneling by the fact that the electric charge of an elementary particle is not constant in time, but periodically changes (oscillates) with a monstrously high frequency, the so-called Schrödinger's jitter ("zitter-bewegung"), then increasing to a maximum, then decreasing to zero in the harmonic the law. Therefore, quantum theory operates with time-averaged quantities of the effective charge of a particle and its mass, which also oscillates in time according to a harmonic law in the range from zero to a maximum [3]. For tunneling to occur, the particle must approach the potential barrier in the phase when the amplitude of the wave packet is small, and the particle, in the absence of charge, overcomes the barrier, "not noticing" it. At another stage, when the amplitude of the wave packet is large, nonlinear interaction begins, and the particle can be reflected from the barrier. Professor Sapogin claims that being in the K-orbital closest to the nucleus of an atom, the electron makes quantum jumps within the orbital not randomly, as physicists thought, but through the nucleus of the atom, each time tunneling through it. It successfully tunnels due to the fact that at this moment it is in the “zero phase”, at which the instantaneous values of the charge and mass of the electron are close to zero, and therefore, by virtue of the law of conservation of momentum, at this time must develop a very high speed of movement through the nucleus atom. We believe that the proof of the correctness of this point of view is the fact that the electronic orbitals of the P- and d-states of the atom have the form of eights with nodal points in the nucleus of the atom (Figure 1).

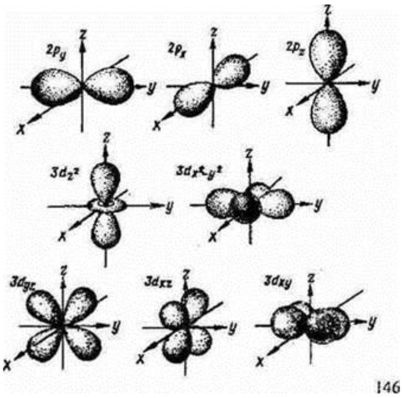

Figure1. *Forms of electron clouds for different states of electrons in atoms*.

Since the regions allowed by quantum mechanics for the presence of an electron in them are only the inner regions of these orbitals, then in order to get from one half-branch of the “figure of eight” to the opposite, an electron must slip through the atomic nucleus. This allows us to take a fresh look at the mechanism of the mysterious K-capture of an electron in an atom. As is known, electron capture consists in the fact that the nuclei of atoms of some isotopes of chemical elements in some mysterious way sometimes capture an electron from the inner (K- or L-) electron shell of the atom. Physicists have long been tormented by the question of how such a capture is accomplished if the electron in the atom, according to existing concepts, is very far (on nuclear scales) from the nucleus. But if an electron, according to Sapogin, constantly tunnels through the nucleus of an atom, then everything becomes clear. After all, any accidental fluctuation in the motion of an electron or nucleus can disrupt tunneling, and then the electron is either captured by the nucleus, or nonlinear interaction begins, and the particle can be reflected from the barrier. In this case, not the entire electron is captured, but only its electric charge and most of the mass, which are attached to one of the positively charged protons P of the nucleus, which turns into a neutron N, the mass of which is greater than the mass of the proton. But the remainder of the electron in the form of an electron neutrino ν_e flies out far beyond the atom. Physicists assume that in this case a process is taking place in the nucleus of an atom:

$$P + e'' \longrightarrow N + \nu_e \quad (1)$$

which, however, has never been observed in experiments on the bombardment of protons by beams of accelerated electrons [3].

As a result of K-capture, the total positive charge of the nucleus decreases by one (in units of the proton charge). Therefore, the nucleus during K-capture is transformed into the nucleus of an atom of one of the isotopes of a chemical element, which is in front of the original chemical element in the periodic table. True, the nuclei of atoms by no means all isotopes can undergo such a transformation. It is realized only when the selection rules and conservation laws existing in nuclear physics are fulfilled. In particular, the sum of the masses of the original nucleus and the electron must be greater than the mass of the resulting atomic nucleus. The proof of the correctness of our understanding of electron capture is the presence of the phenomenon of internal conversion of electrons in the atom. It consists in the fact that when the selection rules prohibit the emission of a γ-quantum by an excited nucleus of an atom, then the excitation is most often removed due to the transfer of the excitation energy of the nucleus to the electron of the atomic shell. The transferred energy is so high (up to MeV) that tens of electrons are knocked out of the atom. Until now, the mechanism of transfer of excitation from the nucleus to the electron of the atomic shell has been a mystery to physicists. Earlier, it was mistakenly believed that excitation to an electron is transmitted by a γ-ray emitted by the nucleus, but it turned out that such radiation is prohibited by the existing selection rules. Therefore, it remains only to assume that the excitation from the nucleus to the electron of the atomic shell is transmitted when, in accordance with UQT, this electron penetrates the nucleus of the atom [3].

