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Review

Dark energy and gravity: Reconsidering Newton's law of universal gravitation

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In many theories of gravity, the cause of gravity is neither mentioned nor clarified yet. Dark energy, which makes the universe accelerate and push all matters in the universe apart, has repulsive power. Every matter in space is equally pressured by this repulsive force from all directions. It is assumed that this force comes from infinity in space. However, if matters exist nearby, the matters shield each other from the repulsive force; and thus, the repulsive force acting on the matter is not isotropic anymore. When two nearby bodies are applied with this shielding effect, they are pushed toward each other; and the theoretically derived net pushing force on each body is mathematically equivalent to the Newton's attractive gravitational force. This result shows that the gravity may come from dark energy.

Key words: Dark energy, gravity, cosmic repulsive force, shielding effect, expanding universe.

INTRODUCTION

The expansion of the universe becomes known to mankind for the first time by the Hubble's observations in 1929 (Hubble, 1929). In the early 1990s, it was found out that the expansion was accelerating (Riesse et al., 1998; Perlmutter et al., 1999; Perlmutter, 2003), and the cause of the expansion was dark energy which permeated all of space (Riesse et al., 1998; Perlmutter et al., 1999; Peebles and Ratra, 2003; NASA and Riess, 2001; NASA and Riess, 2009). Dark energy pushes all matters in the universe apart. On the contrary, gravity pulls all matters together and makes them move toward each other. In 1687, although it was not theoretically derived, Isaac Newton announced the law of universal gravitation (Cohen, 1978), and Albert Einstein's theory of general relativity provided a unified description of gravity in 1915 (Wald, 1977). However, neither of them mentioned what caused gravity or where gravity came from exactly. In the Einstein's general relativity equation, the cosmological constant was needed to allow a static universe, because at that time dark energy was not discovered (Harvey, 2012). But, since 1990s, clear evidence for dark energy has been continuously found (Riesse et al., 1998; Perlmutter et al., 1999; Cong Ma et al., 2010; Tongjie Zhang et al., 2010; NASA et al., 2006, NASA et al., 2003; SDSS Collaboration, 2003).

Although scientists still have no physical understanding

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of dark energy's existence, they have come to believe that there must be dark energy which makes up roughly 68% of the universe (Planck Collaboration, 2013). The finding of dark energy gives a new motivation in our understanding of gravity.

The dimension assigned to the gravitational constant G in Newton's law of gravity is represented by "[L^3 /S^2 /M]" (Sim, 2013). In the dimensional meaning, the constant G is an accelerating rate of volume change per unit mass. This shows that the force of gravity may be related with the accelerating expansion of the universe. It is important because the dimensional meaning of G can indicate where the gravity comes from. There were some scientists who believed that gravity was a pushing, not attractive force before our finding of dark energy (Wright, 1979; Nieper, 1985; Edwards, 2002); however, their theoretical results were not supportive enough to satisfy the gravity described by Newton or Einstein.

In this study, the repulsive force or anti-gravity force acting on every matter by dark energy is defined as "Cosmic Repulsive Force (CRF)". This force is not a kind of force that is transmitted through normal matter. It is a property of space.

PARTICLE DEFINITION IN EXPANDING SPACE

In general, matter particles have a mass, and there are some particles that do not have a mass such as force particles of boson or particles of electromagnetic radiation (Braibant et al., 2012). Particles in this study are defined as anything that occupies a volume of space. The particles must withstand the accelerating expansion of the universe, and their inherent properties should not be changed by the expansion of the universe. Then, these particles are inevitably forced by CRFof the expanding universe.

Spherical shape of an ideal particle is introduced for the understanding of gravity. There is no vacuum of empty space inside the ideal particle. The wave or graviton, which may propagate or mediate the transmission of CRF, cannot penetrate the ideal particle. A proton or neutron is porous in nature. But it can be replaced by an estimated ideal proton or neutron.

Dark energy with some assumptions

Although it is still unknown how CRF propagates or where it comes from, this study suggests one assumption for CRF by considering the fact that the accelerating expansion of the universe is isotropic. That is, if a particle is present in space, CRF is assumed to be transferred from infinity and acts onto the particle from all directions (Figure 1).

