The origin of dark energy and dark matter: the galactic antigravitation

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Abstract

In standard cosmology, ordinary matter makes up 5 % of the universe. Alternative cosmology (MOND, Modified Newtonian dynamics) is developed including only baryonic material. Gravitation is mediated by spherically symmetric spatial circulations denoted as keplerons emitted by massive objects. Circulation velocity follows Kepler's law and reproduces Newton's law along with Schwarzschild's relativistic correction. At long distances, accelerating expansion of space transforms gravity into antigravity. This distance depends on the constants G and H of the gravitational and Hubble laws, as well as on the mass of the astronomical object, and is equal to 2 Mly for the Milky Way. Within galaxies, curved space has elliptical geometry creating attraction between masses, as opposed to hyperbolic geometry of intergalactic space creating repulsion between galaxies. Attractive force of hypothetical dark matter is replaced by external compression through repulsion between galaxies. Intergalactic repulsion force does not decrease with distance, but rather increases when the speed between galaxies is close to the speed of light, and this relativistic enhancement contributes decisively to dark energy. Intergalactic external compression explains why orbital velocities of stars in the inner and outer spiral arms of the Milky Way are identical, why central mass density in nebulae clusters is enhanced, and why gravitational lensing is anomalously intensive. Total mass of universe is estimated 1.74×10^{53} kg, consistent with astronomic number of galaxies. The product of this mass by H is constant, according to which the acceleration of expansion is caused by mass exiting from the observable region of the universe.

1. Introduction

Dark matter and dark energy are thought to account for approximately 95% of the matter in the universe (NASA, 2021). The dark matter is supposed to enhance the power of gravitation in spiral galaxies (Rubin, 1980) and galaxy clusters (Zwicky, 1937), since the amount of ordinary matter is far too less explaining the orbiting velocities of stars in the spiral arms and mass distribution in the clusters. Further evidence of dark matter is given by the enhanced intensity of gravitational lensing (Taylor, 1998). The origin of dark energy stems from the proposal of Einstein introducing the Λ cosmological constant present everywhere in the universe, the role of this energy is to balance the attractive power of gravitation.

Though the Λ-CMD model (Cold Dark Matter) can offer proper explanation for many cosmological observations, the theory is still struggling with a few unanswered questions:

- Why is dark matter concentrated in the external zone of astronomical clusters?
- Why one cannot observe any non-baryonic particles (Weakly Interacting Massive Particles, WIMP)? (Bertone, 2010, Joss, 2016)
- What is the physical origin of dark energy?

The classical law of gravity is based on observing planetary motions within the solar system. The size of the solar system is less than hundred thousandths of the size of the Milky Way, so it is not unreasonable to ask whether the law of gravity still applies throughout the galaxy and even in the intergalactic space? A few alternative cosmologies have already been developed in which modified gravitational rules were suggested to replace the role of dark matter (MOND, Modified Newtonian dynamics). In Milgrom’s concept at a great distance from the galactic center, gravitational force came to vary inversely linearly with radius as opposed to the inverse square of the radius, as in Newton's law of gravity (Milgrom, 1983). This model can help to reproduce the flat shape of the radial acceleration relation (RAR) in the case of spiral galaxies (Chae, 2020), and it can partially resolve further astronomical questions, but misses to explain the origin of dark energy. Furthermore, Milgrom's law is not a complete and self-contained physical theory; it has an interpolation function and ad hoc empirically motivated modifications in the classical gravitational equation.

