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Surfing on Top of a Gravitational Wave

By Stanislav Konstantinov
Herzen State Pedagogical University

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Strictly as per the compliance and regulations of:

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I. Introduction

The warp drive is perhaps the Holy Grail of space exploration. With a propulsion system capable of moving at a speed exceeding the speed of light, man can reach the far corners of our galaxy and even go beyond it. According to professor of aerospace engineering Jason Cassibry (Jason Cassibry), scientists are getting closer to hacking the physics of the warp engine to make it work just like in Star Trek. Cassibry teaches at the University of Alabama, Huntsville, where he advises undergraduate student Joseph Agnew, author of a recently published study on this fantastic type of engine (Figure 1).

Figure 1: Graduate student Joseph Agnew

In 1994, the Mexican physicist Miguel Alcubierre suggested that an object could deform spacetime in front of itself [1]. The Alcubierra drive, which remains theoretical, creates a "wave bubble" around the object. This bubble deforms space-time, creating a region of contracting in front of it and expanding the space behind it, placing the spaceship and everything else - in a new position faster than the light moves. It is important to note that the object inside the bubble never moves than the speed of light. Problems arise in the process of creating this deformation bubble. Initially, estimates showed that the curvature of Alcubierre would require all the energy available in the universe to create such a bubble. However, as Agnew pointed out in his presentation and work, this estimate has since decreased due to the inclusion of exotic matter in the model, which does not yet exist [2]. Theoretical progress is one thing, and the physical creation of such an engine is another, and, as Cassibrey said in an interview with Motherboard, scientists still have a long way to go before they reach this ultimate goal. I think shorten this path by including dark matter as an exotic matter Agana, capable of creating a "wave bubble" around the spacecraft.

II. Propagation of Gravitational Waves in the Elastic Medium of Superfluid Dark Energy and Dark Matter

According to observations using the Hubble Space Telescope space telescope in 1998, established the accelerated expansion of galaxies in the visible part of the Universe. Cosmological antigravity in the standard ΛCDM (Λ- Cold Dark Matter) model is

Author: Department of Physical Electronics, Herzen State Pedagogical University, Saint Petersburg RSC"Energy", Russia.
e-mail: konstantinov.s.i@yandex.com

described Einstein by linear force depending on the distance:

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

Where Λ is Einstein's cosmological constant, and R is the distance [3].

However, Nobel Prize winner Brian P. Schmidt in his Nobel Lecture on 8 December 2011 "The Path to Measuring an Accelerating Universe", was forced to admit: "The discovery of the accelerated expansion of the universe caused a huge amount of theoretical research. Unfortunately, the apparent progress in our understanding of this problem has not yet happened - the cosmological acceleration remains as mysterious as in 1998"[4]. In this paper, based on the development of the theory of superfluid media are invited to expand the scope the standard ΛCDM and give a physical explanation of the cosmological acceleration, based on the structural features and the elastic properties of the space environment. If the deformation arising in the elastic spring or the elastic intergalactic medium (dark energy) would is proportional to the force applied to the body of **F** = k · r (Guka's law), space-time will represent straight lines that go from the observer to infinity [5]. Obeying this law describes the repulsive forces between the structural elements forming dark energy. Phase state quantum vacuum characterizing dark energy, are considered in the model as analogous 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 at the same time acquired gravitational properties. Consider the antigravity mechanism inherent in dark energy. Similarly to the interaction of vortices in superfluid ^{3}He-B, vortices in the environment of dark energy should also interact. In ^{3}He-B, the magnetization of vortex cores takes place along the axis of the vortex; that is, there is a spin polarization of the superfluid liquid. Thus, the space environment in the turbulent region can be characterized by the state of all-round stretching [5]. In the framework of the hydrodynamic model, the effect of a superfluid fluid on the vortex core can be mathematically described by the introduction of pressure **Pn** at the boundary of the vortex. The sign of pressure depends on the nature of the internal stresses in the medium. If these the internal stresses in the dark energy have the character of all-round stretching, then the pressure will be negative. That is, all the dynamic characteristics will have a sign opposite to that which they would have had for the usual ideal incompressible fluid with the same kinematic properties. This behavior of the system is similar to the presence of a negative mass. Strength **Fe** is antigravity repulsive force acting in a space environment (dark energy):

$$Fe = - \int_{s'} Pn \, ds, \quad (2)$$

Where,

n is external normal to the surface S';

ds is infinitesimal element of the surface.

