International Journal of Advanced Research in Physical Science (IJARPS)
Volume 7, Issue 9, 2019, PP 13-26
ISSN No. (Online) 2349-7882
www.arcjournals.org

Immanuel KANT and a New Physics

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Abstract: *A new Physics is born at the time of the crisis of theoretical physics and the entire scientific paradigm. The article proposes to come back to Immanuel Kant's philosophical heritage and, in particular, to his monograph "Critique of pure reason", in order to better understand the concept of quantum vacuum (dark matter) in "New Physics" and its participation in all interactions in an open Universe.*

Keywords: *quantum vacuum*, dark matter, electromagnetism, gravity, nuclear forces

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

1. INTRODUCTION

Nowadays, in the scientific community, there is no unambiguous definition for the concept of "New Physics". So Academician of the Russian Academy of Sciences, chief researcher at the Institute for Nuclear Research Valery Rubakov, who received Hamburg Prize in Theoretical Physics 2020 believes that despite all efforts, no experimental indications of a "new Physics" have yet been received. In his article "Higgs Boson", he writes: "This is actually already starting to cause concern: is it right we all understand, it's quite possible, however, that we still haven't reached the "new physics" in terms of energy and in the amount of data collected. I hope that new, revolutionary discoveries will be associated with of the Large Hadron Collider which, through year begins to work on full energy 13-14 [TeV]." To the question: "What could be a new Physics?", V.Rubakov replies: "Theorists have no unity on this subject. One option is the composite nature of scalar fields that provide spontaneous symmetry breaking, which has already been mentioned. Another common possibility is supersymmetry, which we will only talk about that predicts a whole zoo of new particles with masses in the region of hundreds of GeV - several TeV. Very exotic options are also being discussed, such as additional dimensions of space (say, the so-called M-theory)."[1]. Academician Rubakov wrote these words in June 2012, but even today, in 2020, new revolutionary discoveries have not been obtained at the LHC, although the energy was reached in the collision of 13 TeV proton beams, which means that theoretical physics, unlike experimental physics, is in a state of crisis and is not even able to comprehend the achievements of experimental Physics. Our article will be entirely devoted to the interpretation of the achievements of experimental Physics and Astrophysics obtained at the beginning of the 21st Century. "New Physics", based on the recognition of *quantum vacuum* (dark matter and dark energy) as a galactic and intergalactic *medium*, which, according to the observations of the Planck Space Observatory published in March 2013, makes up 95% of the total mass energy of the observed Universe (the remaining 5% is accounted for by ordinary baryonic matter), these achievements are truly revolutionary [2]. It is correct to write the term "new Physics" in quotation marks, since this Physics originated earlier than the Modern Relativistic Physics of Albert Einstein and the Quantum Physics of Niels Bohr, which currently dominates Theoretical Physics. The philosophical Foundation for new Physics was laid by the great philosopher and thinker of the 18th century Immanuel Kant in his treatise *Critique of pure Reason* [3]. If only the speculative theory of General Relativity (GRT) by Albert Einstein was based not only on the phenomenal intuition of the author, but also on Immanuel Kant's philosophical concepts (Leibniz and Spinoza) and the experimental discoveries of Nikola Tesla, the development of theoretical physics would have taken a different path. The ironic statement of the pillars of Contemporary Physics within the walls of the

Princeton Institute of Higher Studies in 1940 that Tesla is trying to galvanize the long-decayed corpse of ether substance, still kills the sprouts of a new Cosmology. New discoveries of experimental Physics and Cosmology have cast doubt on the truth of this statement. The concepts of ether, *quantum vacuum*, dark matter have resurfaced in the scientific community. This aroused the keen interest of philosophers and physicists in the philosophical legacy of Immanuel Kant. Dr. Stefano Veneroni did a great job of rethinking Kant's transcendental analytics in the light of new cosmological discoveries [4]. In his "Critique of pure reason", Kant traces the difference between concepts of 'nothing' and 'something'. He writes: "Reality is something, negation is nothing, namely, a concept of the absence of an object" and furthermore "The mere form of intuition, without substance, is in itself not an object, but the merely formal condition of one (as appearance), like pure space and pure time, which are to be sure something, as the forms for intuiting, but are not in themselves objects that are intuited" [3]. Albert Einstein needed to think about this before introducing the concept of "space-time fabric" into Cosmology. Why do the authors of recent astrophysical discoveries constantly indicate the presence of the cosmic fabric of space-time in the Universe? So the last discovery by Dr.Vivek Venkatraman Krishnan, an astrophysicist at the Max Planck Institute for Radio Astronomy in Bonn, Germany, of the rotation of space-time around a white dwarf in the PSR J1141-6545 (Figure1) binary star system is interpreted by them as new proof of the correctness of Einstein's theory although it has been established that the halo of dark matter forms spheres around Galaxies, Stars and Planets that rotate with them (Figure2) [5].

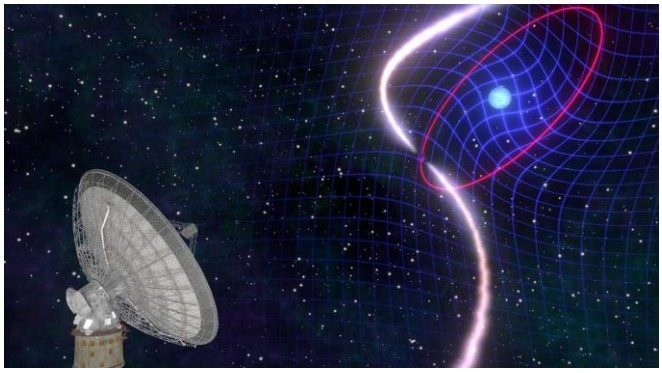

Figure1.*The illustration of Lense-Thirring frame-dragging resulting from a rotating white dwarf in the PSR J1141-6545 binary star system.*