In the UQT, the foundations of the theory of interaction of a microparticle with a macrodevice are laid and the role of an observer in a physical process is considered. In this case, the probable interpretation of the wave function is not postulated, as in the relativistic quantum theory, but strictly follows from the mathematical formalism of the UQT. In ESA, the theory of quantum measurements has been developed [3, 6, 7] and the statistical interpretation now follows from the theory, and not just postulated, as in the usual quantum theory, while the value of the variance of vacuum fluctuations should be finite. In macrodevices of any type, atomic nuclei and electron shells are close to each other and form a very numerous, but discrete series of them. The transition from one such state to another is a quantum leap. Therefore, the absorption and emission of energy between atomic systems occurs in quanta. All quantum measurements are ultimately based on energy absorption and are irreversible processes. For any device that detects a particle to work, you need at least a quantum of energy this is the threshold energy of the device that determines its sensitivity. Consider the process of interaction of a particle with a macro device. Since a particle is a wave packet, its energy is proportional to the packet intensity, and it can change the amplitude of oscillations due to periodic oscillations with a monstrously high frequency, the so-called Schrödinger's jitter ("zitter-bewegung"), then increasing to a maximum, then decreasing to zero according to the harmonic law. In addition, the packet itself can be fragmented when interacting with the device. In order for a macro device to fix a particle, it must wait until the total energy of the particle and the fluctuation of the vacuum are greater than or equal to the threshold energy. It is clear that the probability of instrument triggering will be proportional to the amplitude of the wave packet, or, more precisely, to the intensity of the envelope of the wave function. In the UQT, the equation with an oscillating charge is essentially Newton's equation for the movement of a charge in an external potential, but the amount of charge depends on time, velocity and coordinates [3]. When solving the problem of a harmonic oscillator, in addition to the usual stationary solutions, 2 more new solutions arise (Fig. 2), which were named Crematorium and Maternity Home.

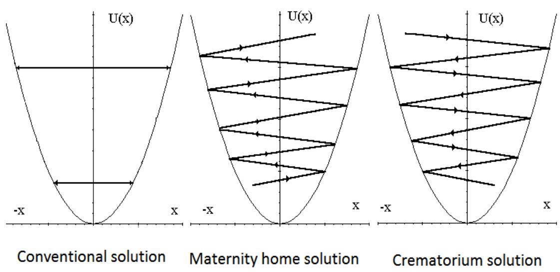

Figure2. *UQT solutions for particle oscillations in a potential well*

In the first solution, the particle oscillates in a potential well with an exponential decrease in energy, and in the second solution, its energy increases (for a parabolic well, it is unlimited).

The autonomous movement equation in the case of a potential well in the shape of hyperbolic secant $U(x) = -Uo\ \mathrm{sech}(x^2)$ will look as follows:

$$m\frac{d^2x}{dt^2}+\frac{4U_0Qx\cos^2\left(-mx\frac{dx}{dt}+\varphi_0\right)\sinh(x^2)}{\cosh^2(x^2)}=0 \quad (2)$$

where *x* is the coordinate of the particle as a function of time;

m, Q, φ_0 is mass, charge and initial phase of the particle.

It turns out that the nature of the trajectory of a particle under the same initial conditions depends very strongly on the initial phase [3].