The CRF shielding effect on the two nearby ideal particles

The CRF acting on an ideal particle is isotropic. Thus, the ideal particle alone in space cannot be accelerated. However, if CRF comes from infinity and nearby ideal particles shield each other from CRF, is the CRF acting on an ideal particle still isotropic? Figure 2B shows two nearby ideal particles forced by CRF. Under the suggested assumption that CRF comes from infinity, the two nearby ideal particles will partially shield each other from CRF.

Thus, the CRF acting on the two ideal particles is no more isotropic. As the CRF toward the side facing the two particles is not reached on the surface, the net CRF force on each particle is pushing toward each other (Figure 2). Therefore, the two particles are pushed away rather than attracted towards each other. The net pushing force by the partial elimination of CRF can be calculated for the ideal particles p_a and p_b (Figure 2). The CRF coming to the circular arc of DF in p_a is eliminated and thus not reached on DF (Figure 2).

We can obtain the length of chord DE from the right triangle ABC. The radius of p_a and p_b is ε_a and ε_b , respectively. If the intervening distance r is sufficiently large compared to the values of ε_a and ε_b, the length of chord DE gives the area of sphere's surface on which the CRF is eliminated. The calculated area in p_a is expressed by:

$$A = \pi \frac{{\varepsilon_a}^2 {\varepsilon_b}^2}{r^2} . \quad (1)$$

In the same way, the area by the circular arc of GH in p_b can be calculated, and the result is same with the obtained area by p_a . Thus, the net pushing force is proportional to the obtained area in Equation 1. This force can be expressed by:

$$f = C_p A,$$
$$= C_p \pi \frac{{\varepsilon_a}^2 {\varepsilon_b}^2}{r^2} . \quad (2)$$

Here, C_p represents the cosmic repulsive pressure per unit area.

The gravity for ordinary atomic matter

An atom is composed of electrons, neutrons and protons.

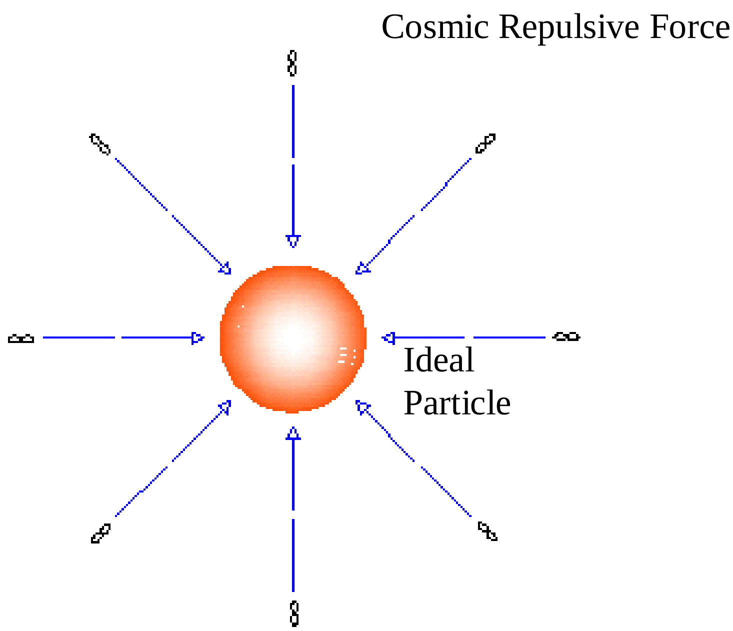


Figure 1. Assumption: CRF is transferred from infinity and acts onto the particle from all directions.

The mass or size of an electron is negligible compared to that of a neutron or a proton. A proton or a neutron can be considered as a unit particle consisting of ordinary matter. It can be replaced by its estimated ideal particle, and every ordinary matter consists of multiple ideal particles of proton or neutron. Figure 3 shows the two nearby bodies M and m: M having a mass of M, and m having a mass of m. Body M consists of p numbers of ideal particles and body m consists of q numbers of ideal particles.