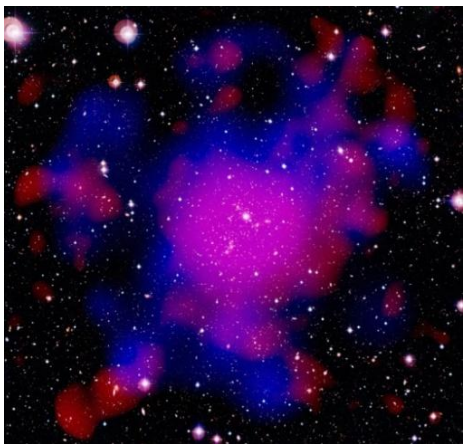

Figure2.*Components of the cluster of galaxies Abell 2744. White color - galaxies, red color - hot gas and blue color - dark matter.*

Observations astrophysicist Vivek Venkatraman Krishnan on January 30, 2020 buried the results of Michelson-Morley's experiments, and with it and Einstein's Special Theory of Relativity [6]. Today, it can be firmly stated that cosmic fabric of space-time is made of the same material as the clothes on the naked king in the fairy tale of Danish writer Hans Christian Andersen: "The King's New Outfit" [7]. But why do all astrophysicists feel its presence? The cosmic space of the Universe is 95% filled with dark matter, which does not emit electromagnetic radiation and does not interact with it directly. This property complicates, and possibly even makes, direct observation of dark matter impossible. But astrophysicists feel its presence and influence on all processes occurring in the Cosmos with

ordinary (baryonic) matter, which is about 5% in the Universe. That is why the cosmic fabric of space-time has taken root in Science at the suggestion of Albert Einstein. In fact, at the beginning of the 20th century, Einstein announced the four-dimensional geometric Minkowski Space as a mathematical model of space-time SRT and later, in 1915, he extended it to the entire Universe in the General Theory of Relativity as a theory of gravity. In 1917, Albert Einstein introduced the cosmological constant, a dimensionless constant, into the equations of the General Theory of Relativity to counter the forces of gravity in the Universe [8]. The cosmological constant, a physical constant characterizing the properties of a *vacuum*, was introduced by Einstein in order for the equations of GR to admit a spatially uniform static solution as counteraction to gravitational attraction, which can lead to the collapse of the Universe, at which all matter will gather at one point. Thus, the cosmological constant should carry the function of antigravity (repulsion). In Newton's universal law of gravity, there are two forces: those of gravity and *inertia*, which control the motion of the planets in the heliocentric solar planetary system. Same gravity and antigravity forces in Einstein's General Relativity should have formed a stationary Universe. Today, the cosmological constant is necessary for description to effects of dark energy and dark matter on cosmological scales in the Universe.

Albert Einstein's boundless faith in his intuition and disregard of Kant's philosophical postulate that the simple form of Intuition without substance is not an object in itself, and that Reality is something (Kant's classification), not nothing, led to the crisis of contemporary theoretical Physics. "Do you know that relativism (STR and GRT) is not a true science? - true science necessarily relies on causality and the laws of nature, given to us in physical *phenomena* (facts). In contrast, SRT and GRT are built on axiomatic postulates, that is, fundamentally unprovable dogmas, which the followers of these teachings are obliged to believe. That is, Einstein's relativism is a form of religion". These are the words of Professor Stefan Marinov from the Institute of Fundamental Physics (Graz), which he wrote in 2010 in the article "Experimental violations of the principles of Relativity, Equivalence and Conservation of Energy" and which reflect the state of theoretical Physics today [9].

2. NEW PHYSICS - REALITIES OF TODAY'S SCIENCE

In the 21st century, experimental Physics and Cosmology reached such heights that "New Physics" was able to open the veil of secrecy of something Real (cfr. Kant classification) - *quantum vacuum* (dark matter and dark energy), which makes up 95% of the total mass energy of the Universe. The participation of *quantum vacuum* (dark matter) in all interactions causes a rejection of the paradigm of the evolution of a closed system and requires a review of all conservation laws and symmetries. For decades, we have known about four fundamental forces: gravity, electromagnetism, and strong and weak nuclear forces. The experimental discovery of the fifth force is associated with the participation of *quantum vacuum* (dark matter) in all interactions inherent in baryonic matter [10, 11]. The new scalar field may belong to a hypothetical particle of dark matter, the protophobic X-boson, which, like the Higgs Boson, creates the scalar field responsible for the fifth interaction between dark matter and ordinary (baryonic) matter [7]. Next, we present experimental evidence of the fifth force in electrodynamics, gravity, and nuclear interactions.

2.1 Dark Matter and Dark Energy like Something Real in the Universe

Dark matter in Astronomy and Cosmology, as well as in theoretical Physics, is a *hypothetical* form of matter that does not emit electromagnetic radiation and does not directly interact with it. This property complicates and, possibly, even makes its direct observation impossible. The conclusion about the existence of dark matter is made on the basis of numerous, consistent with each other, but indirect signs of the behavior of astrophysical objects and the gravitational effects they create. Clarification of the nature of dark matter will help solve the hidden mass problem, which, in particular, consists in the anomalously high rotation speed of the outer regions of galaxies. Of particular interest to astronomers was the Andromeda nebula, in which the speed of stars around its center does not decrease, as celestial mechanics predicts, is inversely proportional to the distance to the center R, but remains almost constant (Figure 3). This may mean that the galaxy along its entire length contains a significant mass of invisible matter ("galactic halo")

Moreover, the approach of the Andromeda galaxy and our Milky Way galaxy, observed with the help of radio telescopes, can be explained by the existence of the fifth fundamental interaction between dark matter and baryonic matter.