In a superfluid ^{3}He-B medium during rotation, quantum vortex filaments are formed in which the angular momentum of paired atoms ^{3}He is $n\hbar$; $\hbar$ is the Planck constant, n = 1, 2 [6]. Today, astrophysicists discovered in 12 billion light-years from Earth in the constellation Aquarius of a previously unknown megastructure. She is a complex interweaving of "channels" or "threads" of hydrogen gas that extend between galaxies. Scientists believe that this is part of the structure, previously called the "space network", which, according to calculations, should connect all galaxies and black holes in the Universe. A detailed map of elusive structures in one of the regions of the early Universe was compiled during observations using the MUSE tool at the Very Large Telescope of the European Southern Observatory (ESO) for the light emitted by hydrogen in the massive proto-cluster SSA22, located at a distance of about 12 billion light-years from Earth in direction of the constellation Aquarius (Figure 2).

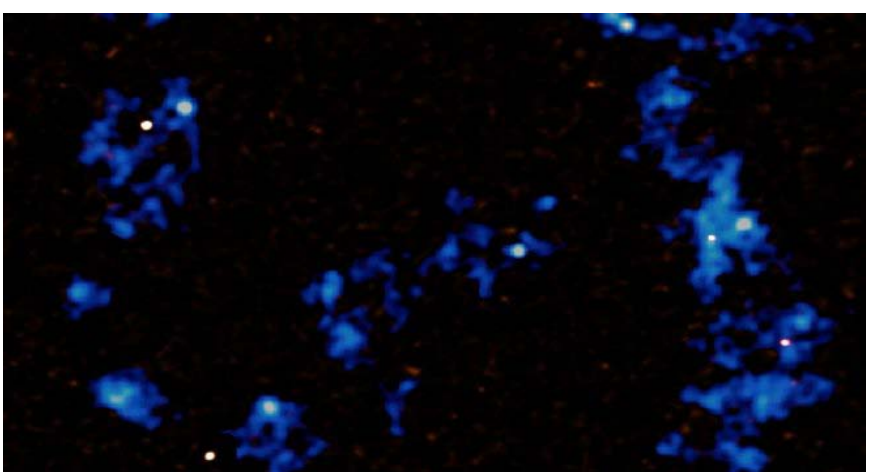

Figure 2: Space network. White dots are actively forming galaxies

The results showed that the gas forms long filaments in the intergalactic space, which exactly corresponds to the simulation performed on this site and forecasts of galaxy formation models. The intergalactic filaments of the space network extend over more than three million light-years and provide "fuel" for the formation of new stars and the growth of supermassive black holes in the parent protocluster. A map of the giant "web" compiled basis on of observations, and the findings of scientists were published in the journal Science on June 6, 2019 [7]. In my opinion, this discovery confirms that in a superfluid medium of dark energy filling the intergalactic space, quantum vortex filaments are formed from paired hydrogen atoms, similar to paired He atoms in a ^{3}He-B superfluid medium (Figure 2).

ESA XMM-Newton X-ray Observatory discovered three massive filaments of hot gas in a cluster of galaxies. So exposed part of the cosmic skeleton that permeates the entire universe. Galaxies gather to form groups and even large agglomerates called clusters. These clusters are the most massive space structures held by gravity. Clusters contain a large amount of hot gas and even more invisible dark matter. On a universal scale, galaxies and clusters of galaxies are connected into a giant network, at the nodes of which are the most massive clusters. XMM-Newton's new study discovered several filaments of galaxies, gas, and dark matter that flow to one of the most massive clusters of galaxies in the universe. This is the first discovery to confirm theoretical calculations. "It was an unexpected and long-awaited discovery!" Says Dominic Eckert of the University of Geneva, Switzerland, author of a report in the journal Nature. Figure 3 shows the image of the four galactic clusters that make up Abell 2744. Four very massive clusters of galaxies are visible where there is a higher concentration of galaxies (white and purple regions). Two clusters in the lower-left corner of the image are in the early stages of the merge process. Two other clusters can be seen in the central part of the image just above the center.

