A review on gravity, antigravity, and gravitational shielding along with related prospective viewpoints and possible practical applications

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Abstract

Subjects on gravity, antigravity, and gravitational shielding are reciprocally related one another. However, we find very few papers which deal with this interrelated topic from the global standpoint. Gravity and gravity-related topics are one of the most intriguing pieces of area to physicists as an ever-lasting and interesting topic and they will continue to be so for many years to come. Einstein's General Relativity equation is ingenious as far as the gravity concept is concerned. However, the contradiction between quantum mechanics and General Relativity has not yet been elucidated. Edwin Hubble reported in 1929 classical article on the expanding universe. By his finding the antigravity effect has been evidenced. Gravitational shielding devices have been reported by many researchers. At this point we would expect more powerful gravitational shielding devices will be developed in the near future. Based on this review article, several prospective and practical concepts and ideas are presented including a cosmic elevator, use of sky-space for vehicles, and modified equation for gravity.

Keywords: gravity, antigravity, gravitational shielding, diamagnetism, superconductor

1. Introduction

Issues on gravity, anti-gravity, and gravitational shielding are corelated and interrelated one another. However, very few articles are published to discuss this interrelated topic from the global standpoint. Gravity and gravity-related topics are ever-lasting and interesting subjects and will continue to be so as a mysterious topic for many years to come. This article intends to elucidate the gravity and gravity-related topics from the broader, more synthetic, and more composite viewpoints. By pursuing the topics in this way, we may be able to acquire some explicit clues to clarify this mysterious paradigm. The antigravity effect has been evidenced by Edwin Hubble's achievement which is a classic finding on expanding universe. Hubble showed that galaxies recede from us and that the further the distance the more rapidly the galaxies recede. Many researchers have devoted their endeavors to find gravitational shielding devices. However, the shielding effect of those devices is too weak to be for a practical use.

It is said that most of the energy force phenomena in the universe can be interpreted applying one or more of the following interactions.

(1) electromagnetism
(2) weak force
(3) strong force
(4) gravity

Researchers have devoted their time to draw various valid predictions from the gravity and gravity-related subjects with experimental results, theoretical observations, and many suggestions. None of those are final. Therefore, the assumptions of another side of gravity, negative gravity, or antigravity, along with its attractive side may give us a reasonable solution to gravity theory [1]. Newton has succeeded to qualify gravity as attractive force using his universal gravity theory. Einstein, in context of his theory of General Relativity (GR), has interpreted gravity as a geometric, space-time curvature. Now one can interpret more physical phenomena than using Newton's one. However, it suffers from several problems, especially those connected with the recent following observations [1].

(1) supernova type la observation [2] [3];
(2) the rotation velocities of stars in spiral galaxies [4];
(3) pioneer 10, 11 velocity observation, "Pioneer Anomaly" [5];
(4) the mass discrepancy in clusters of galaxies [6]

Gauge particles which mediate electromagnetism, weak force, strong force, and gravity are photon, weak boson (Z particle and W particle), gluon, and graviton, respectively. Graviton is not discovered yet. It is long-range force and has neither mass nor charge with the number of spins being two.

Although we are now living in electromagnetic civilization because most of tools depend on electromagnetism, gravity is one of the most miraculous fields of physics [1,2] . Amallanah et al. reported that they discovered the well-measured Type la supernovae at high redshift. Eight new supernovae in the redshift interval of z = High –z were discovered by the High-z supernova Search Team[2]. Cao et al. reported observations with the Swift Space Telescope of strong but declining ultraviolet emission from a type la supernova within four days explosion and indicated that the emission is consistent with theoretical expectations of collision between material ejected by the supernova and companion star. Therefore, this finding provided evidence that some type la supernova arose from the single degenerate channel [3]. The mass discrepancy in clusters of galaxies is reported by pertinent researchers. In order for them to achieve the result they obtained the universal rotation curve of disc galaxies and the corresponding mass distribution out to the virial radius by combining kinematic data of the inner regions of galaxies with global observational properties.

Tonry et al. reported for the first time the observational and experimental evidence for repulsive gravity which emerged from the analytical results of supernovae la observation [2]. They used sophisticated space telescopes and technology through which they measured long distances of the objects in the universe with high accuracy. They also obtained the radial velocities of such objects by measuring their red shifts [2].

Battaner et al. studied rotation curves of spiral galaxies emphasizing standard implication as evidence for the existence of dark matter halos [4]. They stated that when the universe inflated quantum mechanical fluctuations, which survived until the epoch of recombination, took place. They used telescopes and sophisticated equipment and measured long distances in the universe with high accuracy. Next, they obtained the radial velocity of such objects by measuring their red shift. Finally, they calculated the rate of expansion using Hubble's relation. They showed that the universe is in a phase of accelerating expansion. They concluded that their finding is in contradiction with all accepted theories of gravity including General Relativity.

Turyshev et al. stated that the radio-metric Doppler tracking data received from the Pioneer 10 and 11 spacecraft in heliocentric distances of 20 -70 AU have indicated presence of a small, anomalous blue-shifted frequency drift uniformly changing with a rate of $\sim 6 \times 10^{-9}$ Hz/s [5]. Bohmer et al generalized the virial theorem, which provides a general equation that relates the average over the time of the total kinetic energy of a stable system consisting of particles bound by potential forces with that of the total potential energy, in f(R) modified gravity using the collisionless Boltzman equation. They found supplementary geometric terms in the modified Einstein equation providing an effective contribution to the gravitational energy. They stated that the total virial mass was proportional to the effective mass associated with the new geometrical term which might account for the virial theorem mass discrepancy in clusters of galaxies [6].

The second evidence was reported by Battaner et al. who conducted so-called COW experiment [4]. In this study, neutron interferometer was used (Fig. 1). At the point a, beam A is split to A1 and A2, and A1 is reflected at the point b and A2 at the point d. Both reflected beams interfere at the point c. Providing that the path length ab is equal to dc and, ad to dc, and that the trajectory of the neurons is affected by the Earth's potential, a phase difference between the two beams A1 and A2 is expected. This is induced from the difference in earth's gravitational potential affecting the path ab and dc because of the fact that ab is closer to the Earth's surface than cd [1]. They used the theories for calculating the phase shift of quantum mechanics and Newton's theory of gravitation. The Earth's gravitational field is a weak field and Newton's theory of gravitation is a limiting case of General Gravity (GR) in the weak field regime. They found that the experimental results are lower than the theoretical prediction by eight point in one thousand. The absolute value (measured of this potential) is less than the corresponding value predicted by known theories of gravitation. One can probably interpret that this arises from repulsive force or antigravity reducing the value of the potential. The author also mentioned that this discrepancy may throw light on the mystery of physical nature of "Dark Energy" [1].

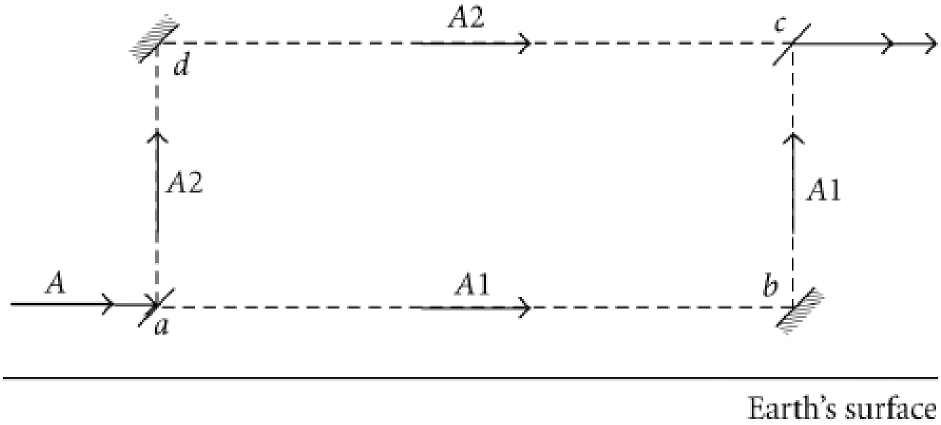

Figure 1 A study of quantum interference of thermal neutron moving in the Earth's gravitational field by using a neutron COW interferometer. 【The journal of this article is distributed under the Creative Commons Attribution License. Therefore, the requirement to cite this Figure is to ensure proper attribution which is 'M. I. Wanas," The other side of gravity and geometry: antigravity and anticurvature," Advances in High Energy Physics, vol. 2012, pp. 1-10, 2012'】