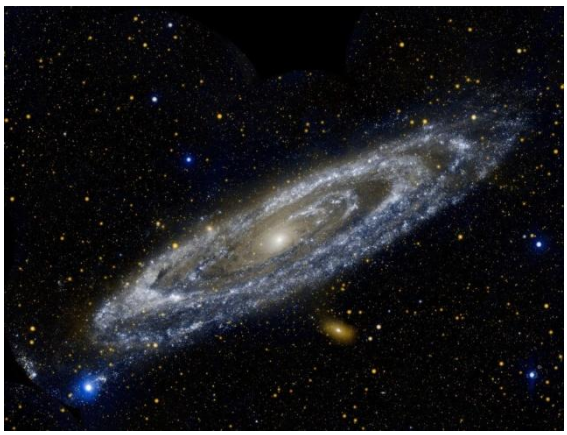

Figure3. *The beautiful Andromeda galaxy*

Dark energy in Cosmology is a *hypothetical* form of energy introduced into the mathematical model of the Universe in order to explain its observed expansion with acceleration. Unlike dark matter with gravity, dark energy has something similar to antigravity. In the standard cosmological model, dark energy is a cosmological constant, a constant energy density that uniformly fills the space of the Universe (in other words, non-zero energy and *vacuum* pressure are postulated). A group of researchers, according to observations using the Hubble Space Telescope (HST) in 1998, established the accelerated expansion of galaxies in the visible part of the Universe. In 2011, researchers were awarded the Nobel Prize for this discovery. Cosmological antigravity in the standard ΛCDM (Λ- Cold Dark Matter) model is described by linear force depending on the distance:

$$Fe = (c^2 / 3) \times \Lambda \times R, \quad (1)$$

where Λ is Einstein's cosmological constant and R is the distance [8].

Phase state *quantum vacuum* characterizing dark energy is considered in the superfluid cosmological model of *quantum vacuum* as analogous to the superconducting α-phase ^{3}He-B while assuming that dark matter can be considered as an analog of the spontaneously ferromagnetic β phase ^{3}He-B, formed in strong gravitational and electromagnetic fields of galaxies and black holes, and with an increase in mass and density dark matter have acquired gravitational properties [12].

2.2 Gravity and the Violation of the Principle of Equivalence

Researchers of the nature of gravitational forces can be conditionally divided into two groups - those who continue to search in accordance with the geometric approach underlying the general theory of relativity, and those who refuse to connect the gravitational field with the geometry of space-time and propose to develop the field concept of gravity. True, recently a group of scientists has appeared who see the nature of the forces of gravity in the activity of the superintelligence, which implements special programs of gravity for all bodies. I think that this approach is generated by the crisis in fundamental physics. The field concept of gravity makes it possible to describe gravitational interactions of bodies similarly to electric and magnetic interaction and does not contradict other experimentally grounded approaches in describing the phenomenon of gravitation and *inertia*, in particular, certain models involving a *quantum vacuum* (dark matter) as a superfluid space environment. It is known that in his work on the creation of General Relativity, Einstein began with the principle of equivalence (PE), in which he postulated that gravitational acceleration is indistinguishable from the acceleration caused by mechanical forces [8]. As a consequence, the gravitational mass became in Einstein's theory under any conditions equal to the inertial mass. In his *Principia* in 1687, Newton, on the basis of his second law, came to the conclusion that the gravitational force is proportional to the mass of the body on which it acts. At the same time, Newton knew that the inert mass m_i, which appears in his second law $F = m_i \times a$, can differ from the gravitational mass mg related to the force of the gravitational field $F = mg \times g$. Indeed, comparing the two equations, we get that $a = (mg / m_i)\, g$ and, in principle, bodies with different values of the *ratio* (mg / m_i) could receive a different acceleration a_r in the same gravitational field. In 1899, numerous 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 allows us to consider gravity as a geometric property of space-time, which leads to the interpretation of gravity from the positions of the General Theory of Relativity. In a message on April 7, 2020 Scientists from the University of Washington, as well as many of their predecessors (the experiment conducted on the MICROSCOPE satellite in 2018 performed a PE test with a record accuracy of $\Delta \sim 10^{-14}$), could not detect violation of the principle of equivalence (PE) [13]. To do this, they measured gravity at a distance of less than 50 microns. Researchers have suggested that the universe has many destroyed dimensions, but they are hidden from direct experiments by scientists. In their opinion, measurements can be compact and appear only on extremely small scales, which can be weak, so they are difficult to detect. I do not agree with this conclusion and am ready to give an example of the violation of the principle of equivalence (PE) as a result of the participation of *quantum vacuum* (dark matter). In 2013, the scientific world was shocked by the article "Einstein's Explanation of Perihelion Motion of Mercury" by the Chinese mathematician Academician Hua Di, published in the collection of articles "Unsolved Problems of the Special and General Relativity", edited by Florentin Smarandach USA [14]. In his article, Academician Hua Di showed that, when calculating the magnitude of the precession of the perihelion of the orbit of Mercury, Einstein made a gross error in the integration. As a result, the deviation was 71.5", and not 43". The theory is completely useless if it is not confirmed by the experiment. Since Einstein's time, the calculation of the motion of the perihelion of Mercury was used to verify the reliability of the theory of gravity. It has long been known in astronomy that because of its proximity to the Sun and under the influence of the gravity of other planets, Mercury moves not just along an ellipse, but an ellipse which itself slowly rotates in 575" within a hundred years. This is an abnormal precession for the planets of the solar system. The corrections calculated on the basis of Newton's theory gave a rotation of the perihelion by 532". It is believed that the remaining value of 43" cannot be explained within the framework of Newton's theory. In 1915, A. Einstein calculated the precession of the perihelion of the orbit of Mercury and obtained the expected value 43", using the field equations of General Relativity [15], thus it became his triumph. However, in 2013 it turned out that Einstein made a mistake in his calculations. The shock of Hua Di's article was quickly forgotten, five years have passed since the article was published, and no one wondered why, in the framework of the field GTR equations, the calculation of the precession of the Mercury orbit perihelion gives 503.5" over 100 years. The result ~ 71.63" was also obtained by direct numerical simulation of the precession of the perihelion of the orbit of Mercury in the field of the spherical Sun within the framework of GTR, conducted by Professor N.V. Kupryaev in 2018 [16]. The time has come to say that Einstein's error is not accidental and GR only works in *equilibrium* integrable systems. For Mercury, whose orbit is subject to strong perturbations due to its proximity to the Sun, there is a violation of the strong principle of gravity, as it happens when spherical bodies move in a superfluid turbulent medium 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 [17]:

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

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

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 (2) 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:

$$Meff\ (\omega R) = \frac{2\pi\rho R^3}{3}\left[1 + \frac{9}{2}\frac{\delta(\omega)}{R}\right] \quad (3)$$

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 [17]. Professor I. Prigogine, winner of the Nobel Prize called this effect "an active influence on the system from the outside, with the transition of the system in a nonequilibrium state." Prigogine clarified Mach's Principle and came to the conclusion that in a steady condition, an active influence from the outside on the system is negligible, but it can become of major importance when the system goes into a non-equilibrium condition [18]. As a result of adding mass to the sphere, the value of the gravitational constant for the non-equilibrium system Mercury-Sun is different from the value of the gravitational constant for the equilibrium of the Earth-Moon-Sun system [19]. To date, the Earth-Moon-Sun system seems to be the best model in the Solar System for testing the strong principle of Gravity. Experiments of the laser rangefinder of the Moon (LRM) were associated with the reflection of laser beams from an array of angular reflectors mounted on the Moon by astronauts of the Apollo program and Soviet lunar rovers. The latest experimental *data* made it possible to establish that the possible inequality with respect to gravitational and inertial masses for the Earth and the Moon has a value $(0.8 \pm 1.3) \times 10^{-13}$ [20]. The Geometric theory of Einstein's General Relativity, which requires compliance with the equivalence principle, does not allow changing the value of the gravitational constant in the solar system, and Newton's law can be modified for different values of the gravitational constant.

Direct numerical simulation of the precession of the perihelion of the orbit of Mercury taking into account all the planets, as well as taking into account the compression of the Sun conducted by in the framework of the modified Newton's law gravity with a value of $G_M \sim 6.63403 \times 10^{-8}$ [dyn·cm²/g ²], obtained by me after analyzing the values of Kepler's constant, allows us to evaluate the result with an accuracy ~ 570" ±5" [19]. This is the most accurate result presented in astrophysics in the entire history of calculating the perihelion precession of Mercury's orbit. Thus, Kepler-Newton's observational astronomy comes into conflict with Einstein's abstract speculative theory. The consequences of this cannot be overcome so far. The historical role of Mercury in front of Science is that the violation of the principle of equivalence when the planet moves in a strongly perturbed orbit requires a revision of the theoretical constructions of Einstein's General Relativity. A new gravitational constant for Mercury and Pluto $Gm \sim Gp \sim 6.63403 \times 10^{-8}$ [dyn × cm² / g²], will be in demand in practical astronomy, computer simulation and space navigation. For other planets of the Solar System, the value of the gravitational constant is equal to or close to the generally accepted value $G_0=6.67408 \cdot 10^{-8}$ [dyn·cm²/g²] [19].

A computer simulation, developed by three US engineers at NASA, can illustrate the special position of Mercury in the solar system. The results of their work were published in Physics Today, in 2019. While scientists usually look at the distance between the orbits of the planets, a computer program does calculations differently. It simulates the location of the planets of the solar system over 10.000 years, and, therefore, can very accurately calculate the average distance between two planets. The results are based on a technique called the dotted circle method - essentially a mathematical equation that takes the orbits of two planets as round, concentric and coplanar, and calculates the average distance between two planets when they rotate around the Sun. Modeling of the orbits of the planets begins to show that Mercury has the smallest average distance from the Earth and most often it is the closest neighbor to the Earth. Mercury is closer to us than Venus and Mars. (Figure 4. Image Source: Physics Today).

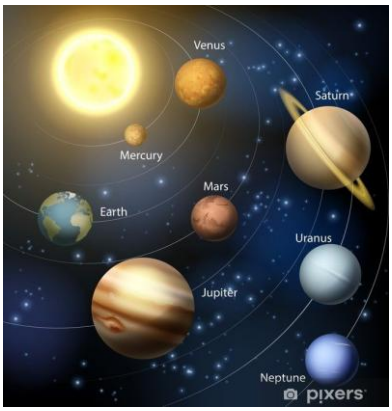

Figure4. *Planets in the solar system*

The average distance between the Earth and Venus is 1.14 [AU]. At the same time, the distance between the Earth and Mercury is only 1.04 [AU] (slightly more than 150 million [km]).

Assessing the prospects of recent gravitational-space experiments and experiments related to the search for hidden measurements, it can be argued that in the framework of the standard cosmological model ΛCDM (Λ- Cold Dark Matter) and Einstein's invariant equations of General Relativity, it is fundamentally impossible to detect gravity disturbance and hidden measurements, no matter how much we increase the accuracy of measurements in experiments.

The use of GTR by physicists to describe non-invariant, irreversible processes leads to gross errors, in some cases fraught with catastrophe. It was noted experimentally that when the maximum speed of rotation of the rotors of electric motors and turbines is reached, spontaneous acceleration of the disks occurs in several cases and, moving vertically along the axis of rotation, they break from the supports and fly out of the device. A similar accident occurred on August 17, 2009, at the Sayano-Shushenskaya hydroelectric power station. The turbine of the second hydroelectric unit suddenly began to rotate at a hypersonic speed, which led to the destruction of the fixing bolts, the destruction of the room, and the death of 75 people. The excitation of *quantum vacuum* (dark matter), caused by the accelerated motion of bodies or their rotation, leads open systems to the violation of the symmetries, conservation laws, and prohibitions in the standard ΛCDM (Λ- Cold Dark Matter) model. This fact must be taken into account in Classical and Quantum Mechanics. The participation of *quantum vacuum* (dark matter) in all interactions causes a rejection of the paradigm of the evolution of a closed system which requires a review of all conservation laws and symmetries. J. Wheeler wrote on this subject, "An object that is central to the whole Classical General Theory of Relativity, "four-dimensional space-time Geometry" simply does not exist if we go beyond the framework of the classical approximation. This argument shows that the concept of space-time and time are not primary concepts in the structure of Einstein's physical theory. There is no space-time, there is no time; there is nothing before, nothing after. The question is, what happens at the next moment, asking in GRT is meaningless."[21].