For the i^{th} ideal particle of body M and the j^{th} ideal particle of body m, having a intervening distance r_{ij}, the infinitesimal net pushing force f_{ij} can be obtained by using Equation 2.

$$f_{ij} = C_p \pi \frac{\varepsilon_i^2 \varepsilon_j^2}{r_{ij}^2} . \quad (3)$$

Thus, the net pushing force F between the two bodies M and m can be obtained by summing all the infinitesimal net forces as follows:

$$F = \sum_{i=1}^{p} \sum_{j=1}^{q} f_{ij} ,$$

$$= \sum_{i=1}^{p} \sum_{j=1}^{q} C_p \pi \frac{\varepsilon_i^2 \varepsilon_j^2}{r_{ij}^2} \quad (4)$$

Here, if the radii of body are too small compared to the distance between the centers of the bodies, r_{ij} can be replaced by r (Figure 3). The mass of a proton is almost equal to the mass of a neutron; thus, the radii of ideal particle for a proton and a neutron are assumed to have the same value of ε. Then Equation 4 can be simplified as follows:

$$F = C_p \pi \varepsilon^4 \frac{pq}{r^2} \quad (5)$$

In Equation 5, p and q are the total numbers of the ideal particles contained in the bodies M and m, respectively. They are ultimately the sum of atomic mass number in their body M and m. As the mass of a neutron is almost equal to the mass of a proton, p and q have the following relationship with the mass M and m, respectively:

$$p = \frac{M}{w} , \; q = \frac{m}{w} \quad (6)$$

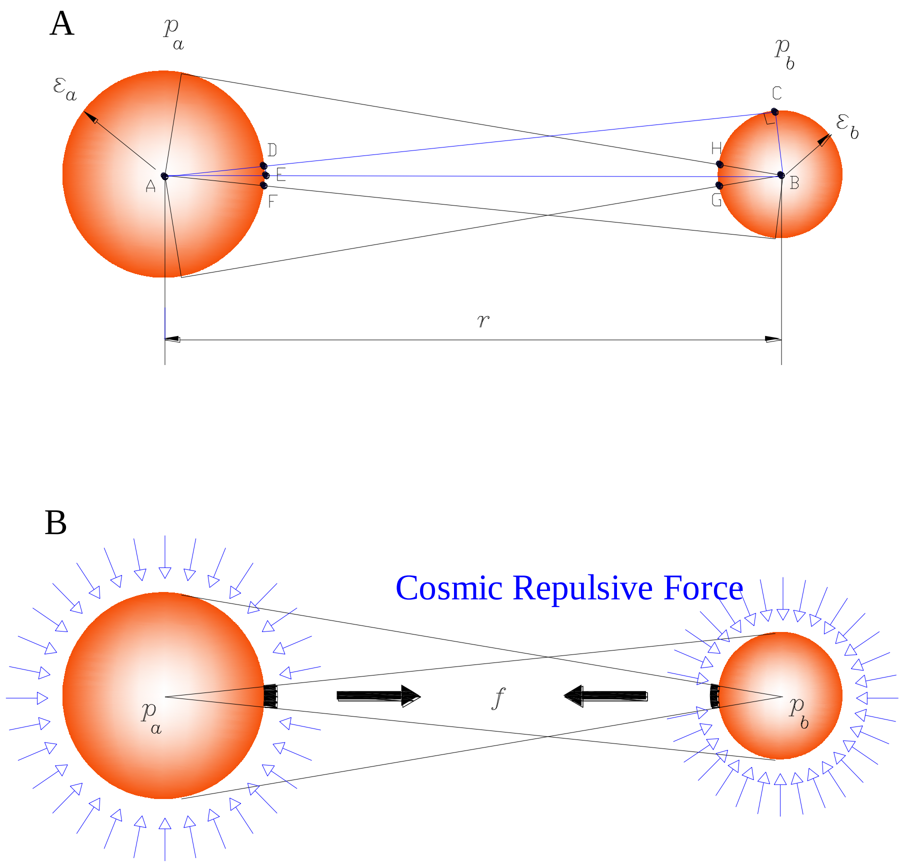


Figure 2. The partial elimination of CRF between the two nearby ideal particlesby shielding effect. (A) The right triangle to calculate the surface area of the eliminated CRF on the sphere of p_a and p_b. (B) The net pushing force between ideal particle p_a and p_b.