In order to surpass ad hoc hypothesizes in the Λ-CDM and MOND theories, we present a new modified gravitational theory based on a priory principles. In this force model attraction between massive objects passes into repulsion at intergalactic distances, which explains the origin of dark energy on the one hand and provides an alternative for the role of dark matter on the other. The starting point of the model is Einstein's concept of gravity, which he traces back to the curved structure of spacetime, we extend this concept by a mediation procedure introduced in field theories (e.g. quantum electrodynamics, QED) to describe long-distance interactions. This mediation, however, has no quanta, unlike the mechanism of virtual photons mediating electromagnetic interaction. The non-quantum nature of gravitational theory is consistent with the continuously observed trajectories of macroscopic bodies, which do not require seeking a quantum description. This standpoint is supported by the long failure for developing a consequent quantum theory for gravitation. In microscopic level the suggested mediators are emitted and absorbed by the mass of elementary particles (baryons) and represented by spherically symmetric circulations in the spacetime, which creates spatial curvatures due to the Lorentz contraction effective in rotating non-inertial frames. (Though the transformation laws of special relativity are valid for inertial frames, the rule of Lorentz contraction can be applied in non-inertial systems as well, since any accelerating frame can be decomposed into infinitesimal parts. While in an inertial frame Lorentz contraction causes only an apparent shortening, the curvature in a rotating system is frame independent.)

We call the mediators of gravitation as keplerons for the honor of Kepler, since the velocity of circulation follows Kepler’s law. Virtual kepleron rotation has spherical symmetry, which can be represented by two-dimensional circulations around two equivalent axes. This circulation can also be called spherical rotation. These mediators propagate with the speed of light similarly to the photons.

Although we cannot speak explicitly of the mass of the kepleron, it circulates around the mass like a physical object with infinitely small mass. Since no momentum or spin is assigned to the kepleron, it mediates the interaction differently than the photon: its mediation is carried out through the spatial curvatures created by the spherical circulation of space. This circulation reduces the area of spherical surfaces due to Lorentz contraction, while it does not change the radius of rotation.

The sign of spatial curvature is related to the character of non-Euclidean geometry (elliptic or hyperbolic) and determines whether the gravitation is attractive or repulsive. In the following we will show that this sign is inverted by the accelerating expansion of space and this inversion can turn attractive gravitation into a repulsive force between galaxies. Furthermore, we will demonstrate that the inversion of gravitation can interpret the origin of dark matter and dark energy.

2. Theory

2.1. Spherical circulation of space

How can we develop a force law, where gravitation is attractive at short distances and becomes repulsive at large distances? The starting point is the spatial geometry produced by the individual baryons, which builds up all macroscopic objects. The addition rules of individual curvatures determine the metric tensor of space. According to Einstein's concept of gravitation, attraction and repulsion can be related to the sign of curvature in spacetime. In this paper we limit ourselves to the Schwarzschild metric (Schwarzschild, 1916) and focus our attention to the predominant spherically symmetric term in the 4x4 dimensional metric tensor. This is true for individual atoms, but it is true for macroscopic bodies only as long as they are spherically symmetric celestial objects, such as stars and planets. In the interior of galaxies, it is necessary to account for the entire anisotropic curvature structure, but at great distances, about 10 million light years (Mly) from the center of the galaxy, we can get a good approach in spherically symmetric approximation. (For interpretation of the cosmic gravitational waves in the LIGO experiments (Barish, 1999) the space anisotropy plays a crucial role, but this question is outside of the scope of present paper.)

Above the boundary of 10 Mly, the receding velocities of galaxies follow the Hubble law, that is, $u = HD,$ where *D* is the distance between galaxies. In the following analysis we discuss how this motion can be connected to spherical circulation of the space around massive objects. Assumption of this spatial motion is based on the Kepler-Newton law (KNL) in which the *v* velocity of orbiting is independent of the *m* mass of the circulating planet and depends only on the *M* mass of the central object provided by that *m* is small compared to *M*. According to KNL, $v^2 = GM/R$, where *R* is the radius and *G* = 6.67×10^{-11} $mkg^{-1}s^{-2}$ is the general gravitational constant. Since the circulating velocity *v* is the same particularly for infinitely small mass, it is justified to assume circulation for the massless light or empty space around the massive objects. This is the point where we can borrow the basic concept of QED, in which the electromagnetic interactions are mediated by virtual photons emitted and absorbed by the charge of the elementary particles.