2.3 *Vacuum* Polarization and Its Participation in Electromagnetic Interaction (Correction of Maxwell's Electrodynamics)

Consider the features of the electromagnetic field in a vacuum from the point of view of classical electrodynamics. First of all, this is a *medium* with absolute dielectric and magnetic permeabilities (ε_a, μ_a) equal to the dielectric and magnetic constants (ε_0, μ_0):

$$\varepsilon_a = \varepsilon_0 = 1/(36\pi) \times 10^{-9} \ [F \times m^{-1}] \quad (4)$$

$$\mu_a = \mu_0 = 4\pi \times 10^{-7} \ [Gn \times m^{-1}]$$

The electric strength of this *medium* should be infinitely high, due to the lack of charge carriers. This means that the electric field E and the magnetic field H, as well as the electromagnetic energy density determined by them in a *vacuum*, can be infinitely large. Such a conclusion, obtained from the position of the theory of Classical Electrodynamics, in the high-energy region, is not consistent [22]. In Quantum Electrodynamics, the instability of *vacuum* in external fields was experimentally established for electric field strengths Es = 1.32×10^{16} [V × cm^{-1}] (Schwinger's characteristic Quantum Electrodynamic field) and magnetic field strength H = 10^{16} [T], caused by the creation of electron-positron pairs in a *vacuum* (polarization effect of the *vacuum*) due to which the *vacuum* itself becomes unstable. With the polarization of *vacuum* and its transformation into the matter, the change in *vacuum* energy w can be represented as the sum:

$$w = w^p + w^e \quad (5)$$

where w^p is the vacuum polarization, $w^p << E^2 / 8\pi$;

w^e is the change in the energy of the substance in the production of particles

$$w^e = eET\varkappa, \quad \varkappa = \frac{e^2E^2T}{4\pi^3}\exp\left(-\pi\frac{m^2}{\hbar E}\right)$$

The creation of particles is the main reason for the change in the energy of the *vacuum*. The small value of the reverse reaction w^p implies the limitation on the electric field's E strength for the given time T (**E**s ≈ 10^{16} [V × cm^{-1}] is the critical Schwinger's field) [23]. Niels Bohr was right when he made, 80 years ago, the statement "about the impossibility of achieving the strength of the order of Es

for a field generating electron-positron pairs". (**E**s = m² / e = 1.32 × 10^{16} [V × cm^{-1}], Sauter's characteristic Quantum Electrodynamics field) [22]. Perhaps the creation of electron-positron pairs in a *vacuum* is a manifestation of the instability of dark matter [24]. From the above, it follows that *quantum vacuum* (dark matter) is macroscopically a polarizing *medium*. Maxwell endowed the light-carrying environment, in which vortex electric fields and currents of displacement have arisen, necessary for him to derive the famous equations of Electrodynamics, with properties surprisingly close to the properties of a superfluid *quantum vacuum* [25]. In the early 20th century after the experiments of Nikola Tesla it became clear that Maxwell's Electrodynamics requires revision and improvement. The non-invariance of the equations of electrodynamics was associated with the assumption of the reality of the existence of a quantum vacuum (dark matter) and with the existence of the effects of retarded potentials and deformations of the electric field of moving charges in a polarizing medium. Full invariance of the equations of electrodynamics is admissible only in absolutely empty space of Einstein's SRT. However, more than 100 years, and this task has not yet been solved. Attempts by a number of scientists [26, 27] to point out the obvious contradictions and paradoxes of the classical and Quantum Electrodynamics encounter complete lack of understanding and fierce opposition from the contemporary apologists of the ruling in the Physics of Einstein's theory. As a result, Maxwell's equations have been separated from the original model of the environment in which the conduction currents and displacement played a very definite physical role. Since then, the Electrodynamics of Maxwell lost virtually every opportunity for additions, changes or improvements. There are relatively modest results after years of work (1950-2020) of the collective of the National Research Centre "Kurchatov Institute" in the creation of a fusion reactor based on the tokamak (a closed plasma trap) due to the fact that Maxwell's Electrodynamics is very different from the real Electrodynamics in a tokamak (Figure 5). Hot plasma particles move in a magnetic trap along the magnetic field lines of an arbitrary topology to the walls of the tokamak and destroy it. For the TM-15 tokamak, which was modernized in 2015, the duration of plasma confinement in the trap was 1 second [28].