Here, w is the mass of aproton or a neutron. By using Equations 5 and 6, the net pushing force F can be defined by:

$$F = C_p \pi \frac{\varepsilon^4}{w^2} \frac{Mm}{r^2} \quad (7)$$

The mutual interference of the infinitesimal forces between the two bodies should be examined to satisfy Equation 4. The planet Earth, for example, has an apparent volume of $1.048 \times 10^{21} m^3$, but the volumeoccupied by nuclei is estimated to be $8.6 \times 10^6 m^3$, which is just 7.8×10^{-13} percent of the apparent volume. It means that the inside of matter is almost empty. Therefore, it is possible to assume that there cannot be mutual interference among the infinitesimal forces.

Comparisons with Newton's law of universal gravitation

The result obtained by Equation 7 is compared with Newton's law of universal gravitation which is described by:

$$F = G \frac{Mm}{r^2} \quad (8)$$

First, the net pushing force is inversely proportional to the square root of the distance between the nearby two bodies. Second, the net pushing force is directly proportional to the product of their masses. Third, we can find that the constant G is directly related with cosmic repulsive pressure C_p. By using Equations 7 and 8, the relationship between the gravitational constant G and

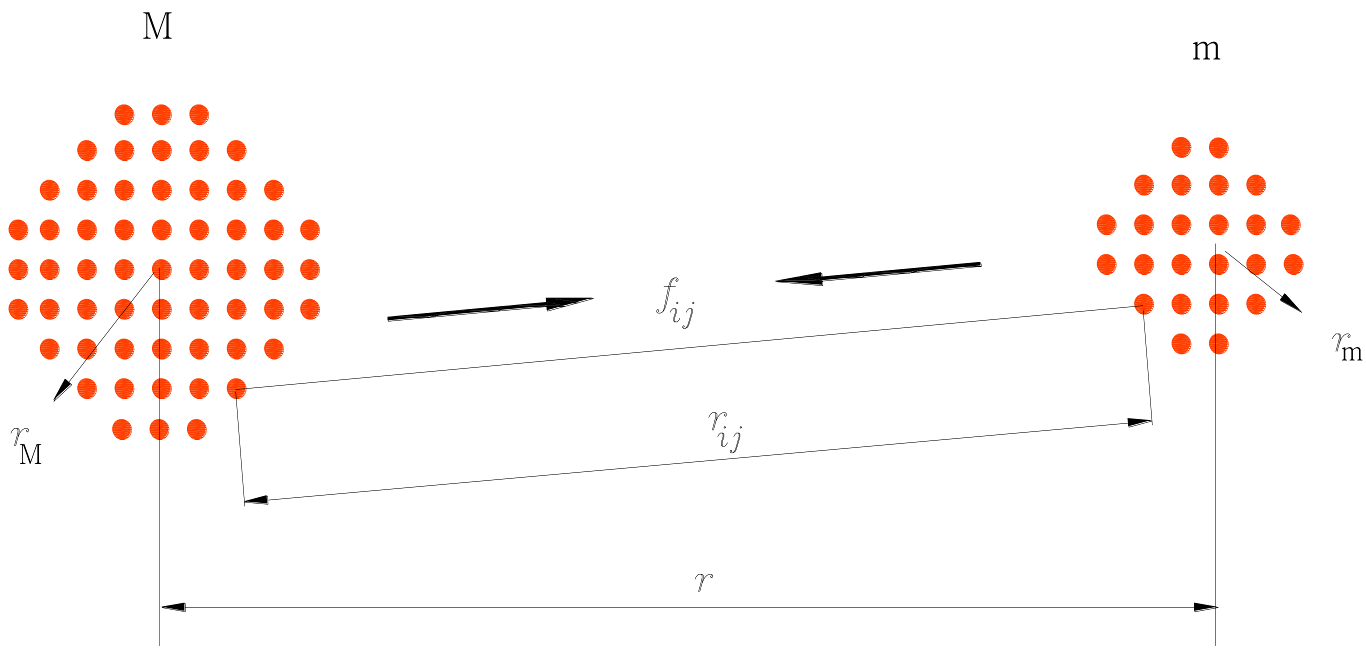


Figure 3. The infinitesimal net pushing force between the i[th] ideal particle of body M and the j[th] ideal particle of body m.

the cosmic repulsive pressure C_p can be obtained by:

$$G = \frac{\pi\varepsilon^4}{w^2} C_p \tag{9}$$

Several differences between the suggested analysis and Newton's law should be noted. First, the object that causes gravity is different from Newton's study. In this study, the object is every particle which occupies a volume of space.