At $\varphi_0 = 0.1$, the particle rolls into the hole and is reflected with greater energy. Under the same initial conditions and at $\varphi_0 = 0.2$, an oscillation of a particle in the well with almost the same energy is observed, and at $\varphi_0 = 3.2$, an increase in oscillations inside the well (Maternity Home) is observed up to an energy sufficient to exit the well [3]. Where does the electron in the potential well get additional energy, thereby violating the law of conservation of energy? Of course, from vacuum fluctuations. But the fluctuation of the vacuum in this case is caused by the fact that the electron is in a nonequilibrium state. The so-called vacuum fluctuations represent a quantum vacuum in an excited (polarized) state. At the same time, returning to its lowest energy level, the quantum vacuum gives up energy to baryonic matter. Professor I. Prigogine, Nobel laureate, called this effect "an active influence on the system from the outside with the transition of the system to a nonequilibrium state." I. Prigogine explains Mach's principle and comes to the conclusion that: “In a steady state, active influence from the outside on the system is insignificant, but it can become very important when the system passes into a nonequilibrium state, time loses its invariance and its behavior is probabilistic. In this case, the system becomes non-integrable ”[8]. This means that under the active influence from the side of the quantum vacuum, the wave function collapsed, the quantum state was reduced and a particle was born, which was fixed by the device [9].

3. PENROSE-DIOSI SCHEME

In the Penrose-Diosi scheme, it is assumed that if the system is prepared in the form of a superposition of two quantum states with different spatial localization of a massive particle, this entails a superposition of the corresponding space-time curvatures, as in this diagram (Fig. 3) [1].

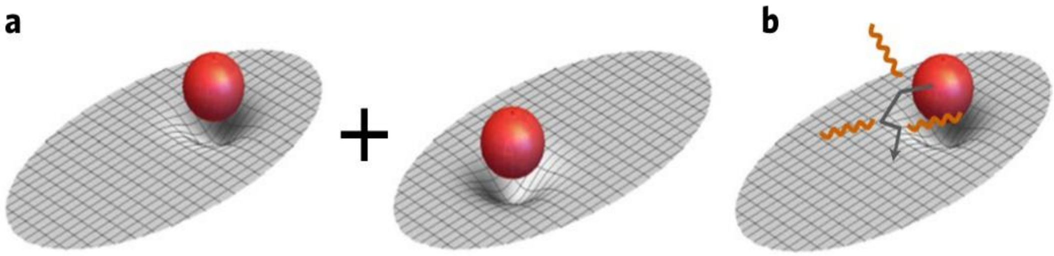

Figure3. *Model of the gravitational collapse of the wave function for the superposition of quantum states (Diosi-Penrose scheme, DP) and the appearance of excess radiation due to the Brownian motion of particles. Donadi et al., Nat. Phys. (2020).*

The quantum theory of gravity is still at the very beginning of its development as a science, and the force of attraction is outside the field of quantum mechanics. It is assumed that with adequate allowance for the forces of attraction, the quantum-mechanical principle of linear superposition of states (the basic postulate of quantum mechanics) should at least undergo changes. According to General Relativity, gravity manifests itself as a curvature of space-time at the location of a massive body. However, such a superposition of curved sections of space-time, according to Penrose and Diosi, is unstable and tends to collapse. They gave independent estimates of the characteristic collapse times of such superpositions of states of massive particles due to the curvature of spacetime. It is intuitively clear that the greater the mass of the particles and the smaller the distance between them, the shorter this decay time of the state. For example (this is an experimental scheme proposed in one of Penrose's works): with masses of the order of 10^{-12} kg and reasonable atomic distances between particles, such times should be measured in milliseconds, which is quite measurable. But for ordinary molecular masses (10^{-25} kg), the characteristic values are far beyond the experimental possibilities. Work in this direction, including experimental ones, is being conducted today and various options for creating quantum gravitationally interacting systems are being considered - for example, the use of macromolecules, tricks with the states of phonons (collective vibrations of atoms in the crystal lattice), etc. Later, in 2014, Roger Penrose in the article "Reducing the Quantum State" specifies: "the case of "gravitational" quantum theory is at least as strong as for the quantum theory of gravity. Accordingly, the principles of general relativity should influence and actually change the very formalism of quantum mechanics. In particular, we need an "Einstein's" rather than a "Newtonian" interpretation of gravitational fields. The field must be accepted, in a quantum system, for the principle of equivalence to be fully fulfilled. This leads to the hypothesis that quantum superpositions of states suggesting significant mass displacement should have a finite lifespan, as suggested earlier by Diosi and the author." However, so far, the hypothesis has been impossible to test with any realistic technology, said Diosi, currently at the Wigner Research Center and co-author of the new study. "In my country, for 30 years, I have been constantly criticized for talking about something completely unprovable." New methods make proof possible. In a new study, Diosi and others have tried to figure out one of those many ways, be it gravity or some other mechanism, by which quantum collapse manifests itself. The authors have proposed indirect methods for measuring the alleged "gravitational collapse" effect of a quantum state. It is used that such an effect should lead to additional chaotic movement, that is, Brownian motion of particles, which can be fixed in different ways. In particular, this should generate additional heat, and this heating can be theoretically estimated and measured. Another method used in the work is that if the particles have an electric charge, then their accelerated motion should cause additional electromagnetic radiation (as in an X-ray tube). Professor Lev Sapogin in his Unitary Quantum Theory noted: "If, when accelerating a charge, the force acting on the charge itself is taken into account, then braking occurs due to radiation. In different works, this effect is called differently: the Lorentz friction force or Planck's radiant friction. This force is proportional to the third time derivative of the x coordinate and was experimentally proven many years ago. If we write down the equations of motion for a charge moving in space free from external fields, and if the only force acting on the charge is "Planck's radiant friction", then we get the following equation of motion:

$$m\frac{d^2x}{dt^2} = \frac{2e^2}{3c^3}\frac{d^3x}{dt^3} \qquad (3)$$

It is evident that equation in addition to trivial particular solution v=dx/dt=Const has general solution where particle acceleration is equal:

$$\alpha = \frac{d^2x}{dt^2} = C\exp\left[\frac{3mc^3t}{2e^2}\right] \qquad (4)$$

i.e. is not only unequal to zero, but more over it unrestrictedly exponentially increases in time for no reason whatever!!! [3].

L. Landau and M. Lifshitz in their classic book "Field Theory" write the following about this: "The question may arise of how electrodynamics satisfying the law of conservation of energy can lead to an absurd result in which a free particle increases its energy. The roots of this are in the infinite electromagnetic "own mass" of elementary particles". I will allow myself to disagree with the classics. In the new physics, the recognition of quantum vacuum (dark matter) in the theories of quantum electrodynamics (QED) and quantum chromodynamics (QCD) leads to the violation of symmetries, conservation laws and prohibitions in the Standard Model.

4. Experiment and its Results

To test this idea, researchers used a detector made of a germanium crystal in the form of a cylinder about 8 cm in size. The purpose of the experiment was to search for excess X-ray and gamma radiation from protons in germanium nuclei, which creates electrical impulses in the material. It is this part of the spectrum that makes it possible to maximize the amplification of the effect under experimental conditions. A germanium crystal was placed in a lead sheath and placed this experimental setup 1.4 kilometers underground at the Gran Sasso National Laboratory in central Italy to protect it from other sources of radiation, primarily from cosmic rays (Fig. 4) [1]. The only unavoidable source of radiation, the contribution from which can be taken into account independently, remains the radioactive elements in the rock surrounding the installation. Over the two months in 2014 and 2015, 576 photons were detected, which is close to the 506 average expected from natural radioactivity in this environment. By comparison, Penrose's model predicted 70,000 of these photons. "We should have seen the effects of quantum collapse in the germanium experiment, but we are not," said study co-author Cătălina Curceanu of the National Institute for Nuclear Physics in Rome. This suggests that gravity, apparently, does not push particles out of their quantum superpositions (the experiment also limited, although did not exclude, collapse mechanisms not associated with gravity) [1].