2.2. The kepleron as a non-boson mediator

There are two protagonists in the concept, the atom, whose mass creates gravity, and the space, which mediates it. Space is conceived as an object with infinitely small mass, which becomes the mediator of interaction through its own movements (circulation or expansion). The mass of the atom initiates circulation, the speed of rotation of which depends on the mass and, according to Kepler's law, decreases with distance. The mediator is virtual emitted and absorbed by the massive objects and have spherical symmetry and propagate, like photons, at the speed of light. Empty space has no finite mass, we do not assign energy, momenta, quanta or spin to its circulation, nor can we consider this space motion a real boson. Therefore, the kepleron cannot be considered a real particle of the Standard Model, unlike the graviton with spin S = 2 required by the hypothetical theory of quantum gravity (Zee 2018). (That is why we propose to the mediator of gravity a distinguished name, kepleron, which was denoted elsewhere as screw (Rockenbauer, 2015). It should be also noted that the kepleron mediated mechanism cannot be classified as a theory of quantum field, it is a rather phenomenological concept.)

Intensity distribution of keplerons follows the KNL, thus it is proportional to the M mass of the emitting objects and decreases with the square of radius. The product of the square of v velocity and R rotation radius is constant according to the KNL: $v^2R = GM$. The mechanism of mediation for keplerons is based on the spatial curvature created by the Lorentz contraction of $\beta = \sqrt{1-(v/c)^2}$ where v is the circumferential velocity. The curvature is related to the asymmetric character of contraction, which reduces the surface of sphere while the radius of circulation is not altered. The reduced ratio of surface versus $4R^2\pi$ creates a 3D elliptic (Riemann) geometry. From this ratio the radial or Lorentz-curvature RC can be defined as:

$$RC = \frac{Surface\ of\ sphere}{4R^2\pi} - 1 \qquad (1)$$

If no circulation takes place, RC is obviously zero. This definition postulates the sign to make RC negative for attraction. (In the metric of Einstein's equation RC can be related to $g^2_{\varphi\varphi} - g^2_{rr}$ in the r, ϑ, φ polar system.) The curvature increases with the square of v velocity due to the Lorentz contraction:

$$RC = -\frac{v^2}{c^2} \qquad (2)$$

The negative sign of curvature corresponds to the attractive gravity. Then the relation $v^2 = GM/R$ gives the potential energy of gravitation defined by the product of dimensionless curvature with the mc^2 mass-energy equivalence:

$$V_{gr} = RC \cdot mc^2 = -\frac{GMm}{R} \qquad (3)$$

The role of the radial curvature RC in the theory of gravity corresponds to the scalar potential in the case of electromagnetism. In the former, RC is multiplied by mass, while in the latter, the same is given by multiplying the scalar potential by charge. Then the negative gradient reproduces the Newtonian force law:

$$F_{gr} = -\frac{GMm}{R^2} \qquad (4)$$

This force law can be interpreted also as a product of kepleron intensity GM/R^2 and the mass m.

The purpose of above elaboration was to show that the kepleron circulations can well reproduce the classical gravitation law. Even the relativistic correction of Schwarzschild can be reproduced by making use the law of energy conservation expressed in the theory of relativity by the covariance principle. When two massive objects are connected, the original energy of objects changes due to the binding energy. Let us consider the Sun of mass *M* and a planet of mass *m*, before the planet is captured. Then the combined energy of the two independent celestial bodies can be given in the inertial system of Sun:

$$E = (M' + m')c^2 = Mc^2 + \sqrt{p^2c^2 + m^2c^4} \approx (M + m)c^2 + \frac{p^2}{2m} \qquad (5)$$

Here *M'* and *m'* are the modified mass in the bonded system, and *p* stands for the momentum of planet. This approximation is valid when the order of v/c is 10^{-4}. After capturing the planet, the kinetic energy can be expressed by the angular momentum *L*:

$$E_{kin} = \frac{L^2}{2mR^2} \qquad (6)$$

In the orbital motion of planet its potential and kinetic energy are connected:

$$V_{pot} = -\frac{GMm}{R} = -2E_{kin} \qquad (7)$$

Unlike fusion reactions, planetary capture does not produce energy radiation, so the total energy of the Sun + planet system remains unchanged, resulting in an increase in the mass of the Sun and planet. Relativistic mass growth adds a relativistic contribution to gravitational potential energy:

$$V_{rel} = -\frac{GML^2}{mc^2R^3} \qquad (8)$$

The difference between gravitational formulas given by Newton and Einstein comes from the fact that Newton does not take into account the change in mass when celestial bodies are connected, unlike Einstein's theory, which takes this fact into account in the covariance law of energy. The agreement of Eq. (8) with Schwarzschild calculations shows (Schwarzschild, 1919) that the kepleron concept can also explain Mercury's perihelion precession. (At short distances and at high mass densities, Einstein's gravitational equation can differ significantly from Newton's theory, but in this paper we focus on phenomena occurring over long distances at lower mass densities. Any further relativistic effect like singularities could have minor importance since only large *R* distances are considered in this paper.)

The mediation model based on spatial circulations is equivalent with the concept of general relativity based on spatial curvatures. Einstein also suggested an equivalence rule between gravitation and inertial force in his elevator example. The same equivalence can be extended between the inertial force and gravitation in a merry go round.

2.3. Expansion of space

The basic law of physical cosmology was established by Hubble, who found that the recessional velocity of galaxies is proportional to their proper distance from the Milky Way, that is $u = HD$. The presently accepted value of Hubble's constant is *H* = 70 kms^{-1}/Mpc = $2.3 \times 10^{-18} s^{-1}$ (Freedman, 2021). The expansion of space is also a spherically symmetric motion similarly to the kepleron circulations. Due to the expansion the radius of kepleron will increase, which affects the spatial curvature on the opposite way compared to the circulation. Since in this case the motion takes place in radial direction, the Lorentz contraction will reduce the radius while the surface of sphere remains the same. Because of this, the ratio of surface versus $4R^2\pi$ increases compared to Euclidean geometry. The positive radial curvature corresponds to hyperbolic (Bolyai-Lobachevsky) geometry.

The *RC* value can be derived from Eq. (1):

$$RC = \frac{u^2/c^2}{1-u^2/c^2} \tag{9}$$

When the recession velocity *u* is small compared to *c*, *RC* can be approached:

$$RC = \frac{u^2}{c^2} = \frac{H^2R^2}{c^2} = \left(\frac{R}{R_{HS}}\right)^2 \tag{10}$$

Here $R_{HS} = c/H =$ 13.78 Gly denotes the Hubble sphere, this distance can be covered by light during the total age of universe. This relation is valid if *R* is small compared to R_{HS}, but, anomalously, for galaxies of extremely far away – close to R_{HS} – the curvature is larger compared to the approximation in Eq. (10).

The positive sign of *RC* represents repulsion mediated by the inverted keplerons. We speak about inverted keplerons when the *u* recession velocity exceeds the *v* circulation velocity. Since the opposite radial dependence of kepleron intensity GM/R^2 and curvature $RC = H^2R^2/c^2$ cancel each other, the antigravitation force exerted on the *m* mass will become independent of the distance:

$$F_{agr} = \frac{GMmH^2}{c^2} = GMm/R_{HS}^2 \tag{11}$$

In the transitional domain where the velocities *u* and *v* are comparable, gravitation and antigravitation can cancel each other, while in the domain where *u* is close to *c* an enhanced relativistic *RC* value is given by Eq. (9) and the complete kepleron force is:

$$F_{kepleron} = \frac{GMm(u^2-v^2)}{(u^2R_{HS}^2+v^2R^2)(1-u^2/c^2)} \tag{12}$$

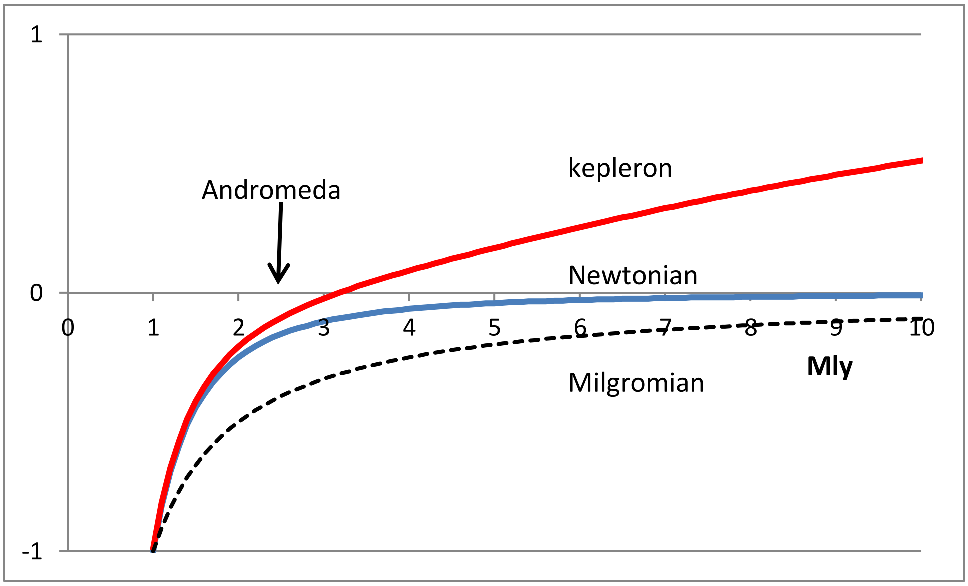

Figure 1. The Milgromian (staggered, black), Newtonian (solid, blue); and kepleron (solid, red) forces (axis y) are compared as a function of distance from the center of Milky Way (axis x). Compared to the Newtonian force the decrease of Milgromian force is slower, while the kepleron force decreases faster. The attractive kepleron force turns into repulsive at ID = 3.26 Mly.

The above considerations allow to interpreting the dark energy of the Λ-CMD cosmology as a sum of galactic antigravitation (GAG) in the whole universe. The GAG force of Eq. (12) has a very unusual feature: its power does not decrease with distance, and even can increase for galaxies at extremely high distances where the recession velocity is close to *c* (See Figure 2).

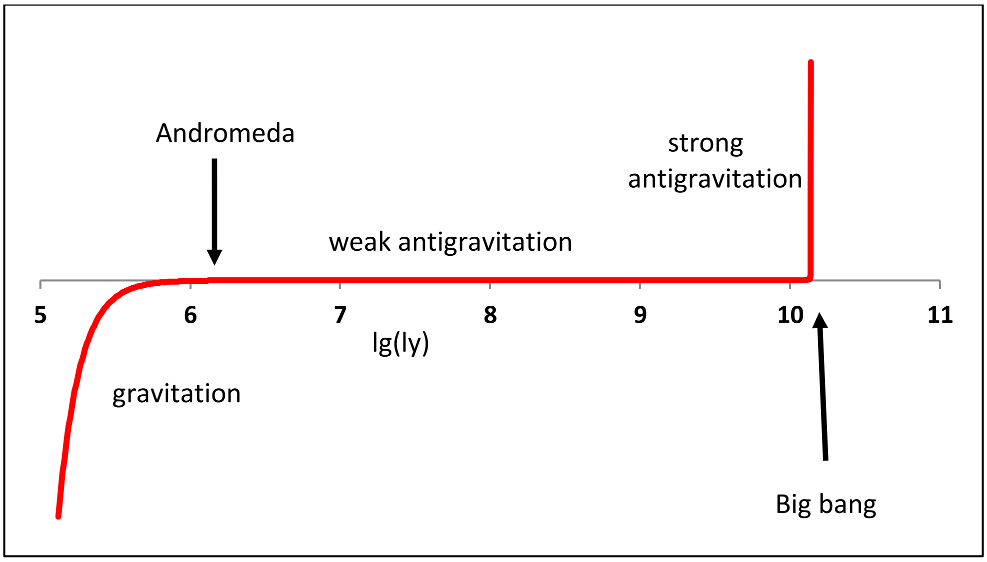

Figure 2. The kepleron force (axis y) is given as a function of logarithmic distance (axis x) from the center of Milky Way in ly units. Left: Newtonian gravitation, middle: weak antigravitation, right: relativistic antigravitation for galaxies with recession velocity close to *c*.