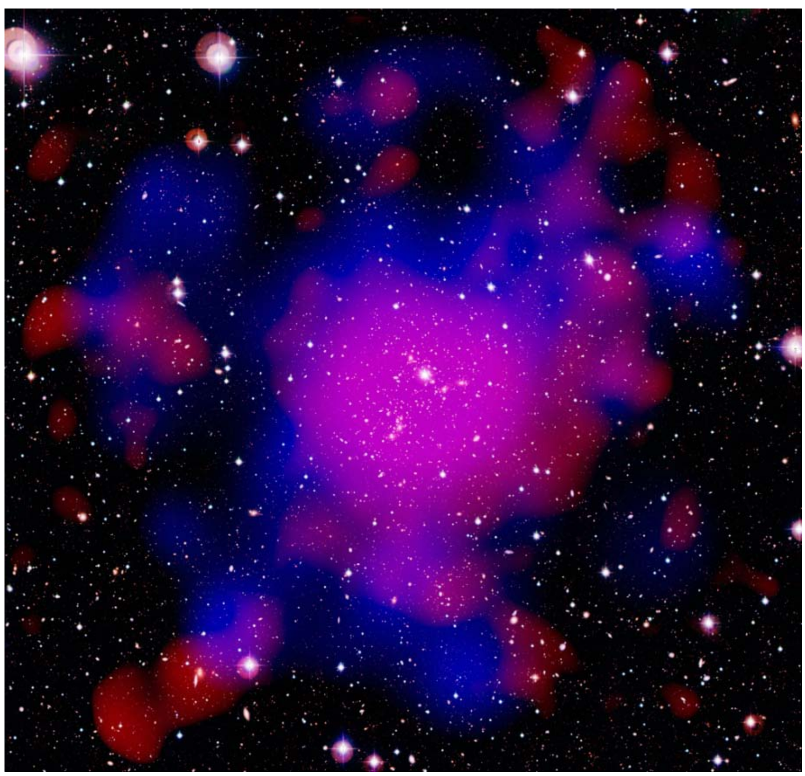

Figure 3: Components of the cluster of galaxies Abell 2744. White color - galaxies, red color - hot gas and blue color - dark matter

In early 2020, scientists managed to register small clumps of dark matter - only 1/10 000 and even 1/100 000 of the mass of the Milky Way. And for dark matter, these are indeed very shallow meanings. Detection is made possible by gravitational lensing of light. If there is even a small cluster of dark matter in the galaxy lying in the foreground, or on the line of observation, the observed picture is distorted. Based on these distortions, we can conclude about the size of the clots. As you know, massive objects can refract rays of light. Not much, but at distances of millions of light-years, deviations will be noticeable. This characteristic gives rise to the effect of gravitational lensing, thanks to which we can see the light from distant stars that are behind galaxies or other massive objects (Fig. 4).

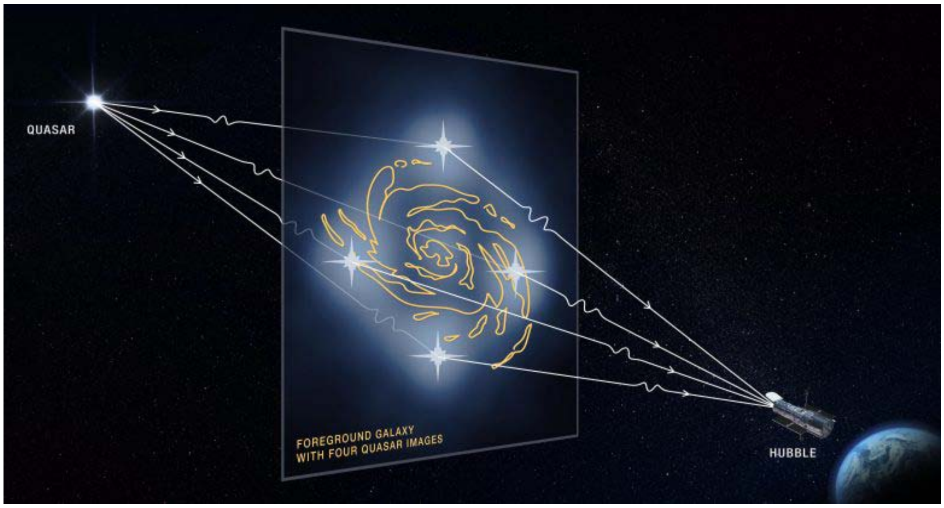

Figure 4: The effect of gravitational lensing

The Hubble observation yields new insights into the nature of dark matter. “We made a very compelling observational test for the cold dark matter model, and it passes with flying colors,” said Tommaso Treu of the University of California, Los Angeles (UCLA), a member of the observing team [8]. Since gravitational fields are not possible to screen by material bodies, the propagation path of the gravitational waves will differ from electromagnetic waves.

It can be assumed that the structure of the Universe is much more complicated than previously imagined in cosmology. This assumption is based on the latest discoveries of astrophysicists who discovered that in the universe, the location of galaxies changes synchronously, like a flock of birds in flight. For example, a study published in the Astrophysical Journal in October 2019 showed that hundreds of galaxies rotate in sync with other galaxies that were tens of millions of light-years away. “The discovery is completely new and unexpected,” said June Heo Lee, an astronomer at the Korea Institute of Astronomy and Space Sciences. “The observed coherence must have some connection with large-scale structures because it is impossible for galaxies separated by six megaparsecs (approximately 20 million light-years) to interact directly with each other,” Lee said. Scientists suggest that synchronized galaxies can be embedded along with the same large-scale structure, which rotates very slowly counterclockwise. This fundamental dynamics can cause some consistency between the rotation of the studied galaxies and the movements of their neighbors.