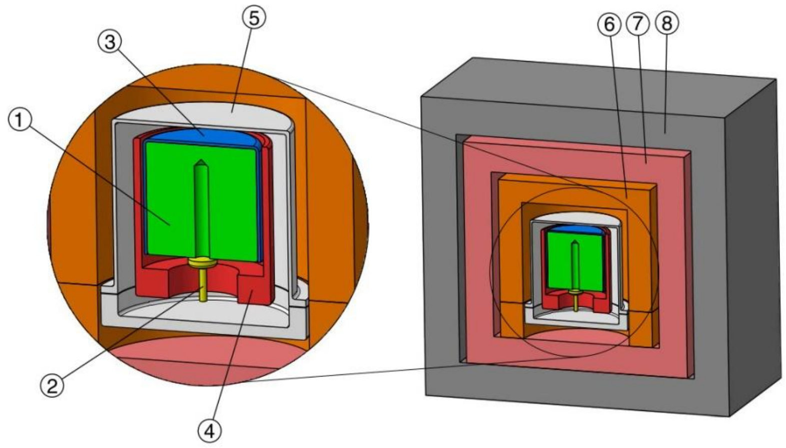

Figure4. *An experimental setup for measuring the spontaneous emission of germanium atoms (the diagram shows a green cylinder about 8 cm in size, shielded by a copper and lead sheath). Donadi et al., Nat. Phys. (2020).*

Confirming the result requires constructing superpositions of states directly, rather than relying on random natural phenomena, says Ivette Fuentes of the University of Southampto: "Basically, you need to learn to create superpositions of quantum states from massive particles. And we are working in this direction." She says her team is working to create clouds of 100 million sodium atoms at temperatures just above absolute zero.

A team of researchers from Germany, Italy and Hungary has tested a theory that suggests gravity is the force behind quantum collapse and has found no evidence to support it. In their paper published in the journal Nature Physics, the researchers describe underground experiments they conducted to test the impact of gravity on wave functions and what their work showed them. Myungshik Kim, with Imperial College London has published a News & Views piece in the same issue, outlining the work by the team and the implications of their results. Quantum physics suggests that the state of an object depends on its properties and the way it is measured by an observer; the thought experiment involving Schrödinger's cat is perhaps the most famous example. But the theory is not universally accepted—physicists have wrangled for many years over the notion, with some arguing that it seems a bit too anthropocentric to be real. Behind the theory is the concept of waveform collapse, by which the observation of a particle, as an example, makes it collapse. To help make sense of the idea, some physicists have suggested that the force behind waveform collapse is not a person taking a look at a particle, but gravity. They suggest that gravitational fields exist outside of quantum theory and resist being forced into awkward combinations such as superpositions. A gravitational field forced to do so soon collapses, taking the particle with it. In this new effort, the researchers devised an experiment to test this theory in a physical sense. The experiment consisted of building a small crystal detector made from germanium and using it to detect gamma and X-ray emissions from protons in the nuclei of the germanium. But before running the experiment, they wrapped the detector in lead and dropped it into a facility 1.4 kilometers below ground level at the Gran Sasso National Laboratory in Italy to prevent as much extraneous radiation from reaching the sensor as possible. After two months of testing, the team recorded far fewer photon hits than theory would suggest—indicating that the particles were not collapsing due to gravity, as theory had suggested. There is no radiation in the experiment, since the quantum-mechanical principle of linear superposition of states in the theory of quantum gravity, which differs from Einstein's geometric theory of gravity, should not undergo changes.

5. Rejection of the "Einstein's" Interpretation of the Gravitational Field in the Light of "New Physics" and Roger Penrose's Mistake

In the article I showed that to apply Einstein's General Theory of Relativity for describe irreversible processes (namely, the collapse of the superposition of particle states belongs to such processes), leads to gross errors, and in some cases to catastrophes [9]. The collapse depends on the effective size of the mass density of the particles in the superposition and is random: this randomness manifests itself as a diffusion of particle motion, leading, if charged, to radiation. Einstein's invariant equations of general relativity are unable to describe such irreversible processes. It is known that in his work on the creation of the general theory of relativity, Einstein began with the principle of equivalence (EP), in which he postulated that the acceleration of gravity is indistinguishable from the acceleration caused by mechanical forces [10]. As a consequence, the gravitational mass in Einstein's theory became equal to the inert mass under any conditions. In 1899, numerous decisive experiments by R. von Eötvös made it possible to prove the equality of inertial and gravitational masses with an accuracy of 10^{-9}. Einstein raised this equality to the level of a leading postulate in his attempts to explain both electromagnetic and gravitational acceleration by the same physical laws. This principle predicts the same acceleration for bodies of different composition in the same gravitational field and allowed him to consider gravity as a geometric property of space-time, which led him further to the interpretation of gravity from the standpoint of general relativity [10]. At present, the most accurate result in testing the weak shape of SE belongs to the space experiment “MicroSCOPE” [11]. Researchers from the French center for aerospace research ONERA and the Cote d'Azur Observatory in an experiment carried out on the MICROSCOPE satellite performed a PE check with a record accuracy of $\Delta \sim 10^{-14}$ [11]. The equivalence principle is always checked for equilibrium systems. As soon as researchers became interested in non-equilibrium systems, a violation of PE was found [12]. Johannes Kepler was the first to discover the violation of PE when calculating the value of "Kepler's constant" for the planets of the solar system. Johannes Kepler formulated his laws of celestial mechanics on the basis of analysis of long-standing astronomical observations of Tiho de Braga in 1609-1619 and Isaac Newton fifty years later received Kepler's third law, as a consequence of the law of universal gravitation and the second law of dynamics, introducing into the spatial model of the universe the forces of gravity and inertia. This was a brilliant confirmation of the correctness of Newton's theory of gravitation. [12]:

$$K = G_0 M_0 \frac{m\,g}{m\,i} = \frac{R^3}{T^2}. \tag{5}$$

where

m g. is the planet gravitational mass, interacting with the Sun, the M_0 mass, produces a centripetal force of gravity;

m i. is the inertial mass of the planet. It is rotating around a circle of R radius and producing a centrifugal force of repulsion,

R is a average value distance from the centre of the planet to the centre of the Sun,

T is a period of the planet rotation around the Sun,

G_0 is the gravitational constant, K is Kepler’s constant.

Johannes Kepler calculated the value of the constant K for 8 planets:

Earth, Venus, Mars $K = 3.35 \cdot 10^{24}\ km^3 \cdot year^{-2}$

Saturn, Jupiter, Uranus $K = 3.34 \cdot 10^{24}\ km^3 \cdot year^{-2}$ (6)

Mercury, Pluto $K = 3.33 \cdot 10^{24}\ km^3 \cdot year^{-2}$

Note the difference in the meaning of Kepler's constant. For planets of the terrestrial group, rotating along stable, slightly perturbed orbits, K = 3.35, and for Mercury, whose orbit is subject to strong perturbations due to its proximity to the Sun, the value of K = 3.33, that is, 1% less. Since the mass of the Sun (M) and the gravitational constant (G) for all planets in formula (5) is unchanged, the difference in the value of K can be explained only by the inequality of the ratio of the gravitational mass to the inertial mass, that is, a violation of the equivalence principle:

$$\left[\frac{\text{mg Earth}}{\text{m}_i\text{ Earth}}\right] \neq \left[\frac{\text{mg Mercury}}{\text{m}_i\text{ Mercury}}\right]; \quad \Delta(\text{mg} / \text{m}_i) \sim 2 \cdot 10^{-2} \qquad (7)$$

For comparison, the latest experimental data allowed physicists to establish that the possible inequality in relation to gravitational and inertial masses Δ (mg / m_i) for the Earth and the Moon does not exceed $(0.8 \pm 1.3) \times 10^{-13}$. In this case, in the experiments of laser rangefinder of the Moon (LDL), the laser beam was reflected from an array of angular reflectors installed on the Moon by the Apollo astronauts and Soviet lunar rovers. To date, the Earth-Moon-Sun equilibrium system has been adopted as the best model in the Solar System to test the strong form of PE [13].

Today, according to the observations of the Planck Space Observatory, published in March 2013, the dark galactic and intergalactic medium accounts for 95% of the total energy mass of the observed Universe (the remaining 5% is accounted for by ordinary baryonic matter) [14]. For Mercury, whose orbit is subject to strong disturbances due to its proximity to the Sun, there is a violation of the strong principle of gravity, as happens when spherical bodies move in a superfluid turbulent medium of dark matter in new cosmological models. The macroscopic approach, in which the hydrodynamic addition of mass to spherical bodies of any nature (including charged clusters) into superfluid ^{3}He-B (an analogue of dark matter), was outlined by Stokes back in the century before last. It is a complex force F (ω), exerted by the fluid on the sphere of radius R, which performs periodic oscillations with a frequency ω. Within the low Reynolds numbers we have [15]:

$$\boldsymbol{F}(\omega) = 6\pi\eta R\left(1 + \frac{R}{\delta(\omega)}\right)V(\omega) + 3\pi R^2\sqrt{\frac{2\eta\rho}{\omega}}\left(1 + \frac{2}{9}\frac{R}{\delta(\omega)}\right)i\omega V(\omega), \qquad (8)$$