2. Gravity

a) Newtonian Theory

Now, gravitational theory was first proposed by Newton as follows:

$$F = G\frac{Mm}{r^2} \tag{1}$$

$$G = 6.67259 \times 10^{-11}\mathrm{m}^3 \cdot \mathrm{s}^{-2} \cdot \mathrm{kg}^{-1}$$

M is a mass of object M
m is a mass of object m
r is a distance between m and M

b) Einstein's Theory (General Relativity)

Einstein’s equation agrees with Newton’s equation in a limited case. In a simple way of saying, Einstein’s equation combines the space, time and gravity into one、and it indicates that the gravity is due to distortion (curvature) of the space-time.

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = (8\pi G/c^4) \quad T_{\mu\nu} \tag{2}$$

$G_{\mu\nu}$ is the distortion (curvature) of the space-time
Λ is the Cosmological constant
$g_{\mu\nu}$ is a (symmetric 4 x 4) metric tensor
G is the gravitational constant
C is the speed of light
$T_{\mu\nu}$ is the energy-momentum stress tensor of matter
μ is coordinate values, and runs from ct(0), x(1), y(2), z(3)
ν is also coordinate values, and runs from ct(0), x(1), y(2), z(3)
t is time

The right-hand side of the equation represents the energy of the matter, and the left-hand site, the curvature of the space-time.

Eventually, $G_{\mu\nu}$ can be further defined as;

$$G_{\mu\nu} = R_{\mu\nu} - 1/2 \; R \, g_{\mu\nu} \quad \text{or,} \tag{3}$$

$$G_{\mu\nu} = 8\pi T_{\mu\nu} \tag{4}$$

,where

$R_{\mu\nu}$ is the Ricci curvature tensor

R is the Ricci scalar (the tensor contraction of the Ricci tensor)
$g_{\mu\nu}$ is a (symmetric 4 x 4) metric tensor
μ is coordinate values, and runs from ct(0), x(1), y(2), z(3)
ν is also coordinate values, and runs from ct(0), x(1), y(2), z(3)
t is time

This Einstein's equation is based on the fact that the speed of light is the highest in the universe. At this point, we believe that there will be a material (or materials) which runs faster than the speed of light, because things unbelievable will exist in the universe. Besides, we do not know what is happening in some other parts of the universe. The other way of saying is that we should not definite matters by absolute terms such as highest, fastest, greatest、largest, and so on, as far as we deal with physics. In this universe anything new will show up. His theory may be true on the earth. However, there will be some substances which move faster than the speed of light in some other part of the universe. One example is a Dark Hole where light is absorbed rapidly, faster than the speed of light which is 299,792,458 m/s.

c) 'Faster Than Light' Photons

Shore reported the possibility of existence of 'faster than light' particle, under the title of "'faster than light' photons in gravitational field—causality, anomalies and horizons". He stated that the possibility of supplemental photon propagation arises because of Equivalence Principle violating interactions induced by vacuum polarization in quantum electrodynamics in curved spacetime. He added by indicating that real photons propagating in a variety of background spacetime may travel with speeds exceeding the normal speed of light [8].

Feinberd investigated the possibility of existence of particles that travel faster than light within the special theory of relativity. He stated that a description of such particles, called tachyon, is possible by the formation of relativistic quantum theory at least for the case of spinless, nonintegrating particles [9].

d) Phonon, and Gravitational-Wave

Volfson invented a device of phonon maser and mentioned that the beam generated from the device changes properties of ambient space, including its gravitational energy. The phonon maser is composed of a resonant cavity, superconductive gain medium, and pumping means. He states that his proposed discoveries and theories bring us closer understanding of gravitational energy and ways to affect its two main effects: repulsion and gravity. Conquering these effects would benefit humanity in many different ways [10].

A gravitational-wave and electromagnetic signal from the coalescing of two neutron stars (GW170817 and GRB170817A) presents not only a marvelous discovery but also challenges against the observational feasibility of large classes of gravitational theories for the late universe [10-16].

e) Dark Matter, and Dark Energy

According to the new Planck telescope observational data for the present epoch, the universe is consistently described by the ΛCDM (Lambda cold dark matter) model. The universe is nearly spatially flat and consists of ordinary matter, cold dark matter, and dark energy, in the ratio of ～4.9%, ~26.8%, and 68.3% [17]. ΛCDM model is a parameterization of the Big Bang cosmological model in which the universe contains three major components, a cosmological constant denoted by Lambda (Λ) and associated with dark energy, the postulated cold dark matter (CDM), and ordinary matter. The dark energy is basically ascribable to late time acceleration, and the F(R) modified theory of gravity provides some of the very promising description of dark energy and late time acceleration issues [17].

Lambda cold dark matter (ΛCDM) is known to be a successful model for the prediction of Hubble diagram, and the energy momentum tensor of the minimal ΛCDM model is composed of the cosmological constant (Λ)term, the cold dark matter (CDM) term, and the radiation dominated (RD) matter term. The cosmological constant can often be introduced by the Weyl-invariant model, or the massive gravity model. In particular, the Weyl model turns up to be a perfect way to induce a cosmological constant by choosing unitary gauge [18].

F(R) theory, which generalizes Einstein's General Gravity, is a family of theories, each one defined by the Ricci scalar, and was first proposed by Buchdahl [19]. In F(R) gravity, one seeks to generalize the Lagrangian of the Einstein-Hibert action:

$$S[g] = \int \frac{1}{2\kappa} R \sqrt{-g}\, \mathrm{d}^4 x \tag{5}$$

to

$$S[g] = \int \frac{1}{2\kappa} f(R) \sqrt{-g}\, \mathrm{d}^4 x \tag{6}$$

,where $\kappa = 8\pi G / c^{-4}$, $g = \det g_{\mu\nu}$ is the determinant of the metric tensor and F(R) is some function of the Ricii scalar, *R*.

In metric F(R) gravity, one arrives at the field equations by varying with respect to the metric and not treating the connection independently. The main steps are the same as in the case of the variation of the Einstein-Hilbert action [20].

The gravity researches are pursued from various angles. One of them is a study of an acoustic gravity wave which propagates across the globe in a dissipative and static background atmosphere extending from the ground to 700 Km. Meyer et al. reported the Transfer Function Model (TFM) which is computationally efficient and well suited to serve as experimental and educational tool for simulating wave pattern propagated across the globe [21] .

Chiba indicated that the problem of dark energy is the problem of Ω:

$$\Omega = 8\pi G \rho_M / 3H_2 < 1 \tag{7}$$

Ω can be regarded as the ratio of the right hand side of Einstein's equation (matter, or energy) to the left hand side of the Einstein's equation (curvature = gravity), and in order to make Ω = 1, one requires either (a) introduction of a new form of matter (energy): dark energy , or (b) modification of the gravity in the large, so that the total energy density is equal to the critical density, which is required by introduction of inflation theory or by observation of Wilkinson Microwave Anisotropy Probe (WMAP) whose data were very well fit by the universe that is dominated by dark energy in the form of a cosmological constant [22].

f) Dark energy

According to the observations since 1990's the universe is expanding at an accelerating rate. In order to accelerate the universe, it is arguable that some type of energy must be engaged. For this rationality to be valid, dark energy theory was established. Although the density of the dark energy is very low much less than those of ordinary matter, or dark matter, it dominates the mass-energy of the universe because it is uniform across the space [66-68].