For the dark energy and dark matter, the generalized vector Lame wave equation is valid. This equation is equivalent to two simpler wave equations, which describe elastic waves of two types: longitudinal waves that propagate with phase velocity *Vp* and transverse waves with phase velocity *Vs*. It can be gravitational, electromagnetic, and torsion waves. The speed of propagation of longitudinal waves is higher than the transverse. Gravitational waves can be attributed to the longitudinal waves since according to the calculations of Laplace, their speed should exceed the transverse electromagnetic waves at least 7000000 times. Otherwise, the retarded gravity of the Sun to cease to be strictly central and the planetary system fall apart very quickly due to cyclic torque [9]. In the work "Elastic Model of Physical Vacuum" Professor V. A. Dubrovsky in 1985 presented an estimate of the speed of gravitational waves based on the fact that the ratio of the interaction forces according to the Coulomb law for transverse electromagnetic waves and longitudinal gravitational waves is determined by the ratio of the corresponding elastic modules, which is equivalent to the ratio of their square of velocities. It follows that the speed of gravitational waves exceeds the speed of electromagnetic waves by 10^9 times [10]. In 1994, when July 16, 1994, the great nucleus of the comet Shoemaker-Levy collided with the Jupiter gas sphere, radial oscillations gave rise to the surface gravity waves, instantly resulted in fluctuations in several geodetic satellite command-measuring complex of Russia. Typically, geodetic satellites have an orbit inside a tube with a diameter of about 1 km. And their orbit control is carried out with very great accuracy - the error in the coordinate is up to a 1meter, and the error in speed is up to 1 cm /sec. During the collision period, the diameter of the tube path increased by 5–8 times. Unfortunately, the author does not have similar information from the USA from NASA. Speed gravitational waves, formed by the collision of a comet with Jupiter, significantly exceeded the velocity of electromagnetic waves (light spreads from Jupiter to Earth is 43.2 min). A more recent example is the registration of gravitational waves generated from the merger of neutron stars on August 17, 2017. So, on the morning of August 17, 2017, at 15:41 Moscow time, two Advanced LIGO gravitational detectors in the USA and Advanced Virgo detector in Italy recorded a gravitational

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wave surge GW170817. Thanks to data from three detectors, it was possible to localize by triangulation the location of the source in the sky (with an area of about 35 square degrees), which turned out to be in the southern sky. After 2 seconds, telescopes Fermi and INTEGRAL detected a short burst of gamma radiation in the same region of the sky. A message about this discovery was promptly sent to observatories located in the southern hemisphere of the Earth. In this case, astrophysicists have suggested that this is a fusion of neutron stars. Since this process, according to modern ideas, basically generates short gamma-ray bursts and superlight neutrinos. Incidentally, superluminal neutrinos were also observed during supernova explosions, when neutrinos first arrive, and then an optical flash is visible after a few hours [11]. Telescopes around the world were waiting for the night and got into work after a few hours. The astronomers at the Las Campanas Observatory in Chile were the first to record a Kilonova flare using the Henrietta Swope optical 1-meter telescope. Almost simultaneously with it, a flash in the infrared was seen by the VISTA telescope. At the moment of merging of two neutron stars into one compact object (a neutron star or a black hole), a "fireball" is formed from gamma radiation, followed by a Kilonova flash, visible in all wavelengths, including the optical, due to the ejection of part of the substance into space (Fig 5). Then, astronomers at another Chilean observatory - Las Chambres - activated their network of 20 robotic telescopes around the world and tracked a 20-fold decrease in the optical brightness of a Kilonova flash for five days, which allowed us to construct a light curve. Estimates of the distance to the object, obtained both from gravitational wave data and from other observations, gave consistent results: GW170817 is at the same distance from Earth as the galaxy NGC 4993, that is, 130 million light-years away.

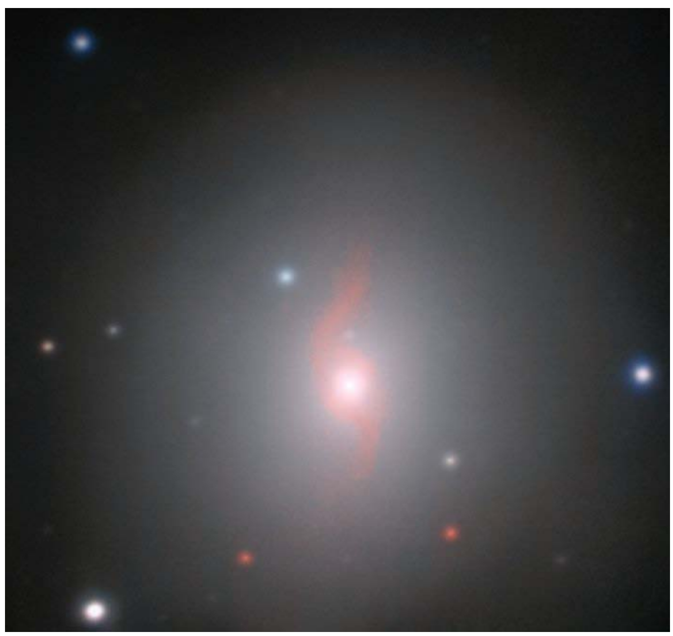

Figure 5: Galaxy NGC 4993, VLT image (ESO, Chile). A faint light source at the top of the center of the galaxy is a Kilonova, an explosion when two neutron stars merge. Red shows gas emission with an unexpected spiral structure. (Photo by ESO / J.D. Lyman, A.J. Levan, N. R. Tanvir)