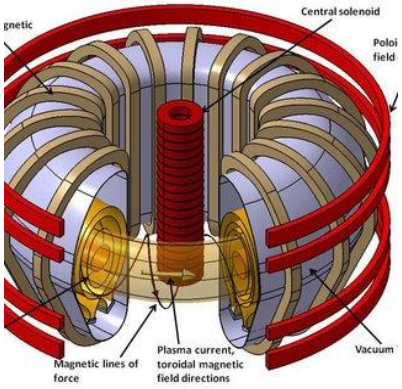

Figure5. *Closed plasma trap (tokamak).*

2020 marks 15 years (2005) since the beginning of the project between Russia, EU, USA, Japan, China, Korea and India for the joint construction of the International Thermonuclear Experimental Reactor (ITER) in France based on the tokamak. Prospects for the tokamak as a thermonuclear (14 MeV) neutron source are examined. In July 2020, it was reported that French President Emmanuel Macron solemnly opened the beginning of the installation of the reactor (ITER). In the ITER project, it is necessary to bring the length of the plasma confinement before 3000s. Today, we can talk about a complex problem faced by the creators of the ITER project, because Maxwell's classical equations are currently used for the calculation of electrodynamics in a tokamak. Real Electrodynamics inside the tokamak is very different from the calculation [28]. Hot plasma particles move along magnetic field lines of arbitrary topology to the walls of the tokamak and destroy it. Chief Scientific Officer of the Siberian Branch of the Russian Academy of Sciences, professor V.V.Aksenov, experimentally and mathematically substantiated the effect of self-excitation and the uncontrolled growth of magnetic fields. This leads to uncontrolled instabilities of plasma column [29, 30]. Vortices of a toroidal magnetic field create a force poloidal magnetic field and vice versa. This is one of the variants of the so-called dynamo excitation of a magnetic field. When the temperature rises inside the tokamak, the diffusion rate will also increase due to the growth of the resistance (conductivity drop), the plasma column and the growth of the poloidal field inside the tokamak. Professor VVAksenov notes that "the

above approach to the description of Electrodynamics in a tokamak needs a more thorough analysis involving the Boltzmann equation describing the behavior of plasma particles with increasing temperature in a complex magnetic field different from the toroidal one that arises in a tokamak due to self-generation. At the present time, electrodynamics in a tokamak is described by the well-known classical Maxwell equations." [30]. In article [29], the mutual generation of force and non-force magnetic fields is formulated by V. Aksenov in strictly mathematical formulas, and the appearance of these fields is determined by the theorem on total electric currents in spherical regions. This points to the inaccuracy of researching only magnetic fields and refusing to study electric bias currents when calculating the Electrodynamics of tokamaks. The problem of controlled nuclear fusion is one of the most pressing problems of Modern Physics. The main obstacle to solving this problem is associated with the need to use dense high-temperature plasma and its retention for a sufficiently long time (Lawson's criterion). To date, controlled nuclear fusion has made important progress, but not the ultimate realization. One of the conditions is that the distance between two target nuclei must be lesser than the radius of the strong interaction. This means that the Nuclear Kinetic Energy must be large enough to overcome the electrostatic potential barrier between two *nuclei*. The ignition temperature is not easily achieved by traditional methods. The traditional method of providing such conditions is based on the inertial or long-term confinement of thermonuclear plasma heated to a temperature of about 10 [keV]. This thermonuclear method has been investigated for 60 years in different laboratories around the world, and the prospect of achieving a positive result is still quite uncertain, despite very large financial and intellectual efforts. An example is the International Thermonuclear Experimental Reactor (ITER) in France based on the tokamak. Great attention is given to the prospects for the tokamak as a thermonuclear source (14 [MeV]) of the neutrons in the pulsed mode of operation. The steady-state regime associated with prolonged plasma confinement in a tokamak is considered to be achieved in the long term. For tokamaks, the risk is caused by the lack of a full theory of electrodynamics, which could adequately describe the actual behavior of electric and magnetic fields and currents, and is further exacerbated by the fact that all fusion programs are based on heating and compressing the reacting material and, at the same time, they are described as "controllable", although there is no control at all. Just the initial amount of the reacting substance is prudently taken as very small. In quantum physics, there are no ways to influence this process. The fusion reaction of the light nuclei of deuterium and tritium occurs at a temperature of hundreds of millions of degrees and is the most promising thermonuclear reaction:

$$_1{}^2\mathrm{H} +_1{}^3\mathrm{H} \rightarrow_2{}^4\mathrm{He} +_0{}^1\mathrm{n} + 17.6\ [\mathrm{MeV}] \tag{6}$$

In future models of reactors, in contrast to all existing projects, only the smallest part of deuterons will react at any moment of time, which will automatically be selected relative to initial phases. It could be possible to obtain as a result the small energy generated during a long period of time until the reserve of light reacting nuclei is not exhausted. That cold nuclear fusion does have the right to be called "controlled" [31].

2.4 Cold Nuclear Fusion and the Role of *Quantum Vacuum* (Dark Matter)

Nature offers mankind various options for nuclear fusion: on the one hand, it is uncontrolled thermonuclear fusion realized in the depths of the sun and accompanied by coronary emissions that have a detrimental effect on all life on the planets. On the other hand, it is the thermal radiation of the universe realized in the form of cold nuclear fusion in the interstellar *medium* of *quantum vacuum* (dark matter). The detected thermal background radiation of the Universe in the microwave range from 10 GHz to 33 GHz received in astrophysics the insufficiently convincing name "relict". This may be a process of cold nuclear fusion occurring in the space environment, with a release of Energy sufficient to raise the temperature of the Universe to 2.7 K. From the point of view of the Unitary Quantum Theory (UQT) of Professor L. Sapogin, the motion of electrons in tunnel junctions can occur at even very low temperatures [31]. This is confirmed by the experiments of American scientists who managed to establish tunnel effects near absolute zero temperature (in liquid helium) [32]. Nuclear fusion occurs when a charged particle overcomes the repulsive Coulomb barrier and enters the region of nuclear attraction forces. To implement tunneling, 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. In another phase, when the amplitude of

the wave packet is large, non-linear interaction begins, and the particle can be reflected from the barrier. From the point of view of unitary quantum theory (UQT), Professor L. Sapogina, the motion of electrons in tunnel junctions can occur even at very low temperatures [31]. The cold nuclear fusion experimental data are extremely numerous and various, but I am going to dwell on the most important and fixed results.

The deeply studied interaction d+d proceeds along three channels [31]:

$$D + D \rightarrow T(1,01) + p(3,03), \quad (1 \text{ channel})$$
$$D + D \rightarrow He(0,82) + n(2,45) \quad (2 \text{ channel}) \qquad (7)$$
$$D + D \rightarrow He + \gamma(5,5) \quad (3 \text{ channel})$$

All these reactions are exothermic. The third channel has a very small probability. It was established experimentally that reactions can occur at arbitrarily small energies.