It is suggested that the space contains energy whose gravitational effect approximates that of Einstein's cosmological constant, Λ, although he deleted this term by saying that this term is not his real intention, but by just a mistake. Anyway, this term is regarded as dark energy or quintessence in recent years. The dark energy may have been detected by the recent cosmological tests which make a good scientific case for the context, in the relativistic Friedmann-Lemaitre model, in which the gravitational inverse-square law is applied to the scales of cosmology. Actually, Friedmann-Lemaitre model is an exact solution of Einstein's field equations of general relativity; it describes a homogeneous, isotropic, and expanding universe that is path-connected, but not necessarily simply connected [69]. Planned observations of the universe may detect the evolution of the dark-energy, bringing stimulus for attempts in understanding the microphysics of dark energy (22,69,70).

3. Antigravity

a) Antigravity force shown by Podkletnov experiment

Podkletnov et al. studied shielding properties of single-phase dense bulk superconducting ceramics of $YBa_2Cu_3O_7{-}x$ against the gravitational force [23,24]. The object is a small non-conducting and non-magnetic sample weighing 5.48 g which was placed over a superconducting disc horizontally oriented in a cryostat and surrounded by liquid helium supported by an alternating magnetic field. They found that the object lost its weight by 0.05 to 0.3 % depending on the rotation speed of the superconducting disk. They proposed that the partial loss of the weight of an object might be due to a certain state of an energy change of the crystal structure of the superconductor at low temperatures.

This aforementioned phenomenon is called Podkletnov effect which is stated as follows [24]. When a disc of superconductive ceramic, being in the state of superconductivity, surrounded in air by alternating magnetic field arising from an electromagnet located under the disc, the dis becomes the source of a radiation. This radiation, travelling like a plane wave above the disc, acts on other bodies like a negative gravity. The radiation becomes stronger with larger discs, so it depends on the disc's mass and radius. When the disc rotates uniformly the radiation remains the same. During acceleration/braking of the disc's rotation the radiation essentially increases.

Kaluza-Klein (K-K) theory is considered as a classical unified field theory of the gravitational and electromagnetic fields built around the idea of a fifth dimension by extending the four-dimensional continuum and it is regarded as an important precursor to string theory. Nashie states that the sum of the dark energy of the wave which is the absolute value of the negative kinetic energy of the holo-like quantum wave modeled by the empty set of a five dimensional K-K (Kaluza-Klein) spacetime and that the ordinary energy of the particle is exactly equal to the energy given by the Einstein formula $E = mc^2$. The ordinary or position energy of the particle is the dual expression of the dark energy and is contained in the dynamic of the quantum particle modeled by the zero set in the five-dimensional K-K (Kaluza-Klein) spacetime. Naschie presented the following interpretation of the results (ordinary energy and dark energy) by using two dual equations as follows [25].

$$E\ (\text{ordinary}) = (\psi 5/2)\, mc^2 = mc^2 / 22 \quad (8)$$
$$E\ (\text{dark}) = |-mc^2\,(21/22)| \quad (9)$$

,where m is the mass and c is the speed of light, ψ^2 is the Hardy quantum entanglement and $\psi = 2/(1 + \sqrt{5})$ gives results in complete agreement with the cosmological measurement of WMAP and supernova. Adding E (dark energy) and E (ordinary energy) one finds,

$$E = (mc^2 / 22) + mc^2\,(21/22) = mc^2 \quad (10)$$

The author claimed that his proposed theory suggests physical reality of Kaluza-Klein extra fifth dimension as well as the fractality of spacetime and ontology reality of quantum wave all apart from the reality of dark energy. In addition to it, the negative dimensions, which can be looked upon as another physical interpretation of dark energy, exist in the back of the experimentally observed negative Kelvin absolute temperature. Furthermore, our cosmos is clopen, i.e. closed and open universe, because it is suggested that the building blocks of spacetime are random Cantor sets which are clopens. One could consider the repelling effect of dark energy on a cosmic scale based on the fact that the motion of quantum objects and its spatial location is determined by the quantum wave. It is speculated that the spinning of Gödel's universe is associated with dark energy and repelling gravity [25].

b) Electrogravitic (antigravity) technology

Beginning in the mid 1920s, Townsend Brown discovered that it is possible to create an artificial gravity field by charging an electrical capacitor to a high voltage [26]. His innovation was to build a capacitor which utilize heavy, high charge-accumulating dielectric material between its plates. When this capacitor was charged with between 70,000 to 300,000 volts, it would move in a direction of its positive pole. He oriented it with positive side up, and found that it would proceed to lose about one percent of its weight.

c)Antigravitational force created by the phase transition

A movement against the gravitational field has been shown to be created on the particles which undergo a change of state or phase transition to a gaseous form by acquiring latent heat [26]. Piyadasa studied upward mobility of iodine molecules under different conditions and geometries. Since the buoyancy force and convection force are untenable for the upward mobility of iodine molecules, he speculated the driving force behind the upward movement of particles against the gravity under vacuum conditions [27]. His proposal seems to be reasonable because the buoyancy force and convention force are ruled out and the cause of the upward mobility in the observed particles could be identified as antigravity force.

Thomas Townsend Brown applied the high voltage to the cooling tube, and found it produced some thrust. He concluded that the tube had moved because its gravity field had somewhat been affected by the plate's high--voltage charge. He conducted additional experiments and developed an electric capacitor device that he named a gravitator [28-30]. The device contained a series if massive, electrically conductive plates made of lead and separated from one another by electrically insulating sheets of glass which served as the capacitor's dielectric medium. His another version was made satisfactorily with aluminum plates and paraffin.

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d) Antigravity evidence using gyroscope

Hayasaka et al. conducted the experiment in which they found a detected loss of weight in clockwise spinning gyroscopes and noticed that when a gyroscope is dropped in a vacuum at 18,000rpm its weight lost one part in 7,000 per every 160cm fall in vacuum [31]. They found that the mean value of the fall-acceleration of the right-spinning <g(R)> is significantly smaller than the left-spinning <g(L)> at 18,000 rpm, with almost identical to the zero-spinning <g(0>. They proposed that the right-spinning generates antigravity and that the parity (the reflection symmetry) of gravity breaks down completely in the same way as the weak interaction of elementary particles that select the left-handedness.

e) Warp drive and antigravity

Aleuberre mentioned that one needs a matter of fantasy to travel faster than the speed of light and that quantum theory permits the existence of regions with negative energy densities in some special circumstances. He also stated that it is possible to modify the spacetime in a way that allows a spaceship to travel with an arbitrarily large speed. By a purely expansion of spacetime behind the spaceship with an opposite contraction in front of it, a relevant motion faster than the speed of light is possible as seen by the observer outside the disturbed region. He then stated that the resulting distortion is reminiscent of the "warp drive" of science fiction [32]. Aleuberre exhibited a space-time metric that describes a surprising phenomenon occurring in a flat, Euclidean space : a spherical region of the space glides along geodesically with a prescribed velocity vs(t) as if it were a (practically) rigid body unmatched to the remainder of space. The velocity directed along x-axis, is arbitrary as to magnitude and time dependence. The speed of the moving region can be anything from zero to many times the speed of a light pulse travelling on a parallel track outside the sphere [32,33].

f) Space time singularities

Carrasco et al. proposed a possibility of journey through antigravity, with the suggestion that Weyl invariant expansion of scalars coupled to Einstein gravity allows for an unambiguous classical evolution through cosmological singularities in anisotropic spacetimes. They computed the Weyl invariant curvature squared and found that it blew up for the proposed anisotropic solution not only at the Big Crunch but also at Big Bang. They indicated that the cosmological singularities are not resolved by uplifting Einstein theory to a Weyl invariant model [34].