The discovery of 2017 was the second case, after the explosion on Jupiter during the impact of the nucleus of comet Shoemaker-Levy, when an astronomical event was observed both on light and gravitational waves, ushering in a new era of "multi-medium astronomy". The information received gave scientists invaluable evidence that gravitational waves can propagate at a speed different from the speed of light. Professor of Osaka University of Japan L. Baiotti, in his article published in September 2019 states: "While the GW170817 event was very fortunate because of its proximity to us, it can be expected that future observations will not all have such a high signal-to-noise ratio, but the increasing sensitivity of advanced GW detectors over the next years will surely lead to a large number of detections of merging BNS systems" [12]. Here, it should be noted that experiments to study longitudinal gravitational waves in plasma-like media both in laboratory conditions and in outer space are carried out using methods and recording equipment designed to receive transverse electromagnetic waves. Visible space Universe contains more than 90% of the substance in a plasma state in which various types of longitudinal waves arise. Especially strong generation of longitudinal waves of great intensity is manifested during the collapse of stars or their explosive evolution, for example, the formation of new and supernova stars, when powerful ejections and plasma flows are formed.

During these processes, charge separation occurs, leading to the generation of longitudinal waves. The same applies to the Sun, especially during activity cycles. In-ground and airborne detectors, waves are usually recorded as transverse electromagnetic waves, even when their longitudinal nature is known. It is believed that longitudinal waves are transformed into transverse at various inhomogeneities of the plasma, its boundaries, or due to various interactions with other waves. On the way from Jupiter to the Earth, longitudinal gravitational waves underwent fewer transformations than on the way 130 million light-years from the galaxy NGC 4993 and maintained a high superluminal speed when they met the Earth. For a reliable interpretation of gravitational waves in GW detectors, specific methods for recording longitudinal gravitational waves should be developed this primarily relates to antennas.

Consider the famous "Einstein Field Equation" which governs the behavior of general relativity. The left-hand side describes the curvature of space-time, while the right-hand side describes the distribution of matters [3]:

$$R\mu\nu - \frac{1}{2} g\mu\nu = \frac{8\pi G}{c^4} T\mu\nu \qquad (3)$$

Where $R\mu\nu$ is the Ricci tensor; $g\mu\nu$ is the event space metric tensor; $T\mu\nu$ is the energy-momentum tensor of matter.

Einstein is talking about gravitational waves propagating in the free space, which means there is no matter, not even electromagnetic field, consequently the right hand side should be zero. So the equation is simplified to $R\mu\nu - \frac{1}{2} g\mu\nu R = 0$, which is equivalent to a more concise form $R\mu\nu = 0$, which is also known as "Vacuum Einstein Field Equation". Both EFE and VEFE are nonlinear partial differential equations, while in the weak field setting, they can be approximated with linear equations. The linear EFE is similar to other wave equations like Maxwell's Equations, so Einstein predicted the existence of transverse gravitational wave and predicted that the speed of the gravitational waves is equal to speed of light. However, there is no free space in galaxies, there is dark matter there, which is five times more than baryonic matter and the right side of equation (3) cannot be equated to zero. Therefore, Einstein's predictions regarding the type and the speed of gravitational waves in the new cosmology need to be clarified. In 2019, thanks to the Event Horizon telescope, an M87 image was obtained - the world's first photograph of a black hole (Figure 6).

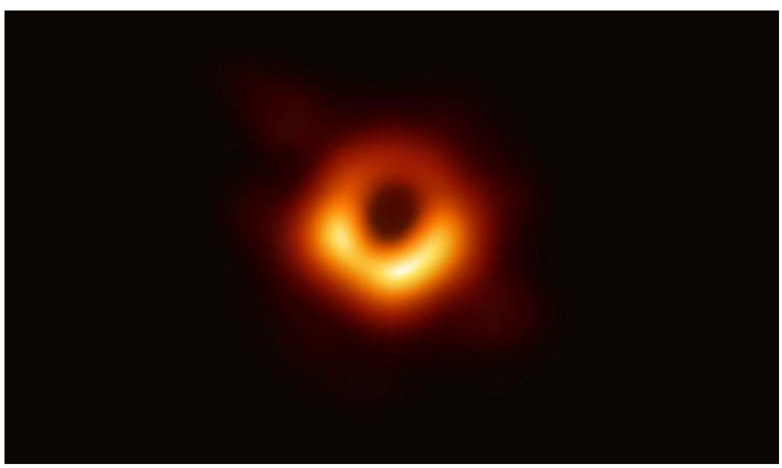

Figure 6: The famous photo of a black hole in the galaxy M87

This hole is located in the center of the eponymous galaxy, also known as NGC 4486, it is about 6.5 billion times more massive than the Sun and emits streams of red-hot "semi-digested" stellar matter into space. The super-giant elliptical galaxy is about 53 million light-years distant from Earth, and its length is about 240,000 light-years - that is, it is slightly larger than the Milky Way.