Second, a new approach for the basic concept of gravity is suggested. Whereas Newton's laws assume that gravity is an intrinsic property of matter, this study suggests that gravity is a kind of external force acting on matter. This study has some consistency with Einstein's theory of general relativity. In the theory of general relativity, a massive object causes a distortion in space-time. Space-time curves in all directions when matter is present. The curved space-time field has effect up to infinity.

In this study, CRF acts on a matter from all directions when matter is present. It comes from infinity. The concept of curved space-time is consistent with the shadow effect by CRF shielding. All the small matters in the region of the large matter's shadow should have acceleration motion. Thus, the distortion in space-time due to the massive object can be a kind of distortion from the CRF shielding.

DISCUSSION

If the values of C_p and ε are known in the gravity Equation 7, the net pushing force *F* can be calculated, and the numerical result can be compared with that of the Newton's gravity. Unfortunately, the values of C_p and ε are not yet reported. However, the similarity between the two gravity equations shows how to evaluate the cosmic repulsive pressure. The Equation 9 explains how the gravitational constantG is related with the cosmic repulsive pressure. Figure 4 shows the predicted value of C_p which is dependent on ε. If the value of ε is the observed radius which is estimated to be 0.8775 fm, then the calculat C_p is about $1.68 \times 10^7 \, N/m^2$. Considering that the radius of an ideal particle for a proton can be smaller than the observed, the calculated C_p should be the minimum value.

Although there is much similarity between two gravity Equations 7 and 8, there may be different results in a special case that is elaborated. In Newton's gravity, the attraction force is always symmetric in the two bodies. The net pushing force in this study is obtained from the shielding effect. When the shape of shielding body is spherical, as shown in Figure 2B, the net pushing force is also symmetric. Thus, the results are expected to have the same values in the two gravity Equations 7 and 8.