They concluded that the antigravity regime in the Weyl uplifted geometry with $\alpha(t) = 1$ is separated from the gravity regime by an infinite Weyl invariant curvature singularity and that the combination of the squares of Riemann curvature, Ricci, and scalar curvature is infinite indicating the existence of the standard textbook classical cosmological singularity. They also mentioned that since the Weyl invariant is infinite for solutions with anisotropy, the universe cannot pass from gravity to antigravity and back [34].

g) Antigravity propulsion and relativistic hyperdrive

Febler derived new solutions for the gravitational field of a mass moving with arbitrary velocity and acceleration, within the weak field approximation of general gravity. A mass having a constant velocity greater than $3^{-1/2}$ times the speed of light gravitationally repels other masses at rest within a narrow cone [35]. Gravitational repulsion at relativistic speeds opens vistas of opportunities for spacecraft propulsion.

The propulsion of a massive payload to relativistic speeds can be accomplished because the only stresses in acceleration along a geodesic field arise from tidal forces much weaker than the propulsion forces [36].

At high Lorentz factors ($\gamma \gg 1$) the force of repulsion in forward direction is about $-8\gamma^5$ times the Newtonian force which makes it possible for one to conduct laboratory tests of gravity ［35］. An exact strong dynamic gravitational field is the field on the sensor at rest from a mass m moving along a z-axis. Since the 3-velocity of the senor is zero, the exact equations of motion from the geodesic equations are;

$$dt/d\tau = (g_{00})^{-1/2} \qquad \cdots\cdots (11)$$

where τis a proper time and, in coordinate time t, $d^2x^i/dt^2 + c^2\Gamma^i{}_{00} = 0$, where i = 1,2,3 and the $\Gamma^i{}_{00}$ are Christoffel symbols. The exact strong dynamic gravitational field on a sensor at rest (t, x, y, z), as seen by a distant inertial observer, is therefore,

$$g(r,t) = -Gm\left\{\frac{\left(\frac{\alpha}{\gamma^2}\right) n + \left[2\gamma + \frac{1}{\gamma}\right)\kappa - 4/\gamma]\,\beta}{k^3R^2} + \frac{(n\dot{\beta})(\alpha n - 4\gamma\beta) + \kappa(\dot{\alpha}n - 4\dot{\gamma}\beta - 4\gamma\dot{\beta})}{c\kappa^3 R}\right\}_{ret} \qquad \cdots\cdots (12)$$

Equation (12) is the gravitational field that woud be observed by a distant inertial observer to act on a test particle at rest [35].

The strong field of suitable driver mass at relativistic speed can quickly propel heavy payload faster than the driver, condition called hyperdrive. Felber calculated the propulsion of the payload directly by two-step procedure without calculating the field that produced the motion [37]. He also calculated the trajectory of the playload in the static Shwarzschild field of stationary, spherically symmetric mass as a first step. And then, he performed a simple Lorenz transformation from the rest frame of the driver mass to the initial rest mass of the payload far from the driver. The Schwarzschild solution is one of the simplest and most useful solutions of the Einstein field equations (general relativity). It describes spacetime in the vicinity of a non-rotating massive spherically symmetric object.

Earlier calculation of Einstein equation for the gravitational field of moving sources was applied to relativistic or time-dependent sources. Even in a weak static field, what is solved is only the geodesic equation for a nonrelativistic test particle in the slow-velocity limit of source motion. The field at a moving test particle consists of terms that look like the Lorentz field of electromagnetism. Only when Einstein's equation is solved for relativistic time-dependent source, even weak gravitational fields can be shown to be repulsive.

One of the ways to derive the threshold velocity of $3^{-1/2}$C for an antigravity field is to use Leonard-Wiechert retarded field. In the weak field approximation, a general expression was derived in three-vector notation for the retarded gravitational field g (r, t) of a source in an arbitrary relativistic motion. From this expression, the retarded field of a source moving with constant velocity $c\beta_0$ is given in the forward (upper sign) and the backward (lower sign) direction by,

$$g_{\pm}(r,t) = -\gamma_3{}^5\,(1 \pm \beta_0)^2\,(1 - 3\beta_0{}^2)\,GM/\{R^2\}_{ret} \qquad \cdots\cdots (13)$$

,where $\{R^2\}_{ret}$ is the separation of the source and the observation point (r,t) at the retarded time,

$t - \{R\}_{ret}/c$ [37]. ..... (14)

In conclusion, he stated that a simple Lorentz transformation of the well-known unbound orbit of a payload in Schwarzschild field gives the exact payload trajectory in the strong field of a relativistic driver with constant velocity, as seen by a distant inertial observer. He also stated that suitable drivers at relativistic speeds can quickly propel a heavy payload from rest to speeds close to the speed of light [37].

h) Antigravity from a spacetime defect

Klinkhamer et al. claim that there may exist space time defects embedded in Minkowski spacetime, which have negative active gravitational mass. Then a test particle will be repelled by one such spacetime defect, corresponding to what may be called "antigravity"[38]. They have pointed out a soliton-type spacetime defect which has nontrivial topology for both the spacetime manifold and the matter-field configuration [39].

i) Control of energy oscillation

Kiyoie reported the antigravity device using barium titanate [40]. First, he prepared the disk consisting of barium-titanate ceramics (30ψ x 12.5t). The coating is applied on the top and bottom of the disk. When the high voltage was applied, the entire weight is reduced indicating that the disk acquired the antigravity power.

j) The Searl effect generator to defy gravity

British inventor John Searl invented the permanent magnet generator which levitated off its bench and finally bumped into the shieling [41]. His generator not only propel itself but also defy gravity. His generator consisted of three concentric ring magnets flanked by three sets of roller magnets that revolved in a clockwise direction about their circumference. The innermost ring consisted of a stationary stator magnet which had its magnetic north pole pointing down perpendicular to the plane of the ring [42].

k) Antigravity effect of the polar corner motion and the Klein roll

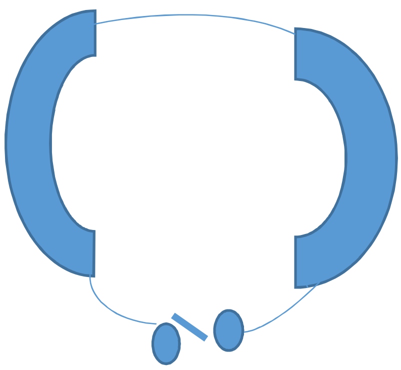
Kiyoie tested a device in which silver was plated on the disk made of barium titanate and the high voltage (DC 7,500 volt) was applied. The weight reduction was 0.0075%. He mentioned that this is due to the polar corner motion [43].

Kiyoie prepared a set of the ferrite toroidal core with copper coil made of 15 times Klein rolls, and the electric power was applied through three UMI batteries (DC7,500 V) connected in the direct current circuit. The weight of the device was reduced from 103.612g to 103.604g indicating the antigravity effect of 0.008g (0.0077%) [44]. Kiyoie modified the previous version of the device, which consisted of a set of ferrite toroidal core with copper coil made of 17 times Klein rolls (62.5ψx13.5tx39ψ), and the 3.3 Ampere electric power was applied through three UMI batteries connected by the direct current circuit. The weight of the device was reduced from 103.612g to 103.457 g indicating the antigravity effect of 0.158g(0.152%) [45,46]. Antigravity effect can be obtained even by using the alternating current. Kiyoite prepared the ferrite toroidal core with copper coil made of 13 times Klein rolls and he applied three Ampere of AC current (60 Htz). The weight of this device was reduced by 0.091g (0.087%) [46].

l) Antigravity effect obtained without using the electric current

The Klein bottle can be divided to two opposite-turned Mebius rings. As shown in Figure 2, the Mebius coin bottle was created with right-turn Klein coil on the right-hand side and the left – turn Klein coil on the left-hand side. The diode was connected to the Klein coil which was wound by the diode wire. The diode was made of silicon and the lead wire was made of copper. The ratio of the copper to silicon is one to one. The left-turn Klein coil and the right-turn Klein coil were connected by the on-and-off switch. The Klein coil was rolled up by the diode wire. When the switch was turned on, the weight was reduced by 0.060 g. No electric power was applied [46].