The substance erupts from a black hole at speed significantly higher than the speed of light. Although the erupted substance takes the form of an elongated ray, it does not look like a uniform stream - it is rather lumpy, inhomogeneous clumps of hot material flying on the crest of a longitudinal gravitational wave (Figure 7). The results of the latest study are presented in a paper published in the Astrophysical Journal [13].

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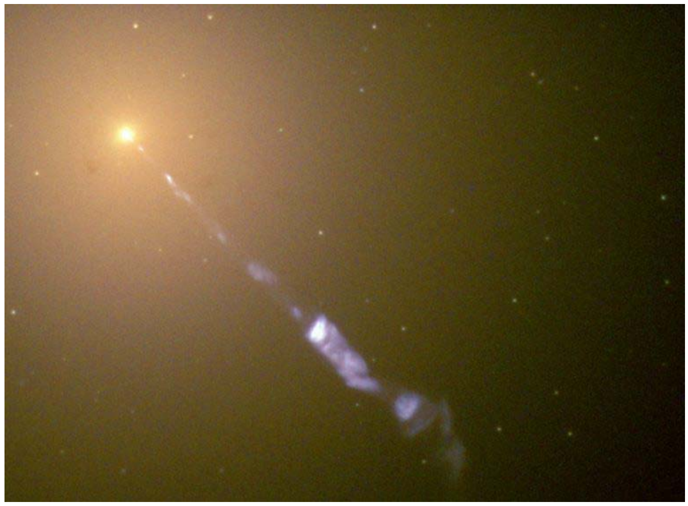

Figure 7: The flow of matter discharged from a black hole NGC 4486 at speed 6.3 times the speed of light

The model of the quantum vacuum as an analog of superfluid ^{3}He-B clearly shows how microscopic processes studied only by quantum mechanics manifest themselves in macroscopic processes. The initial information from classical hydrodynamics on the motion of spherical bodies in a fluid (Stokes work), which has been the primary source of progress in the study of low-frequency anomalies [14], allows you to theoretically calculate the additional energy extracted from dark matter to create gravitational waves. 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:

$$F(\omega) = 6\pi\eta R\left(1+\frac{R}{\delta(\omega)}\right)V(\omega) + 3\pi R^2\sqrt{\frac{2\eta\rho}{\omega}}\left(1+\frac{2}{9}\frac{R}{\delta(\omega)}\right)i\omega V(\omega), \quad (4)$$

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

Where ρ - fluid density, η - the 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 (4) 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:

$$\text{Meff}(\omega R) = \frac{2\pi\rho R^3}{3}\left[1+\frac{9}{2}\frac{\delta(\omega)}{R}\right] \quad (5)$$

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 [14]. It's in the laboratory, and in space, the reason for the increase in the inertial mass of Mercury is the perturbation of the space environment caused by the nonequilibrium state of Mercury, whose orbit is subject to strong perturbations due to proximity to the Sun, when the vector of velocity is constantly changing, forming vortices in the medium. The pressure in the region of the vortex formed behind the planet will become lower, which, in turn, will cause an increase in drag and, as a result, an additional field of inertia. The relationship between friction resistance and pressure resistance depends on the Reynolds number (Re). The more Re, the greater the compaction of the medium is created in front of the planet, and the more rarefied medium will be behind it [15]. This creates longitudinal gravitational waves in the space environment. If a spaceship moves in the wake of such a super-light gravitational wave, then it will move in space with super-light speed.

III. Wakefield -the Mechanism of Spacecraft Acceleration by "Surfing" on Top of a Longitudinal Gravitational Wave

As in AWAKE accelerators, where particles are accelerated when "surfing" at the top of a plasma wave (or Wakefield field), a spaceship can accelerate at the top of gravitational waves in the quantum vacuum (dark matter) which contains similar zones of positive densifications and discharges in the galactic and intergalactic environment. The team behind the Advanced Proton Driven Plasma Wakefield Acceleration Experiment (AWAKE) at CERN in Geneva has been working five years after CERN approved the project in 2013. In an interview with the project manager AWAKE Edda Gshwendtner "This is fantastic: the new method of particle acceleration works" explains the essence of the experiment. "In the classical scheme, the electron beam in the collider accelerates under the influence of the electromagnetic field. In our experiment, a beam of protons flies in the plasma. It creates a wave and