The first creator of the technology of "warm" nuclear fusion, which is so persistently preferred not to recall in the Russian Academy of Sciences, was engineer Ivan Stepanovich Filimonenko. In 1957, he created a "clean" thermionic installation (TEGEU) for the synthesis of helium from deuterium at a temperature of 1150 ° C. In 1989, the electrochemists M. Fleischman and S. Pons [33] carried out the electrolysis of heavy water with a palladium wire helix. A large amount of heat has been detected. Realizing that chemical reactions on palladium cannot be responsible for such thermal effects, they reported that the D + D nuclear reactions took place in their experiments. The products of nuclear reactions, which they found in microscopic quantities they could not be responsible for the release of heat. So in the experiments of M. Fleischman and S. Pons, the energy of deuterons in a conventional electrolytic cell of Fleischman-Pons is about 0.025 [eV], and the height of the Coulomb barrier for this case is 0.8 [MeV] [33]. In classical and quantum mechanics, overcoming such a barrier with a height of tens of millions of times greater than the kinetic energy of a particle is simply not possible. This circumstance allows official nuclear physics to assume that there is no cold nuclear fusion in nature. Fleischman and Pons were declared scammers. However, the presence of the tunnel effect and a large number of experiments accumulated in physics suggest the cold nuclear fusion exists [31]. In fact, the history of perception of cold fusion at is the history of the crying scientific fraud of those researchers who in 1957 in Russia and in 1989 in America tried to eliminate cold fusion as quickly as possible and have since received hundreds of millions of dollars for their research on hot fusion.

Today the science world is agitated by E-Cat of Andrea Rossi. The reactor is a ceramic pipe, in which nickel powder is placed under pressure with hydrogen. When there is an electrical current system heats up and emits in 3-50 times more heat than it consumes (Figure 6).

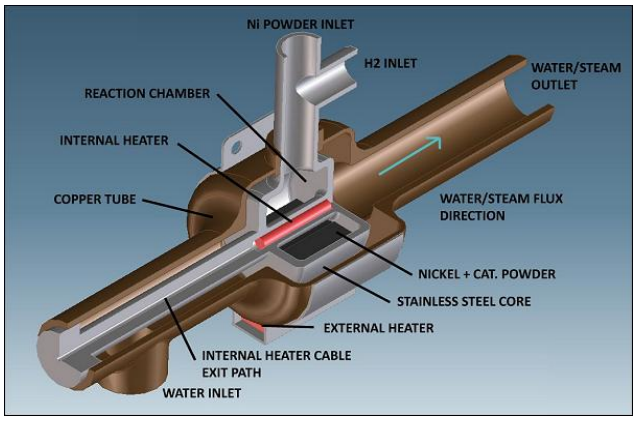

Figure6. *Andrea Rossi's reactor E-Cat*

Official scientific commissions have come to the conclusion that nuclear reactions cannot produce so much heat, although the isotopic composition of the nickel and changes, and self heat generation is quite mysterious, but it does not preclude the use of such facilities. In 2014, Rossi provided his facility for independent 30-day tests, during which two different laboratories conducted an isotopic analysis of the initial substance (fuel) and the spent substance after the tests. The analysis showed that the initial statement about the transmutation of nickel into copper is not true. In practice, the installation of Rossi is the transmutation of nickel-58, 60, 61 to nickel-62, as well as lithium-6 to

lithium-7. Independent tests showed that the heat dissipation in the Rossi unit during the 30-day test was 5.8 [GJ] per 1 gram of fuel. The power of energy release is about 2 [MW / kg], for comparison, the power output of the VVER-1000 is 111 kW / l of the core or 0.035 [MW / kg] of fuel. Thus, the energy release of TVEL in the Rossi facility is approximately 50 times more than that of modern nuclear reactors in TVEL, which is quite consistent with nuclear fusion reactions.

In Randall Mills's reactor "SunCell" electromagnetic energy concentrated in a powerful pulsed beam of light energy in the range $\lambda d = (20\text{-}170) \times 10^{-9}$ meters is generated when hydrogen atoms go into a newly discovered state - they turn into a "hydrino" and their electrons go to lower energy levels [34]. Quantum vacuum (dark matter), by definition, is in a lower energy state with respect to baryonic matter. Therefore, "hydrino" is a dark matter that is born as a result of the Randall Mills reaction from baryonic matter with the release of enormous energy. The transition of dark matter to baryonic matter is accompanied by absorption of energy, and the reverse transition of baryonic matter and dark matter is accompanied by the release of energy. The Randall Mills is currently testing a device called the SunCell in which hydrogen (from splitting water) and an oxide catalyst are introduced into a spherical carbon reactor along with dual streams of molten silver. An electric current applied to the silver ignites a hydrino-forming plasma reaction. Energy from the reaction is then trapped by the carbon, which acts as a "blackbody radiator." When the carbon heats up to thousands of degrees, it reemits the energy as visible light that is captured by photovoltaic cells, which convert the light to electricity Figure 7. The hydrino concept explains how solar disturbances associated with dark matter collect more energy than it can transmit in the form of light. According to the results of experiments at company BrLP, confirmed by external observers, when a megawatt of radiant energy was issued, the energy consumption of the unit, called SunCell, was only 8 [kW]. The main fuel for the reaction is ordinary water. "This is the end of the era of an internal combustion engine, centralized power, and fuel," says Mills. "Our technology will make all other energy technologies obsolete." [34].