Right-turn Klein coil



Left-turn Klein coil

Figure 2 The gravitational shielding device in which the Klein bottle is divided to two opposite-turned Mebius rings and the switch was connected to the ring. No electric power was applied and the weight was reduced by 0.06g, 0.058% [46].

m) Cosmic antigravity

In 1929 Edwin Hubble published a classical article on the expanding universe in PNAS [47]. He stated that the distances of extra galactic nebulae depend ultimately upon the application of the absolute-luminosity criteria to relevant stars whose types can be recognized. Numerical values depend upon the zero point of the period -luminosity relation among Cepheids, and the other criteria merely check the order of the distances. A study of these nebulae indicates a probability of an approximately uniform upper limit to the absolute luminosity of stars. The apparent luminosities of the brightest stars in such nebulae are thus criteria which, although rough and to be applied with caution, furnish reasonable estimates of the distances of all galactic systems in which even a few stars can be detected. He plotted radial velocities against distances estimated from involved stars and mean luminosities in a cluster (Fig. 3) and obtained the straight line between distance and velocity. He then claimed that the velocity-distance relation may represent the de Sitter effect and that numerical data may be introduced into discussions of the general curvature of space.

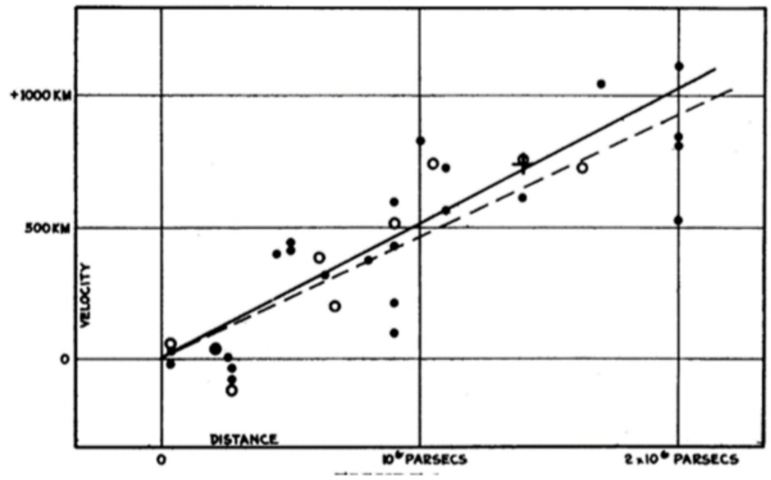


Figure 3 Velocity distance relation among extra-galaxy nebulae [47]. Radial velocities, corrected for solar motion, are plotted against distances estimated from involved stars and mean luminosities of nebulae in a cluster. The black discs and full line represent the solution for solar motion using nebulae individually; the circles and broken line represent the solution combining the nebulae into groups; the cross represents the velocity corresponding to the mean distance of 22 nebulae whose distances could not be estimated individually.

NOTE: Cited from " E. P. Hubble, "A Relation between Distance and Velocity among Extra-galactic Nebulae," Proc. Natl. Acad.Sci. UAS, 15, 168-173, 1929". Since this article is in public domain, the permission to cite this article is not required.

This Edwin Hubble's achievement is a classic finding on expanding universe. The chief result is that a galaxy's distance is proportional to the redshift [48]. Hubble showed that galaxies recede from us and that the further the distance the more rapidly the galaxies recede. Kirshner states with confidence that a geometrically flat universe has been expanding for the past 14 billion years, growing in contrast through the action of gravity from a hot and smooth Big Bang to the lumpy and varied universe [48]. Observations infer that a dark matter in the universe accounts for ∼ 30% with only 4% of the universe made of protons and neutrons [48]. The big surprise is that recent observations show that cosmic expansion has been speeding up over the last 5 billion years. This acceleration suggests that the other 70% of the universe is composed of a dark energy whose property we only dimply grasp but that must have a negative pressure to make cosmic expansion speed up over time [49].

Doglov considered a simple, though not precise, the following analogy. A stone thrown from the earth surface would either stop at some moment and return back to the earth, or would fly away forever to infinity with sufficiently large initial speed; at some point of time as a special intermediate case the velocity tends to be zero [49]. It is practically established that at the very beginning the universe expanded with acceleration. It is the well-known inflational stage when the initial cosmological push was operated for a short time. It is analogous to the initial acceleration of the stone in the pointed-out example. After that stage, the sequential motion both of the stone and the universe was simply inertial one. Both of the initial inflationary push and the cosmological expansion of the recent time are created by an antigravitating state of matter as a major factor. Our existence is owed by the antigravity at the beginning because a source of expansion created the large and suitable stage for the life of universe [50]. He also paid attention to the adjustment mechanism of the energy which in principle could compensate originally huge vacuum energy down to cosmologically acceptable value and solve the coincidence problem of a close magnitudes of the non-compensated remnants of vacuum energy and the energy density of the universe at present time. As a consequence he considered a possible modifications of gravity at large scales which could induce accelerated cosmological expansion [50].

The strength of the gravitational pull of the dark matter helps keep galaxies from spinning apart at the speeds at which they whirl. On the contrary the dark energy is pushing the universe apart, driving up the rate at which the cosmos expands. The dark matter involves quintessence, a fifth element in addition to the four ancient-time, classical elements of air, fire, earth and water. Considering the fact that the universe is expanding and that the universe consists of dark matter, dark energy, and the remaining 4% of familiar protons and neutrons where we reside, Einstein’s equations should be limited for the 4% of the universe, and the completely new equations should be constructed for the entire universe.

Energy of the entire universe = Energy of the dark matter + Energy of the dark energy + Energy of the protons and neutrons where we reside

Krauss stated that the long derided cosmological constant—a contrivance of Einstein’s that represents a form of energy inherent in space itself—is one of two contenders for explaining changes in the expansion rate of the universe [51]. It is known that distant galaxies are moving apart as they would if the entire cosmos were uniformly swelling in size. He claims that these outward motions are counteracted by the collective gravity of galaxy clusters. The unrelenting gravitational attraction of matter could cause the universe to collapse eventually, and so Einstein, who presumed the universe to be static and stable, added an extra term to his equations, “cosmological term”, which could stabilize the universe. If its value were positive, the term would represent a repulsive force, a kind of antigravity that could hold the universe up under its own weight. However, Einstein abandoned within five years this kludge, which he associates with his "biggest blunder." He stated that the force caused by the constant operates even in the complete absence of matter or radiation. Thus, its source must be a curious energy that resides in empty space. The cosmological constant endows the void with an almost metaphysical aura. With its demise, nature was once again reasonable. However, in the 1930's the glimmers of the cosmological constant arose in a completely independent context: the effort to combine the laws of quantum mechanics with Einstein's special theory of relativity [51].

n) Antigravity effect using electromagnetic field through gas or plasma

Aquino constructed a chamber which is filled with Hg at ultra low-pressure, and then he applied extra low – frequency electric field (1mHg — 0.1mHg) through the chamber above which the sample ball was hanged. The gravitational acceleration of the same ball was strongly reduced. He concluded that the gravity control will agitate the generation of and detection of virtual gravitational radiation （quantum gravitational transceiver) and also the construction of gravitational motor and the gravitational spacecraft. He advocates that the gravitational transceiver leads to a new concept in telecommunication, and that the gravitational motor alters the paradigm of energy conversion. Consequently, the gravitational spacecraft points to a new concept of aerospace flight [52].