$\delta(\omega) = (2\eta/\rho\omega)^{1/2}$

where ρ - fluid density, η – viscosity, V - velocity amplitude sphere, δ (ω) - the so-called viscous penetration depth, which increases with an increase in viscosity and a decrease of the oscillation frequency.

The real part of the expression (8) is a known Stokes force derived from the movement of fluid in the sphere. Imaginary component (coefficient of iωV) is naturally identified with the effective mass of the cluster added:

$$\mathrm{M}eff\,(\omega R) = \frac{2\pi\rho R^3}{3}\left[1 + \frac{9}{2}\frac{\delta(\omega)}{R}\right] \qquad (9)$$

Origin added (attached) mass Meff (ωR), depending on the frequency ω and the radius R of the sphere of the cluster associated with the excitation of the field around a moving cluster of hydrodynamic velocity υ_i (r) and the appearance in connection with this additional kinetic energy. In superfluid, additional mass has two components: superfluid and normal [15].

Nobel Prize laureate Professor I. Prigogine called this effect "an active influence on the system from the outside with the transition of the system to a nonequilibrium state" [8]. Professor I. Prigogine, explaining the Mach principle, comes to the conclusion: "In a stable stationary state, the active influence on the system from the outside is negligible, but it can become very significant if the system passes into a nonequilibrium state. In this case, the system becomes non-integrable, time loses the property of invariance and its behavior is of a probabilistic nature "[8]. Alternative theories of gravity using scalar fields predict a violation of Einstein's equivalence principle [13]. Within the framework of these theories, it is possible to formulate Mach's principle, according to which the inertia of bodies manifests itself due to the interaction with distributed matter in the Universe [13]. It should be recalled here that after 100 years of the victorious march of the general relativity on the planet, in 2013. it turned out that Einstein in 1915 in his calculations of the perihelion precession of Mercury's orbit, using the field equations of general relativity [16], made a gross error ~ 71.63´´, instead of the expected value 43´´, and this error was not accidental [17]. In 2013, the scientific world was shocked by the article by the Chinese mathematician Academician Hua Di "Einstein's Explanation of Perihelion Motion of Mercury" published in the collection of articles "Unsolved Problems in Special and General Relativity", edited by Florentin Smarandach USA [18]. In his article, Academician Hua Di showed that, when calculating the magnitude of the perihelion precession of the orbit of Mercury, Einstein made a gross error in integration. As a result, the result was 71.5´´, and not the expected 43´´. The magnitude of the error ~ 71.63 " was also obtained by direct numerical modeling of the perihelion precession of the orbit of Mercury in the field of the spherical Sun in the framework of general relativity, carried out by Professor N. V. Kupryaev in 2018 [19]. The time has come to say that Einstein's error is not accidental and general relativity is applicable only in equilibrium integrable systems in reversible processes for which there is no violation of the equivalence principle. Non-equilibrium systems should be described by other theories of physics within the framework of a new scientific paradigm [17]. Researchers of the nature of gravitational forces can be conditionally divided into two groups - those who continue to search in line with the geometric approach that underlies the general theory of relativity and those who refuse to connect the gravitational field with the geometry of space-time and develop the field concept of gravity. The field concept of gravity allows one to describe the gravitational interactions of bodies similar to the electric and magnetic interactions and does not contradict other experimentally substantiated approaches to describing the phenomenon of gravity and inertia, in particular, some models involving quantum vacuum (dark matter), like a superfluid space environment.