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thereby ensures the acceleration of the electron beam that follows. The beam of electrons with the energy of 19 MeV flew in the plasma ten meters and increased energy to 2 GeV, that is, more than 100 times. This means that the average acceleration rate was 200 MeV / m." [16]. The experiment was carried out by the AWAKE collaboration and scientists from the Budker Institute of Nuclear Physics, Siberian Branch of the RAS. Traditional accelerators use what are known as radio-frequency (RF) cavities to kick the particle beams to higher energies. In Wakefield accelerators, the particles get accelerated by "surfing" on top of the plasma wave (or Wakefield) that contains zones of positive and negative charges. Allen Caldwell, spokesperson of the AWAKE said, "Wakefield accelerators have two different beams: the beam of particles that is the target for the acceleration is known as a witness beam, while the beam that generates the Wakefield itself is known as the drive beam. AWAKE is the first experiment to use protons for the drive beam, and CERN provides the perfect opportunity to try the concept. Drive beams of protons penetrate deeper into the plasma than drive beams of electrons and lasers. Therefore, Wakefield accelerators relying on protons for their drive beams can accelerate their witness beams for a greater distance, consequently allowing them to attain higher energies." Like an accelerator AWAKE, the spaceship can get accelerated by "surfing" on top of the longitudinal wave, caused by an explosion similar to the explosion comet Shoemaker-Levy collided with Jupiter (Figure 8).

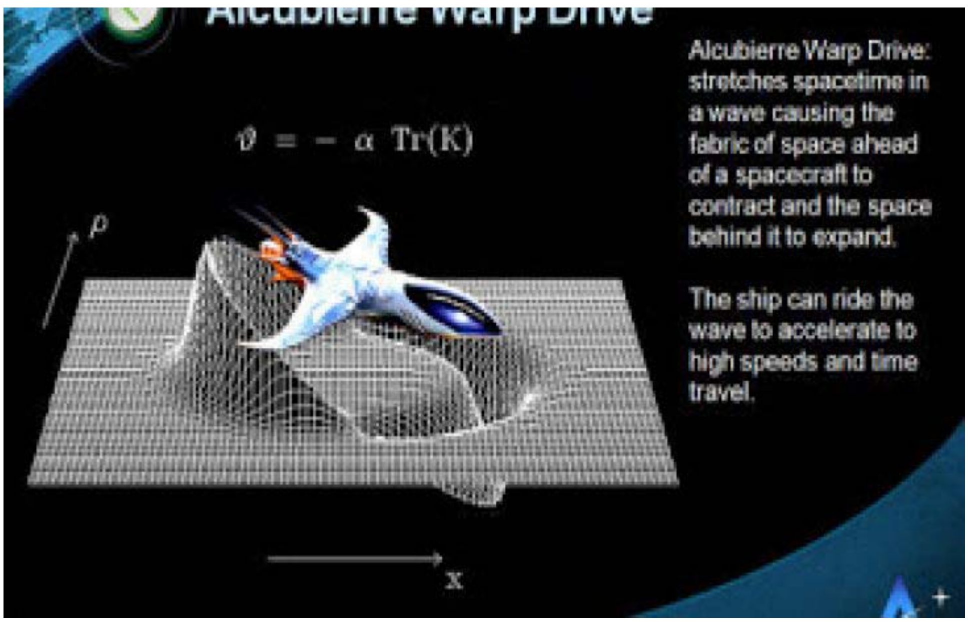

Figure 8: Spaceship on top of a gravitational wave

Like in the AWAKE accelerator, in space primary protons generated by supernova fusion could accelerate by "surfing" at the top of a longitudinal gravitational wave and upon reaching the Fermi and INTEGRAL space telescope detectors cause a short burst of gamma radiation in them. There is a process, leading to the birth of gamma-rays generated by the interaction of protons accelerate to ultra-high energies with matter:

$$p + X \rightarrow \pi^0 + Y \rightarrow \gamma + \gamma + Y \qquad (6)$$

Therefore, the categorical approval of astrophysicists that the speed of gravitational waves is equal to the speed of light, because that only 2 seconds elapsed between registering a gravitational burst GW170817 that is, 130 million light-years away and the gamma-ray burst, should be verified again. A new burst of gravitational waves, recorded on January 18, 2020, is explained by a collision of neutron stars that occurred at a distance of 520 million light-years, was not accompanied by the detection of a gamma-ray burst. This may indicate that at such a great distance the primary protons and gamma rays do not reach the Earth.