3. Gravitational Shielding

a) overview

Aquino reported the device which produces gravitational shielding generated by ZnS: Ag phosphor [53]. Carlotto stated that one can essentially iterate their construction by developing a systematic method to localize a given scalar flat, asymptomatically flat metric inside a cone of arbitrary small aperture, and get a new class of N-body solutions to the Einstein constraint equation which exhibits the phenomenon of gravitational shielding in the sense that one can prepare data that do not have any interaction for finite but arbitrarily long times, in striking contrast with the Newtonian gravity scenario [54]. The issues of gravitational shielding has been paid attentions from various angles, and it is worth examining the gravitational shielding to understand the gravity itself and the gravitational blocking for our future research and benefit.

b) Aquino's device

Aquino produced a device filled with gas or plasma through which an electromagnetic field is applied and it controlled the local gravity acceleration [52]. It is shown [36,37] by Aquino that the relativistic gravitational mass is,

$$Mg = m_g/(1-V^2/C^2)^{½} \quad \cdots\cdots \quad (15)$$

And the relativistic inertial mass is,

$$Mi = m_{i0}/(1-V^2/C^2)^{½} \quad \cdots\cdots \quad (16)$$

And thet are quantized and given by $Mg = n^2_g m_{i0\,(min)}$, $Mi = n^2_i m_{i0\,(min)}$ respectively. N_g and n_i are the gravitational quantum number and the inertial quantum number respectively. $m_{io(min)} = \pm 3.9 \times 10^{-73}$ kg is the elementary quantum of inertial mass. The masses m_g and m_{i0} are correlated by the following equation,

$$m_g = m_{io} - 2\,[(1+(\Delta p/(m_i c))^{½} -1]\, m_{io} \quad \cdots\cdots \quad (17)$$

where Δp is the momentum variation on the particle and m_{io} is the inertial mass at rest.

c) Gravitational anomalies

Allais reported that a Foucault pendulum exhibited abnormal movements at the time of a solar eclipse that cannot be explained by conventional phenomena such as disturbances of a coincidental order, periodic luni-solar effects, indirect influence of some conventional factors including seismic activity, temperature changes, atmospheric pressure, magnetism and so on [56]. Serge recognized Allias 's work and mentioned that one can understand the phenomenon of change of the gravitational acceleration during the total solar eclipse (Allias's effect) [57]. Amador suggested that a global measurement under strictly controlled conditions is needed in order to determine whether these effects are real or not [58]. He also proposed that several different instruments must be used simultaneously with a different pendulum such as paraconical pendulum composed of different material other than Foucault pendulum. He further stated that possible modifications to Einstein's General Relativity might be necessary, and gravity may attract a little harder than expected at large distances or small accelerations.

d) Lead usage to block the gravitational force

Yanbiko constructed an equipment made of lead (heavy mass, M) filled in the cylindrical vessel with the diameter of 1 meter and the length of 2 meter at the bottom. On the top of the cylinder he positioned the small mass (m) placed in the protective glass. The mass was hung on the right-hand of the balance. As the equipment launches the operation, the small mass was raised, and the balance was broken owing to the rising outcome of the small mass. He stated that this up-ward movement of the small mass (m) was created by the gravitational shielding effect of the heavy mass (M) [59].

e) Chiral Gravitational Shielding Material

Wallace discovered that when certain metals are set into rapid rotation, their neutrons are polarized. These metals have atomic weight of 63 or beyond and are higher on the periodic table. Those metals exhibit the ability to alter the gravitation through the act of simple rotation. Copper has the atomic weight of 63, and is composed of 29 protons, 29 electrons and 34 neutrons. He termed these metals as odd-atomic nuclide materials [60]. When these metals are polarized they give rise to a second gravitational field as is indicated in his US PT. 3,626,605 [61]. The second gravitational or "kinemassic" field has the ability to alter gravitational interaction. When the spin polarized material is placed in gyroscopic set of gimbals and is undulated, a secondary gravitational wave is generated, which is not shielded by currently available materials. A gallium arsenide detector device, which catches these waves, would shield conventional electromagnetic forces of local origin [60].

f) Torsind unaffected by gravitational influences

Purgach constructed a so-called "torsind" balance consisted of a very light aluminum disk and a very thin suspension fiber. The balance makes it insensitive to variations in gravitational potential and ensures that it is unaffected by gravitational influences from any direction [62]. His work is based on the idea on the abnormalities observed in the motion of paraconical pendulum with anisotropic support [63].

g) The gravitational shielding effect explained by quantum gauge theory of gravity

Under gauge transformations, which can take the form of a simple multiplication by a constant phase, all measurable quantities remain unchanged. The phases of the fields in local gauge transformations are altered by a function of time and space. It is considered now that gauge theories provide a bases for an elementary particle interactions including electromagnetic interaction which is described by quantum electromagnetics.

Ning mentioned that the gravitational shielding effect can be explained by quantum gauge theory of gravity. If the gravitational gauge field propagates in the unstable vacuum of the complex scalar field it will decay exponentially, which is the nature of gravitational shielding effects. He then proposed three models on gravitational shielding, i.e. ordinary supercurrent in phase transition, inhomogeneous ordinary superfluid, and Quark-Gluon Plasma (QGP). If the vacuum of the complex scalar field is not stable and uniform, there will be a mass term of gravitational gauge field after the collapse of spontaneous symmetry [64].

h) Podkletnov's device

A gravity shielding device which was constructed by Podkletnov[9,10] is a high-Tc dense bulk created by $YBa_2Cu_3O_{7}$-x superconducting ceramic. It operated at the temperature below 77° K reducing the weight by 0.03 – 0.5%. This is an interesting device because they used superconducting ceramic. One can construct new superconducting device which is composed of different elements exhibiting stronger antigravity effect than Podkletnov's device. At the same time some confutation is reported. Modanese argued that an interpretation of the first experiment as a "shielding" of the Earth's field is theoretically untenable, and both experiments raise serious conceptional problems concerning the equivalence principle and should probably only be explained at the quantum level [65]. Various kinds of antigravitational shielding devices are listed in Table 1.

Table 1 A list of gravitational shielding devices

NO	Description	References
1.	Dense bulk superconducting ceramic YBa2Cu3O7-x showed shielding property against the gravitational force at temperatures below 77 K. by 0.05- 0.3%	K. Podkletnov 23)
2.	Gravity acceleration above a chamber filled with gas or plasma by applying Extra Low-Frequency (ELF) electromagnetic field was strongly reduced at ambient temperature. And the author claims that his gravity control cell lead to the gravitational motor which changes the paradigm of energy conversion leading to the contrivance that the gravitational spacecraft points to a new concept in spacecraft flight.	F. de Aquino 52)
3.	As a consequence of "Casimir polarization" electromagnetic component of the physical vacuum ("EM vacuum) in the vicinity of any material objects, the existence of gravitational shielding was proposed.	T. Serge 57)
4.	Silver was plated on the disk made of barium titanate and the high voltage (DC 7,500 volt) was applied to it. The weight reduction was 0.0075%.	S. Kiyoie 43)
5.	Klein-whorl coil of 15 times rolls made of copper was connected with three UMI electric cells, and after the switch was turned on, the weight was reduced from 103.612 g to 103.604 g	S. Kiyoie 44)
6.	Klein-whorl coil of 17 times rolls connected to ferrite toroidal core was prepared, and then the electric currency of 3.3 amperes was applied. The weight was reduced by 0.152%	S. Kiyoie 45)
7.	Klein-whorl coil of 13 times rolls connected to ferrite toroidal core was prepared, and then the alternating electric currency of 3 amperes was applied. The weight was reduced by 0.087%	S. Kiyoie 46)
8.	A Mebius coil made of a right-turned Klein—whorl coil and another Mebius coil made of a left-turned Klein-whorl are arranged side by side. And then an on-and-off switch was installed. The diode wire made of silicon was wound around the Klein-whorl coil. The weight was reduced by 0.075%	S. Kiyoie, 94)
9.	By the effect of tachyon, the weight of Klein-whorl coil was decreased.	S. Kiyoie 100)

10. Klein-whorl coil of 50 times clockwise twining roll connected to ferrite toroidal core was prepared, and then the alternating electric currency of 6 amperes was applied. The weight of 103.612 g was reduced by 0.367 g — S. Kiyoie 101)
11. The standing Japanese Sumo (wrestling) wrestler weighing 142 Kg on the magnet weighting 60 Kg was levigated by superconductor placed below the magnet. The magnetic susceptibility of superconductor as diamagnetic material was strongest (X_m = -1). The total weight above the superconductor t was 202 Kg. — M. Murakami 102)

5. Paramagnetism, ferromagnetism and diamagnetism

a) Paramagnetism and related issues

Paramagnetism is a form of magnetism in which an external applied magnetic field weakly attract certain materials and the induced internal magnetic fields are formed in the direction of the applied magnetic field.