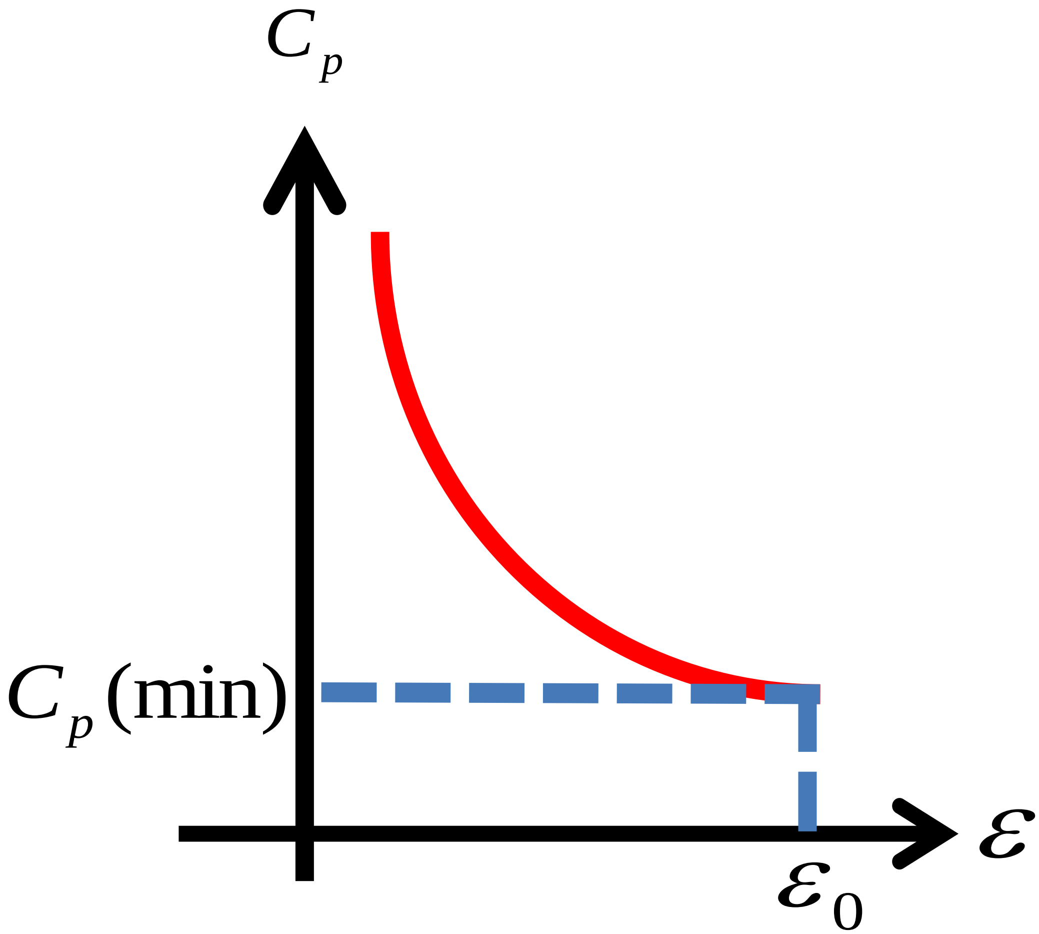


Figure 4. The graph for the relation between C_p and ε.

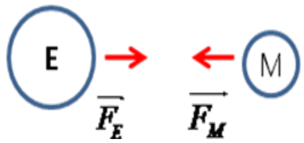
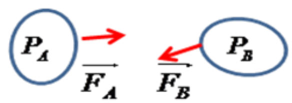
However, in the special case when the shape of body is non-spherical, the net pushing force defined by the Equation 7 becomes asymmetric in the two bodies. Almost all bodies which are moving in space have spherical shape. But, to see the inside of a molecule, it consists of many nuclei, and the nucleus is vibrating infinitely. The shape of this nucleus is a non-spherical type. This is a new attempt to investigate the internal forces of a molecule by the gravity theory. By applying Newton's gravity to the protons of the hydrogen molecule of gas, the attraction force is symmetric. Thus, the sum of the inner attraction force is zero. But when applying this paper's newly developed gravity theory to it, the inner attraction force is not zero because non-spherical type of proton makes an asymmetric attraction force by shielding effect.

Finally, the resulting attraction force comes to have some magnitude with direction. The random motion of hydrogen molecule of gas could be related with this mechanism. It is a suggestive result; however, more studies should follow to prove it. Table 1 shows the predicted differences between the Newton's gravity and this paper's theory of gravity. As an example of the spherical type, Earth-Moon in solar system has been introduced. As an example of the non-spherical type, a hydrogen molecule of gas has been introduced.

Conclusion

In this study, it has been assumed that the universe consists of vacuum of empty space and particles occupying a volume of space. Dark energy in the vacuum of empty space has repulsive power. This force named "CRF" pushes all the matters in the universe apart. The only assumption for CRF is that it comes from infinity. Although the verification of the assumption should be followed to assure this study, the theoretically derived net pushing force by the shielding effect well explains the gravitational attractive forcel. In addition, this study shows

Table 1. Predicted results from the concept of the two gravity equations.

Type	Object	$F = G\dfrac{Mm}{r^2}$	$F = C_p \pi \dfrac{\varepsilon^4}{w^2}\dfrac{Mm}{r^2}$	Remarks
Spherical -symmetric shielding effect	Solar system (Earth-Moon)	 $C_p = 1.68\times 10^7\, N/m^2$ $w = 1.67\times 10^{-27}\, Kg$ $\varepsilon = 0.8775\, fm$	$\vec{F_E} + \vec{F_M} = 0$ $\lvert\vec{F_M}\rvert = \lvert\vec{F_M}\rvert = 1.98\times 10^{20}\, N$	-same results
Non-Spherical *-asymmetric shielding effect*	Molecular of gas (H2)	 $\vec{F_A} + \vec{F_B} = 0$ $P_A = P_B = proton$ $\lvert\vec{F_A}\rvert = \lvert\vec{F_B}\rvert$	 $\vec{F_A} + \vec{F_B} \neq 0$ $\lvert\vec{F_A}\rvert \neq \lvert\vec{F_B}\rvert$	-different results *-the random motion of molecular of gas is possible*

that the value of gravitational constant G is dependent on the cosmic repulsive pressure C_p.