6. Conclusion

Thus, in the experiment of the collapse of the gravitational wave function, the researchers dealt with a nonequilibrium system and an irreversible process accompanied by the diffusion of particle motion, leading, if they are charged, to radiation. As shown above, in this case it is impossible to use Einstein's invariant equations of general relativity. Roger Penrose's attempt to construct a "gravitational quantum theory" of particles based on Einstein's general theory of relativity is doomed to failure. It is necessary to re-analyze the results of underground gravity wave function collapse experiments carried out at the Gran Sasso National Laboratory mine in central Italy from the standpoint of the Unitary Quantum Theory of Professor Lev Sapogin. It is necessary to abandon Einstein's geometric theory of gravitation and preservation of the principle of equivalence, and use the field concept of gravity with the participation of a quantum vacuum (dark matter) [20].

References

[1] Sandro Donadi, Kristian Piscicchia, Catalina Curceanu, Catalina Curceanu, Matthias Laubenstein & Angelo Bassi "Underground test of gravity-related wave function collapse", Nature Physics (07 September 2020) doi:10.1038/s41567-020-1008-4

[2] Roger Penrose, "Quantum State Reduction",- Found Phys (2014) 44:557–575

[3] DOI 10.1007/s10701-013-9770-0

[4] Leo G. Sapogin, Ryabov Yu.A., Boichenko V.A. “The Unitary Quantum Theory and a New Sources of Energy”. - Science Publishing Group, USA.(2015)

[5] J. Schwinger, “On Quantum-Electrodynamics and the Magnetic Moment of the Electron”, Phys. Rev. 73, 416 (1948), Published 15 February 1948

[6] Burkert V.D., “Elouadrhiri L, Girod FX. “The pressure inside the proton” ¬Nature, 557:396–399, (2018)

[7] Sapogin L.G. “A Statistical Theory of Measurements in Unitary Quantum Mechanics” Nuovo Cimento (1982)

[8] Sapogin L.G. “A Statistical Theory of the Detector in Unitary Quantum Mechanics”, Nuovo Cimento (1982)

[9] Prigogine I.R., Stengers I., “Time, chaos, quantum”, Moscow: Progress, 1994

[10] Konstantinov S.I., “Epistemological Dualism between Einstein's Relativity and Quantum Mechanics in the Five-Dimensional Continuum for Universe”, Global Journals Inc. (USA) GJSFR-A, Volume 20, Issue 6, Version 1.0, pp 31-38, (2020)

[11] Einstein, A, “The Collected Papers of Albert Einstein”, Princeton University Press, pp. 112-116, (1915)

[12] Physics news on the Internet, Checking the principle of equivalence - Physics-Uspekhi, Volume 61, Number 1, p.88, (2018)

[13] Stanislav Konstantinov, "Violation of the Equivalence Principle and the Boundary of Einstein's General Relativity",- International Journal of Advanced Research in Physical Science, Volume 5, Issue 2, 2018, Page No: 18-24

[14] Turyshev S.G. Experimental tests of general relativity: recent progress and future directions -Physics-Uspekhi, Volume 52, Number 1, (2009)

[15] Jean – Loup Puget,“The sight on the relic background” Scientific American, No.9, (2014)

[16] Shikin, V., “Low – frequency anomalies of effective mass of charged clusters in liquid helium”, Low Temperature Physics, 39(10), p.837, (2013), DOI: 10.1063/1.4825362

[17] A. Einstein, Explanation of the Perihelion Motion of Mercury from the General Theory of Relativity. The Collected Papers of Albert Einstein. – Princeton University, 6: – 112-116.

[18] Konstantinov S.I., "Calculation Method the Value of the Gravitational Constant for the Non-Equilibrium System of Mercury-Sun", International Journal of Advanced Research in Physical Science, 5(6),pp 1-5, (2019)

[19] Hua Di Einstein's Explanation of Perihelion Motion of Mercury in "Unsolved Problems in Special and General Relativity" \ed. F. Smarandach. Columbus, Ohio, USA: Education Publishing. P. 3-7 (2013)

[20] Kupryaev N.V. Concerning the Paper by A. Einstein "Explanation of the Perihelion Motion of Mercury from the General Theory of Relativity" - M: Russian Physics Journal, Vol. 61, N4, (2018)

[21] Konstantinov S.I. Dark Matter is an Extreme State of Dark Energy (Fifth Interaction)- GJSFR-A , Volume 19 Issue 9 Version 1.0, pp 1-10 (2019)

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