Most chemical elements and some compounds exhibit paramagnetism. A relative magnetic permeability (K_m) of those paramagnetic materials is slightly greater than 1 (one), that is, a small positive magnetic susceptibility. The magnetic moment, which is induced by the applied field, is weak and linear in the field strength. Paramagnetism is caused by the presence of unpaired electrons in the material. Therefore, all atoms with incompletely filled atomic orbitals are paramagnetic. Unpaired electrons exhibit a magnetic dipole moment due to their spin and act like tiny magnets. The electron spins caused by an external magnetic field results in aligning parallel to the field inducing a net attraction. Examples of paramagnetic materials include oxygen, aluminum, titanium, and iron oxide (FeO) [71].

Nair et al. showed by using magnetization measurements that point defects in graphene, i.e. fluorine adatoms and irradiation defects (vacancies), carry magnetic moments with spin 1/2. They stated that both types of defects lead to notable paramagnetism but that no magnetic ordering could be detected down to liquid helium temperatures. Despite the fact that maximum response they could observe was limited to one moment per 1,000 carbon atoms, the induced paramagnetism dominated graphene’s low-temperature magnetic properties [72].

b) Ferromagnetism and related issues

Ferromagnetism is a kind of magnetism associated with iron, cobalt, nickel, and certain alloys or compounds containing one or more of these elements. Those elements and compounds are called ferromagnetic materials which are magnetized easily, and in strong magnetic fields the magnetization approaches a definite limit called saturation. The ferromagnetism in ferromagnetic materials is caused by the pertinent alignment patterns of their constituent atoms, which act as elementary electromagnets. Ferromagnetism occurs in the way that some species of atoms possess a magnetic moment, i. e. such an atom itself is an elementary electromagnet produced by the spin of its electrons on their own axes which is the motion of electrons within its nucleus [73].

It is said that electrical manipulation of magnetism has been proved elusive. Ohno et al. demonstrated electric-field control of ferromagnetism in a thin-film semiconducting alloy, using an isolating-gate field-effect transistor structure [74]. By applying electric fields, they were able to vary isothermally and reversibly transition temperature of hole-induced ferromagnetism. They used (In, Mn)As as the magnetic channel material which is one of the ferromagnetic III-V semiconductors [75-78]. Ferromagnetism in manganese compound semiconductors makes it possible tailoring magnetic and spin-related phenomena in semiconductor with a precision specific to III-V compounds and at the same time it undertakes a question about the origin of the magnetic interactions that lead to a Curie temperature (Tc) as high as 110° K for a manganese concentration of just 5% [79]. Combinations of semiconductor spintronic devices with the field-controlled ferromagnetism may also be important in quantum information technologies that are based on manipulation of spin states in semiconductors [80-83].

c) Diamagnetism and related issues

Diamagnetism was first discovered by Sebald Justius Brugmans in 1778 who found that bismuth, Bi, and antimony, Sb, were repelled by magnetic fields. Then, Michel Faraday discovered in 1845 that it was a property of matter and concluded that every material responded to an applied magnetic field. As far as diamagnetism is concerned it is said that all materials in the world exhibit diamagnetism which is a quantum mechanical effect and a magnetic field repels diamagnetic materials. An induced magnetic field is created by an applied magnetic field causing a repulsive force. Although most of materials possess a weak diamagnetic effect which can be detected by a sensitive instrument, a superconductor acts as a strong diamagnet because it repels a magnetic field entirely from its interior. The magnetic permeability of magnetic materials is less than the permeability of vacuum, μ_0. An effect of diamagnetism of most materials is weak and it can only be detected by sensitive laboratory instruments. Water or water-containing materials exhibit a relative magnetic permeability (μ_v) that is less or equal to one (1), and so a magnetic susceptibility (X_m) is less than or equal to zero, since susceptibility is defined as $X_m = \mu_v - 1$ [84].

The electrons in a material generally settle in the orbitals, and act like current loops. As any applied magnetic field generate currents in these loops which oppose the current change, in a similar way to superconductors which are intrinsically a perfect diamagnet. Nevertheless, because the electrons are tightly held in orbitals by the charge of the protons and are further constrained by Pauli exclusion principle, which states that two or more identical fermions (particles with halfinteger spin) cannot occupy the same quantum state within a quantum system simultaneously, many materials show diamagnetism although most of them respond very little to the applied field [84].

The quantity, K_m, in the Table 2 is called the relative permeability, which measures the ratio of the internal magnetization to the applied magnetic field. If the material does not respond to the magnetic field by magnetizing, then the field in the material will be just the applied field and the relative permeability K_m is equal to one . The quantity, $\chi_{m,}$ is called magnetic susceptibility, and it is just the permeability minus 1. The magnetic susceptibility is then zero if the material does not respond with any magnetization. So, both quantities give the same information from different angles, and both quantities are represented as dimensionless numbers [85].

Table 2 Magnetic susceptibilities of paramagnetic and diamagnetic materials at room temperature

Paramagnetics		Diamagnetics	
Material	$\chi_m = K_m — 1$ (x 10^{-5})	Material	$\chi_m = K_m — 1$ (x 10^{-5})
Iron oxide (FeO)	720	Bismuth	—16.6
Magnesium sulfate	370	Gold	—3.55
Chromium chloride	151	Mercury	—2.9
Iron ammonium alum	66	silver	—2.38
Uranium	40	Carbon (diamond)	—2.1
Chromium	31.3	Aluminum oxide	—1.81
Platinum	26	lead	—1.8
Titanium	18.1	Carbon (graphite)	—1.6
Molybdenum	11.9	Zinc	—1.56
Tungsten	6.8	Sodium chloride	—1.4
Cesium	5.1	Copper	—1.0
Aluminum	2.2	water	—0.91
Lithium	1.4	silicon	—0.41
Magnesium	1.2		
Sodium	0.72		
Oxygen gas	0.19		

Cited in part from: Wikipedia, "Magnetic susceptibility of paramagnetic and diamagnetic materials at 20°C"[85]

Jackson reported the early history of diamagnetism research pursued by Tyndall who started his substantial period of research into the phenomenon of diamagnetism, which was based on his belief in the importance of underlying molecular structure, an idea which suffused his later work such as the study of galaxies and the interaction of substances with radiant heat. He subdued the challenge of the weak phenomenon of diamagnetism with all its geometric and structural complexity under the complete consistency, on the basis of both a model of diamagnetic polarity and an effect of magnetic forces acting in couples [86].

Recent investigations in diamagnetism includes a study on universal fluctuations in orbital diamagnetism by Pal et al. They found that the average magnetic moment saturate to a finite value in the case of free particle but goes to zero when the particle is confined by a 2D harmonic potential, while the fluctuations in magnetic moment shows universal features in the presence of arbitrary friction inhomogeneity leading to the situation in that the system reaches equilibrium asymptotically. They concluded that as far as the fluctuation of orbital diamagnetism is concerned, they were able to obtain universal fluctuations independent of the nature of the system [87].

Semenenko et al. reported that the c-axis susceptibility of high purely oriented graphite samples is not really constant, but can vary several tens of percent per bulk sample with thickness t ≳ 30 μm, whereas by a much larger factor for a sample with a smaller thickness, and stated that the observed decrease of the susceptibility with sample thickness qualitatively resembles the one reported for the electrical conductivity and indicated that the main part of c-axis diamagnetic signal is not intrinsic to the ideal graphite structure, but it is due to the highly conducting 2D interface [88].