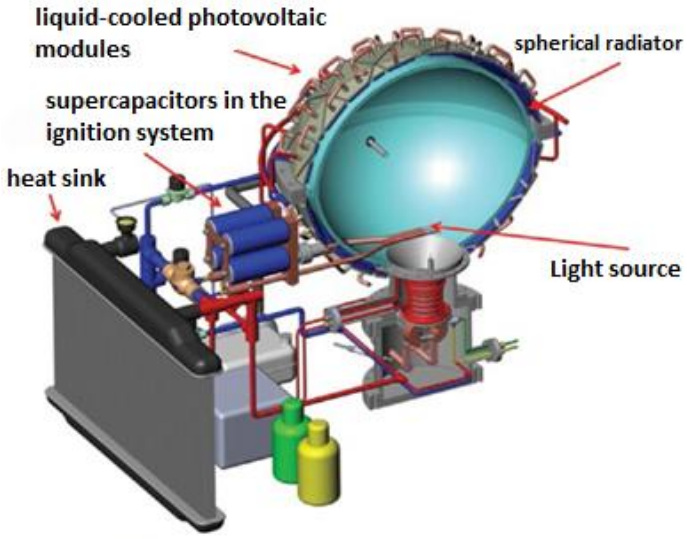

Figure7. *SunCell device diagram ("solar cell")*

Cold nuclear fusion have again become the subject of increased interest in recent years not only for scientists, but also for governments of a number of countries and major companies. This is what the US National Defense Law for the 2017 Fiscal Year says: "The Committee is aware of recent positive developments in the development of low-energy nuclear reactions (LENR), which produce ultra-clean, inexpensive renewable energy that will have strong implications for national security. According to the Defense Intelligence Agency (DIA), if LENR works, it will be a destructive technology that can revolutionize the production and storage of energy. "

2.5 *Quantum Vacuum* (Dark Matter) in the Large Hadron Collider

We'll consider experimental discoveries recently made at the Large Hadron Collider (LHC) but have not received an explanation in the Standard Model. The recognition of the polarization of quantum vacuum (dark matter) under the action of ultrarelativistic protons and superpower magnetic and electric fields distorts the spatial patterns in the LHC and allows us to state the presence of the third channel of proton interaction in the LHC, in addition to their mutual collisions [35] (Figure 8).

Figure8. *Large Hadron Collider*

The New model represents quantum vacuum (dark matter) as the third full participant of proton collisions in the LHC, whose presence the apologists of the dominant 100 years in the physics of Einstein's Special Relativity Theory deny. Until recently, it was believed that the use of such an important connection as the unitarity condition (the assertion that the total probability of all elastic and inelastic processes during proton collisions should be equal to unity) allows us to elucidate the spatial picture in the LHC of the proton interaction region and its evolution with a change in energy [36]. However, the results of recent experiments obtained in the LHC, where the proton collision energy reaches 13 [TeV], make it possible to doubt the reliability of the unitarity condition when two channels of elastic and inelastic proton collisions are rigidly connected to each other in the probability of particle production events [37]. The recognition of the polarization of quantum vacuum (dark matter) under the action of ultrarelativistic protons and superpower magnetic and electric fields leads to the creation of jets of unstable particles in the LHC and distorts the spatial picture of the proton interaction region adopted in the SM, that is, the third channel is added. It can be assumed that the creation of new particles in energy range Wp ≈ 10-100 [GeV] is associated with the polarization of a quantum vacuum (dark matter) and are irrelevant to the integrity of the protons. The most striking thing/feature is that the interval of resonant proton energy in the LHC, at which the greatest probability of inelastic collisions of protons and the creation of new particles is observed, corresponds to the energy interval Wp ≈ 10-100 [GeV] [37, Fig. 2], however, with increasing energy of relativistic protons, the effect of their stability after collision increases; that is, the probability of conservation of the proton as a single particle increases with increasing collision energy [37]. Today scientists at the Large Hadron Collider at CERN think that they may have discovered a new particle, the decay of which gives rise to muon pairs in a narrow peak of the energy of colliding protons strictly defined at 28 GeV. The new result has been published as a preprint on ArXiv and Roger Barlow's article was published as an on November 13, 2018 [38]. The LHC collaborations have very strict internal review procedures, and we can be sure that the authors have done the amounts correctly when they report " 4.2σ standard deviation value". If this particle really exists, then it should be outside the standard model. In most cases, pairs of muons come from different sources from two different events, and not from the decay of a single particle. If you try to calculate the parent mass in such cases, it will spread over a wide range of energies, rather than creating a narrow peak. In the new experiment, the CMS detector detected a large number of pairs of muons and, after analyzing their energies and directions, found that these pairs originate from the decay of one parent particle. This may indicate the instability of quantum vacuum (dark matter) and its polarization both in the Large Hadron Collider and in near-Earth space [35].

The CMS collaboration in the experiment at the Large Hadron Collider in 2019 demonstrated a decrease in the t-quark mass with increasing energy for the first time [39]. They studied the distribution of reaction products in pp collisions with an energy from 1 [TeV] to 13 [TeV]. It was found the decrease in the mass of elementary particles obtained from data up to an energy of 13 [TeV], as well as a decrease in the magnitude of the interaction constants at a confidence level of 95%, depend on the energy at which measurements are made. This effect, explained by vacuum polarization, was indeed observed in experiments in particular, the decrease in the mass of b and c quarks was measured, as well as the decrease in the strong interaction constant [39].

3. CONCLUSION

Epistemological optimism is a philosophical doctrine, which asserts the possibility of an absolutely complete, exhaustive knowledge of the world, and it is the opposite of agnosticism, which is a

philosophical doctrine that denies the possibility of knowing the objective world and its laws. Today, a "New Physics" is being born, the object of consideration of which is, in addition to ordinary baryonic matter, quantum vacuum (dark matter), which takes part in all interactions in an open Universe. To overcome the crisis of theoretical physics, which led to the dominance of militant agnosticism in the scientific community, preaching the illusory nature of the universe, it is useful to turn to Kant's scientific heritage and, in particular, to his monograph "Critique of pure reason".

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Citation: *Stanislav Konstantinov, Stefano Veneroni, (2020). Immanuel KANT and a New Physics. International Journal of Advanced Research in Physical Science (IJARPS) 7(9), pp.13-26, 2020.*