At intermediate distances antigravitation between galaxies is practically constant and rather weak, in absolute value it is equal to the usual gravitational force between two galaxies at the largest observable distance, namely at R_{HS}. All galaxies in the observable universe can contribute to the repulsive energy in the intergalactic space, which integrates the impact of masses in the whole universe. Since all physical interactions propagate with the speed of light, the antigravitation energy accumulates the impact of the entire history of universe and it seems that galactic motions in the early universe can have a decisive imprint on the present structure and motion of astronomical objects. The important role of early galaxies is expressed in the dominance of dark energy, which is defined as a driving force for the accelerating expansion of universe. Originally Einstein introduced this energy by the Λ cosmological constant to counterbalance the gravitation in the field equation of general relativity. In the cosmology proposed in this paper this repulsive energy is not an *ad hoc* constant in space, but expresses the repulsive gravitational energy of ordinary matter, which is not uniform, it can be different from galaxy to galaxy. Accordingly, there is no need to speak about vacuum energy or energy of the empty space (Sean, 2001). Proposed model also supports the concept of flat universe (Shirley, 2008) since the antigravitation is very weak between individual galaxies except where the distance is close to R_{HS}.

Extragalactic compression also explains the stability of rotating spiral galaxies and the enhanced mass density of complex astronomical objects. Any selected object is surrounded by hundred billions of galaxies and their repulsive force creates a strong external compression. This compression can substitute the attractive force of hypothetical dark matter, that is, the kepleron concept can replace the dark matter in all its aspects. It means that all results gained by the Λ-CDM theory (NASA, 2021) can be utilized, and there is no need to assume arbitrary distribution of dark matter, or to search for any non-baryonic particles.

3. Discussion and Results

3.1. Inversion distances

Gravitation is inverted into antigravitation if the *v* circumferential velocity of keplerons at *R* distance from the center of an emitting massive object becomes equal to the *u* velocity of space expansion:

$$R^3{}_{ID} = \frac{GM}{H^2} \qquad (13)$$

The third power of inversion distance (ID) is proportional to the mass of astronomical objects. In the case of Milky Way (Carlesi, 2022) the mass is estimated around 2.3x10^{42} kg and consequently the gravitation is compensated at the distance 3.26 Mly. In this estimation the overall mass includes the hypothetical dark matter, as well. Smaller inversion distance is obtained if only the ordinary matter is taken into account. If interstellar gas and dust as well as contribution of the halo are included (Gupta, 2012), the observable mass of the Milky Way can be around 0.5x10^{42} kg, which yields an ID of 2 Mly. The value obtained at the inversion distance is of particular significance because the conversion of gravity to antigravity is not just a hypothesis, but an experimental fact supported by astronomical data! This ID is less than the average distance between neighboring galaxies (c.a. 4 Mly), that is, practically all galaxies repel each other. Systematic recession from the Milky Way can be observed for galaxies farther away than 10 Mly, in this domain the overall mass of astronomical objects can be large enough to produce adequately strong tossing power. However, no efficient tossing or attracting power is expected between the Milky Way and Andromeda Galaxy separated by 2.5 Mly in the Local Group, where the distance is close to ID. In this case the random character of galactic motion determines whether the nebulae are approaching or moving away from each other.

The inversion radius of galaxies of the order of millions of light-years also determines the resolution of antigravitational repulsion. It exerts compression and rotation on objects whose size is comparable to the inversion radius, therefore it plays an important role in the structure and motions of galaxies and galaxy clusters, but it does not affect the gravitational conditions of relatively small astronomical objects, such as the interior of the solar system.

We can define ID for any well separated massive objects. ID increases with the cubic root of mass. For electrons ID is 1 cm, for hydrogen atoms 20 cm, for heavier atoms around 1 m, for the Earth 1 ly, for the Sun 300 ly, for galaxies around a few Mly, respectively. Since in condensed matters the separation of atoms is around 10^{-10} m, which is much smaller than the ID of any massive particle, the spatial curvatures created by each atom add up linearly. In this case the amplitude of spatial curvatures will be proportional to the overall mass of condensed objects and the respective ID increases with the cubic root of mass. The summation rule of gravitation, however, is not valid in the intergalactic space where the number of hydrogen atoms can be less than 30 in a cubic meter (Gupta, 2010).