Dirl et al. demonstrated that a certain physical meaning can be attributed to permeability, μ, for all frequencies, and that in the presence of spatial dispersion, μ does not necessarily tend to become 1 for high frequencies ω and fixed wave number k. They also stated that diamagnetism can be compatible to Kramers-Koning relations, which are bidirectional mathematic relations connecting the real and imaginary parts of any physical function that is analytical in the Cartesian upper half-plane, even if the imaginary part of the permeability is positive [89].

The superconductor exhibits a perfect diamagnetism, and when the magnet is placed above the superconductor, the magnet levigate a subject as heavy as 200 Kg or more (Figure 4) . This phenomenon is called as the Meissner effect.

Figure 4 The standing Japanese Sumo (wrestling) wrestler weighing 142 Kg on the magnet weighing 60 Kg is levigated by superconductor placed below the white cloth whose magnetic susceptibility as diamagnetic material is strongest ($\chi_m = -1$). The total weight above the superconductor is 202 Kg. This phenomenon was made it possible by so-called the Meissner effect.

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The Meissner effect is the expulsion of a magnetic field from a superconductor during its transition to the superconducting state. The samples, in the presence of an applied magnetic field, were cooled below their superconducting transition temperature, whereupon the samples cancelled nearly all interior magnetic fields. The experiment demonstrated for the first time that superconductors were more than just perfect conductors but provided a uniquely defining property of the superconductor state.

6. Entanglement among Gravity, Antigravity and Gravity Shielding

a) the quantum gauge general relativity

A study of gravity has been reported from various angles. Wu claims the theory of the quantum gauge general relativity in the framework of quantum gauge theory of gravity and mentions that the field equation of gravitational gauge field is just the Einstein's field equation. He further mentioned that the quantum general relativity is a perturbatively renormalizable quantum gravity, which is one of the most important advantage of the quantum gauge general relativity [90].

Yang et al. reported a new constraint of gravitational shielding parameter, Majorana parameter h, after the ground tilt corrections, which is,

$$h \leq 6 \times 10^{-18} \mathrm{cm}^2/\mathrm{g}, \qquad \cdots\cdots \quad (18)$$

They stated that this constraint is best limit obtained and provides a new constraint on the strength of the possible gravitational shielding [91].

b) Prediction of Einstein Equation

One of the note-worthy prediction of Einstein's general relativity was the advance of the perihelion of Murcury's orbit whose measurement provided one of classical tests of Einstein's theory. General gravity also predicts that the rotation of a body including the earth drags the local inertial frames of reference around it, which will affect the orbit of a satellite. This is so-called the Lense-Thirring effect. Glufolini et. al. reported the considerably accurate measurement of the Lense-Thirring effect on two Earth satellites by using orbiting gyroscope [92].

7. Related prospective viewpoints on gravity, antigravity, and gravitational shielding

a) Dark energy, dark matter and baryonic matters.

In physical cosmology and astronomy, dark energy is a hypothesized, unknown form of energy. It is proposed that the dark energy permeates all matters in the space, accelerating the expansion of the universe [1, 93]. Dark energy is the most accepted hypothesis to explain the observations since the 1990s when Hubble indicated that the universe is expanding at a certain accelerating rate. Assuming that this standard model of cosmology is correct, the best current measurements indicate, as previously observed., that dark energy contributes 68% of the total energy in the present-day observable universe. The mass–energy of dark matter and ordinary (baryonic) matter contributes 27% and 5%, respectively, and other components such as neutrinos and photons contribute a very small amount[2,3-6]. The density of dark energy is very low (~ 7×10^{-30} g/cm^3) much less than the density of ordinary matter or dark matter within galaxies. However, it dominates the mass–energy of the universe because it is uniform across the space [19,20,23].

Two proposed forms for dark energy are; the one, the cosmological constant oriented [24,25] representing a constant energy density filling space homogeneously, and the other, scalar fields oriented such as quintessence or moduli, so-called dynamic quantities whose energy density can vary in time and space. Contributions from scalar fields that are constant in space are usually also included in the cosmological constant. The cosmological constant can be formulated to be equivalent to the zero-point radiation of space i.e. the vacuum energy [26]. Scalar fields that change in space can be difficult to distinguish from a cosmological constant because the change may be extremely slow.

Regardless of the different concepts, it is worth identifying the real feature of the dark energy [7, 8, 9]. It will permeate any solid, liquid, or whatever exit in the universe. It should carry the form of wave and extremely small particle (neutrino), or something yet identified. The number of particles is extremely large, although the size of the particle is extremely small.

b) Addition of magnetic susceptibility for the gravitational equation

Any object in the universe exhibits magnetic powers which consist of paramagnetism, ferromagnetism, and diamagnetism. Newtonian equation is valid, in a sense that it consists of the quantitative values, while Einstein's equation not. One might say that magnetic elements should be included in gravitational equation.
The following can be one such candidate.

$$F = G \frac{M(Mp+Mf+Md)N(Np+Nf+Nd)}{r^2} \quad \cdots\cdots \quad (19)$$

,where M is the mass of M, Mp is the susceptibility value (χ_m) of paramagnetism of mass M, Mf is the susceptibility value of ferromagnetism of mass M, and Md is the susceptibility value of diamagnetism of mass M. N is the mass of N, Np is the susceptibility value of paramagnetism of mass N, Nf is the susceptibility value of ferromagnetism of mass N, and Md is the susceptibility value of diamagnetism of mass N. r is the distance between M and N. The values of Mp, Mf, Md, Np, Nf, and Nd are yet to be determined.

c) Application of the basic science to the practical areas in our society

The basic science takes an essential domain of our knowledge. At the same time, the application of the basic science to the practical areas in our society is important to maintain the well-being of our human life as well as to develop the prosperous stage of our society.

c-1) A preliminary concept to produce a vehicle from the earth to the other planets

The linear motor car runs horizontally. If we construct the linear motor car runs vertically, which might be called vertical motor car (VMC), we will be able to reach the other planets easily. We should use the super- conductivity magnet for the entire vertical motor car, because the use of electric power will cost too much if we use the electromagnet. At the same time, we should use the robot which works as a vertical motor car construction robot (VMCCR). In this way, we can avoid the human accidents.

c-2) A preliminary concept to produce a motor car which levitates to the sky avoiding potential accidents.

In case we encounter a potential car collision, we would like to avoid it by all means if possible. Our preliminary concept to avoid the car accident is as follows:

First of all, we propose that a driver should be seated in the passenger compartment, which is an important part of this motor car, consisting of electromagnetic seat, a driver seat and a floating instrument like a balloon all of which will be separated from the main part of the car in case of a potential accident to save the passenger. Five or more layers of diamagnetic superconductor equipped beneath the magnetic seat , because one layer of the superconductor is not powerful enough to make the passenger compartment to float. The electromagnetic seat is equipped with the ON/OFF switch. When a car almost collides with the other car, the driver or an automated accident-avoiding system turns ON the switch of the electromagnet converting the electromagnet to an active magnet. And then the superconductor and the magnet repel each other kicking the passenger compartment into the sky by the Meissner effect. After the passenger compartment kicks out in the sky, the floating instrument like a balloon keeps the passenger compartment in the sky. Finally, a passenger (driver) is able to avoid the car accident. The mechanism of the magnetizer and the super-conductive magnet theory is mentioned in the Huno's document [94].

c-3) An application of gravitational shielding devices

Various types of gravitational shielding devices are reported. Those reported devices can be more powerful by applying technical reform and improvement. One can equip such a device under the airplane with ON/OFF switch. The switch activates the device and the OFF swath is used in the usual fight. In case of a potential airplane accident the pilot or automated-crash detecting machine turns ON the switch of the device and then the airplane float in the sky avoiding the crash (falling-down),

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