IV. Plasma Engine for Spacecraft based on the SMOLA Installation

To accelerate the spacecraft by "surfing" on top of a longitudinal gravitational wave, it must be equipped with a SMOLA plasma engine. The SMOLA installation (Spiral Magnetic Open Trap) is a new technology for creating a space fusion engine. In stationary mode, it works like a thermonuclear reactor, providing spacecraft with energy, and in the pulsed mode it accelerates the spacecraft for surfing on the crest of gravitational waves. Scientists at the G. Budker Institute of Nuclear Physics, RAS have tested the installation SMOLA (Spiral Magnetic Open Trap), with which you can keep the thermonuclear plasma in linear magnetic systems

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(Figure 9). On the one hand, the new installation should help to make one more step towards controlled thermonuclear fusion (TNF), and on the other hand, it will enable the spacecraft to accelerate to record speeds. Open traps, which are dealt with in the Institute of Nuclear Physics, are free from the shortcomings the closed plasma traps (tokamaks). The thermonuclear energy of the future is unlikely to be generated on the basis of a tokamak. First of all, it costs too much (the estimate of the ITER Tokamak exceeded 15 billion euro), and construction time is constantly delayed. And secondly, in tokamak it is possible to ignite the only plasma, consisting of a tritium and deuterium mixture. But tritium is itself radioactive, and the reaction process creates neutron radiation. So such a thermonuclear station will cause nearly the same environmental problems as the nuclear power plant today.

$$ {}_1^2H + {}_1^3H \rightarrow {}_2^4He + {}_0^1n + 17.6\ MeV \qquad (7) $$

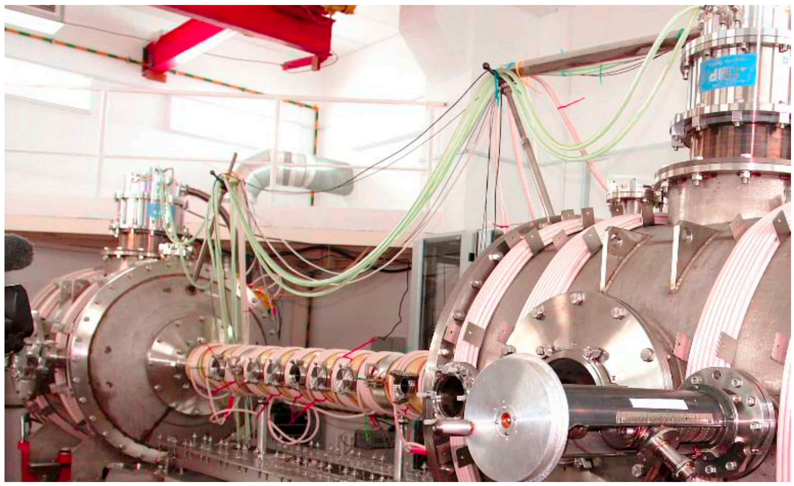

Figure 9: The installation of SMOLA

Open traps are way simpler and cheaper and can generate a clean, neutron-free thermonuclear reaction. But the trouble is that they are open, which means that the plasma may possibly leak out of them. The installation SMOLA is meant to solve this issue. “The idea was to create a magnetic field in the form of a screw. Imagine a meat grinder that is turning minced meat. In our case that minced meat is the plasma” - senior researcher of the Institute, Anton Sudnikov explained. “Plasma particles tend to fly out of the meat grinder through the grill, but if we turn the handle in the opposite direction, the mincemeat will move backward - the opposite impulses compensate each other, and the plasma remains in place, that is, in trap” [17]. Deputy Director of the Institute Alexander Ivanov gave additional comments: “According to theoretical estimates, the longitudinal plasma losses will decrease by 20-100 times. This will make it possible to raise the plasma temperature a lot. It is planned that two SMOLA units will become parts of a new gas-dynamic multi-mirror trap, which is designed in the Institute. It is expected to attain plasma parameters, which are not inferior to the best tokamaks. This can be a real breakthrough. Besides, if we start turning the handle of the meat grinder in the opposite direction, then the plasma particles will not be decelerated, but, on the contrary, will fly out with acceleration”. Alexander Ivanov told that the scientists achieved a temperature of plasma of 100,000 degrees and reached a sufficient density. These parameters are enough for the creation of the rocket engine. The Institute director, Pavel Logachev said: “If the experiments planned on it are successful we expect to get new technologies for thermonuclear fusion, on the one hand, and a promising plasma engine for spacecraft, on the other hand” [18].

V. Conclusion

In the framework of the new cosmological model, which includes superfluid dark energy and dark matter, it is proposed to revise Einstein's “vacuum field equation” and, based on new astronomical observations, to clarify the type and speed of gravitational waves. For this, further improvement of the gravitational wave detectors is necessary by developing new specific methods for detecting longitudinal gravitational waves.

In the article, I cited astrophysical observations confirming the existence of superluminal speeds, and proposed a real mechanism for accelerating primary protons and spacecraft by "surfing" at the top of a longitudinal gravitational wave.

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