3.2. The total mass of the universe

A special ID can be defined for the entire observable universe, where the size is given by $R_{HS} = c/H$. The standard cosmological model allows expansion rates greater than *c*. This assumption allows a space domain outside the R_{HS} Hubble sphere but no information can be obtained from this external zone. It means that the overall gravitational energy should be calculated inside the Hubble sphere, and the force becomes zero at the limit R_{HS}. This boundary condition is equivalent in the kepleron model when the force of gravitation can be cancelled by antigravitation. Applying Eq. (13) for the whole universe its total M_U mass can be assessed:

$$M_U = \frac{c^3}{GH} = 1.74x10^{53}\text{kg} \tag{14}$$

This value is compatible with the astronomic estimation for the number of galaxies, since M_U is 350 billion times larger than the mass of Milky Way, and the number of galaxies is estimated between 200 billion and 2 trillion (Camarillo, 2018, Castelvecchi, 2016, Lauer, 2021). It is also important to emphasize that the product of the M_U mass of universe and the Hubble constant can be given by two basic constants of physics: the speed of light and the general gravitational constant. This expresses the fact that the accelerated expansion of space is governed by the overall mass of universe! The acceleration of expansion can be interpreted as some of the mass escaping from the observable region of the universe, since the expansion velocity can exceed the speed of light.

The power of GAG is rather weak when only two galaxies are considered. This fact can be visualized by comparing the power of antigravitation with that of the gravitation existing in the outer arm of Milky Way at 43 500 ly from the center (Goodwin, 1998). Here the attraction force is 100 billion times stronger than the repulsion between two galaxies of average size. The overall compression of 350 billion galaxies can enhance the stabilizing force by 3.5 times, which is close to the six times enhancement suggested in the CDM model. This estimation is valid if the Milky Way is indeed an average galaxy in size.

The kepleron model can be also tested by making use the proportion of dark energy in the universe (NASA, 2021). The sum of antigravitation energy is proportional to the square of M_U, if GAG is independent of the distance. (Note: The total number of pairs of galaxies making contact in the n-element system is n(n-1)/2, but the present of an object *A* interacts with the past of *B* and the present of *B* interacts with the past of *A*, respectively, which leads to doubling). Then the ratio of GAG to the energy of observable matter:

$$\frac{E_{GAG}}{M_U c^2} = \frac{GM_U H}{c^3} = 1 \tag{15}$$

In the Λ-CMD model the proportion of dark energy in the universe is estimated around 65-70 % (NASA, 2021). In Eq. (15) the overall GAG energy is equal to the energy of ordinary matter. This ratio is derived from the truncated Eq. (10) RC formula, which significantly underestimates the GAG energy for galaxies with large recessional velocities. The large proportion of dark energy can be assessed to the relativistic effect of galaxies receding from each other at the velocities close to *c*, that is the major contribution to the GAG energy are given by galaxy pairs of extremely far distance. It means that the early history of universe has a predominant imprint on the present universe.

3.3. Astronomical evidences for the kepleron concept

There is a clear example, where the kepleron model offers more convincing explanation than the Λ-CDM cosmology: this is the flat dependence of orbital velocities in the arms of spiral galaxies (Joss, 2016). In the Milky Way this velocity is between 210-220 kms^{-1}. The rotation curve of the Milky Way agrees with the universal rotation curve of spiral galaxies. The nearly constant velocity is contrary to the KNL, where the velocity has to decrease with the radius of spiral arms according to the rule $v^2 = GM/R$. This contradiction is resolved in the CDM model by assuming a particular distribution of dark matter concentrated mainly in the external zone of the spiral galaxy. There is, however, a rather weak point in this argument: if dark matter can govern mass distribution of the ordinary matter by the gravitational law, why is the same law not effective for the distribution of dark matter itself? Maybe a further unknown force exists organizing the distribution of dark matter? Further disputable point is, that in spite of many efforts, not any non-baryonic particles were detected. Our proposed model, based on the external compression, avoids these logical pitfalls. Pressure is determined by the ratio of force to compressed surface. The surface of spiral arms is proportional to the product of the *R* radius and thickness, where the thickness is the same in each spiral arms (Bland-Hawthorn, 2016) and, consequently, the external pressure will decrease linearly with *R,* similarly to the centrifugal force. This circumstance clearly explains why the orbital velocity of stars does not depend on the radius of the spiral arms. The external compression can also explain the anomalously large mass density in the globular clusters (Zwicky, 1937), and so is the case for the enhanced intensity of gravitational lensing (Taylor, 1998).