This result assures that gravity may come from dark energy and that gravity and anti-gravity can be the same kind of fundamental forces of nature. Any particles in space shielded from CRF can have acceleration motion. If this is true, all kinds of motion in objects, from galaxies and planet to the molecular gas can be related with this CRF shielding effect.

Conflict of Interests

The author has not declared any conflict of interests.

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REFERENCES

Braibant S, Giacomelli G, Spurio M (2012). Particles and fundamental interactions: An Introduction to Particle Physics (Springer). pp. 1-3.
Cohen IB (1978). Introduction to Newton's 'principia' (Harvard University Press, Cambridge.
Cong Ma, Tongjie Z (2010). Power of observational Hubble parameter data: A figure of merit exploration. Astrophys. J. 730(2):74.
Edwards MR (2002). Pushing gravity: new perspectives on Le Sage's theory of gravitation. Montreal: Apeiron.
Harvey A (2012). How Einstein Discovered Dark Energy. Available at: http://arxiv.org/abs/1211.6338v1
Hubble EP (1929). A relation between distance and radial velocity among extra-galactic nebulae. Proc. Nat. Acad. Sci. U.S.A. 15:168-173.
NASA, Blakeslee J (2003). Far-Flung Supernovae Shed Light on Dark Universe. Available at: http://hubblesite.org/newscenter/archive/releases/2003/12/.
NASA, ESA, Riess A (2006). Hubble Finds Evidence for Dark Energy in the Young Universe. Available at: http://hubblesite.org/newscenter/archive/releases/2006/52/.
NASA, ESA, Riess A (2009). Refined Hubble Constant Narrows Possible Explanations for Dark Energy. Available at: http://hubblesite.org/newscenter/archive/releases/2009/08/.
NASA, Riess A (2001), Blast from the Past: Farthest Supernova Ever Seen Sheds Light on Dark Universe. Available at: http://hubblesite.org/newscenter/archive/releases/2001/09/
Nieper HA (1985). Conversion of Gravity Field Energy (MIT VerlagOlderburg).
Peebles PJE, Ratra B (2003). The cosmological constant and dark energy. Rev. Mod. Phys. 75(2)559-606.
Perlmutter S, Aldering G, Goldhaber G, Knop RA, Nugent P, Castro PG, Deustua S, Fabbro S, Goobar A, Groom DE, Hook IM, Kim AG, Kim MY, Lee JC, Nunes NJ, Pain R, Pennypacker CR, Quimby R, Lidman C, Ellis RS, Irwin M, McMahon RG, Ruiz-Lapuente P, Walton N, Schaefer B, Boyle BJ, Filippenko AV, Matheson T, ruchter AS, Panagia N, Newberg HJM, Couch WJ, and The Supernova

Cosmology Project (1999). Measurements of omega and lambda from 42 high-redshift supernovae. Astrophys. J. 51(2):565–586.
Perlmutter S (2003). Supernovae, dark energy and the accelerating universe. Phys. Today 56(4):53-60.
Planck Collaboration (2013). Planck results, A&A. Available at: http://dx.doi.org/10.1051/0004-6361/201321529
Riesse A, Filippenko AV, Challis P, Clocchiatti A, Diercks A, Garnavich PM, Gilliland RL, Hogan CJ, Jha S, Kirshner RP, Leibundgut B, Phillips MM, Reiss D, Schmidt BP, Schommer RA, Smith RC, Spyromilio J, Stubbs C, Suntzeff NB, Tonry J (1998). Observational evidence from supernovae for an accelerating universe and a cosmological constant. Astrophys. J. 116(3):1009-1038.
SDSS Collaboration (2003). Physical evidence for dark energy. Available at: http://arxiv.org/abs/astro-ph/0307335.
Sim CG (2013). The universal law of gravitation and the hubble constant. J. Chungbuk Health Sci. Univ. 22:57-68.
Tongjie Z, Cong M, Tian L (2010). Constraints on the dark side of the universe and observational Hubble Parameter data. Adv. Astron. 14p.
Wald R (1977), Space, Time and Gravity (Chocago Univ. Press).
Wright WC (1979). Gravity is a push (Carlton press).