There are further phenomena that the CDM model cannot properly describe, while the kepleron concept can offer straightforward explanation. Look at a few examples! Why do the majority of galaxies have a spiral structure indicating rotation of the whole nebula? The reason is that the symmetry of GAG compression is not perfectly isotropic in space and can be different for individual galaxies. The anisotropic compression can yield to torques causing the galaxies to rotate. This concept is in line with the observation that the cosmic microwave background is also anisotropic (Riess, 1998 and Perlmutter, 1999). Recently oscillation of stars was observed in the Milky Way (Poggio, 2020). This oscillation can be created by an inhomogeneous compression in the plane of galactic disk.

The age of Milky Way is close to the age of universe allowing more than a dozen revolutions, but the number of arms is much less (Sparke, 2007). The reason is the stability limit of galaxies: when the size of galaxy exceeds a limit, the separation of stars becomes larger than their ID causing repulsion between the neighboring stars in the external arm. Another astronomical phenomenon that needs to be reinterpreted is the question of non-observable Great Attractor (Dressler, 1994). In the model based on galactic repulsion, the inhomogeneity of spatial distribution can toss the Milky Way in the direction of the constellation of Centaurus at about 600 kms^{-1}. At the largest scale, the associations of nebulae are generally arranged into sheets and filaments surrounded by immense voids (Tully, 2008 and Bradley, 2013). These astronomical phenomena also point to external compression present throughout the universe.

4. Conclusions

A new cosmology is developed in which the whole universe is built up exclusively from observable materials and all anomalies observed for densities and orbital motions of stars in astronomical clusters are interpreted by a predominant external compression. Galactic antigravitation explains the origin of dark energy and substitutes the role of hypothetical dark matter in the Λ-CDM cosmology. The proposed concept can avoid any arbitrary and non-controllable assumptions for distribution of the non-observable dark matter and there is no need to assume existence of any non-baryonic particles.

In microscopic level gravitation is mediated by keplerons emitted by the mass of baryons, which interaction is integrated for macroscopic bodies and can turn attraction into repulsion at intergalactic distances. The respective borderline depends on the cubic root of mass of astronomical objects. Inside galaxies the massive force is attractive due to elliptic geometry, while the intergalactic space has hyperbolic geometry causing repulsion between galaxies. The proposed modification of gravitational force brings about a change only at intergalactic distance. It doesn't change the way LIGO experiments are evaluated either, because gravitational waves are created by black holes merging inside galaxies.

The great variety of galaxies reflects the local differences of external compression, in which inhomogeneity and anisotropy can play a decisive role. Through the boundary condition of the universe, an estimate can be made of its total mass, which is consistent with astronomical data. The acceleration of expansion is interpreted by the escaping mass from the observable region of the universe, when the velocity of expansion exceeds the speed of light.

In the early epoch of the universe, there was neither antigravity nor external compression; the entire universe was built up by a single elliptical geometry, which was then torn apart into separate clusters of galaxies by the Big Bang and inflation. In the history of the evolution of the universe, galactic separation has led to secondary expansion and external compression because in the multicenter universe isolated elliptical regions are enclosed in hyperbolic space. This geometrical concept explains the subsequent stages in the cosmological history.

Our concept is limited to the isotropic component of the 4x4 metric of spacetime in the theory of general relativity. Elaboration of a more complete theory is under development in which the kepleron concept can be combined with the field equation of Einstein.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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