ZERO POINT FIELD POWER

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INTRODUCTION

A scientific speculation exists about a zero point field that exists in the universe and which could become a limitless source of potential power. If true, it is thought to possibly hold the key to defying and controlling gravity, and providing propulsion systems for Earth and space travel within and beyond our solar system.

The theoretical basis for electromagnetic zero point energy is clear: in its ground state, a quantum system possesses fluctuations and an associated zero point energy, since otherwise the Heisenberg uncertainty principle would be violated. The vacuum state of a quantum field and the electric and magnetic fields in the electromagnetic vacuum are fluctuating quantities. The Casimir effect is an effect in quantum electrodynamics that can be explained by the zero-point energy concept.

The concept of zero-point energy originated with Max Planck in 1911. At the same time Einstein and Hopf in 1910 and Einstein and Stern in 1913 were also studying the properties of zero point energy. Nernst in 1916 proposed that empty space was filled with zero point electromagnetic radiation. In 1925 the existence of zero point energy was shown to be required by quantum mechanics as a direct consequence of Heisenberg's uncertainty principle. The way to quantize the electromagnetic field is to associate each mode of the field with a harmonic oscillator with the result that the minimum energy per mode of the electromagnetic quantum vacuum is $h\nu/2$.

In 1934, Georges Lemaître used an unusual perfect-fluid equation of state to interpret the cosmological constant as due to vacuum energy. In 1973 Edward Tryon proposed that the universe may be a large scale quantum mechanical vacuum fluctuation where positive mass-energy is balanced by negative gravitational potential energy.

During the 1980s, there were many attempts to relate the fields that generate the vacuum energy to specific fields that were predicted by the Grand Unification Theory, and to use observations of the universe to confirm that theory. These efforts have failed so far, and the exact nature of the particles or fields that generate vacuum energy, with a density such as that required by the Inflation theory, remains a mystery.

What is known is that we can identify 4 forces of nature that supposedly separated at the time of the Big Bang. One can suggest a fifth force encompassing yet undiscovered forces as follows:

1. The strong Force, expressed in nuclear binding by the intermediary of gluons,
2. The Electromagnetic Force, expressed in the electromagnetic spectrum, through the intermediary of photons,
3. The Weak Force, expressed in radioactivity, through the intermediary of W and Z bosons,
4. The Gravitational Force, expressed in Gravity, by the intermediary of gravitons,
5. Other possible undiscovered forces, expressed in antigravity, dark energy, dark matter and the neutrino universe.

HEISENBERG'S UNCERTAINTY PRINCIPLE

Heisenberg's Uncertainty Principle (Fig. 1) states that the position x and momentum p of a particle cannot be simultaneously measured with arbitrarily high precision. There is a minimum for the product of the uncertainties of these two measurements. There is likewise a minimum for the product of the uncertainties of the energy E and time t:

$$\Delta x \Delta p \geq \frac{\hbar}{2} = \frac{h}{4\pi} \tag{1}$$

$$\Delta E \Delta t \geq \frac{\hbar}{2} = \frac{h}{4\pi} \tag{2}$$

where: h is Planck's constant = 6.6262×10^{-27} [erg.sec].

Figure 1. Werner Heisenberg.

In some instances in the literature, the right hand side of Eqns. 1 and 2 are presented as double the shown values.

This is not a statement about the inaccuracy of measurement instruments, nor is it a reflection on the quality of experimental methods. It arises from the wave properties inherent in the quantum mechanical description of nature. Even with perfect instruments and techniques, uncertainty and randomness is inherent in the nature of things.

MASS ENERGY FORMULA

The complete annihilation of a particle's rest mass m_0 into energy releases its rest mass energy:

$$E_{rest} = m_0 c^2 \tag{3}$$

where: c = 2.9979 x 10^{10} [cm/sec] is the speed of light.

The total energy of a particle is its rest mass energy plus its kinetic energy E:

$$E_{total} = mc^2 = E + m_0 c^2 \tag{4}$$

Thus the kinetic energy E of a particle is:

$$E = mc^2 - m_0 c^2 = \Delta m.c^2 \tag{5}$$

When a particle moves at a relativistic speed v, its mass varies as:

$$m = \frac{m_0}{\sqrt{1-\left(\frac{v}{c}\right)^2}} \tag{6}$$

Consequently its kinetic energy becomes:

$$E = m_0 c^2 \left[\frac{1}{\sqrt{1-\left(\frac{v}{c}\right)^2}} - 1 \right] \tag{7}$$

THE DE BLOGLIE HYPOTHESIS

According to L. de Broglie in 1924, a dual character of waves and particles should be assigned to electromagnetic radiation as well as the other physical entities such as molecules, atoms, and nucleons. This would explain numerous experiments involving the interaction between radiant energy and matter, such the photoelectric effect and the phenomenon of Compton scattering.

This hypothesis relates the momentum p of a particle to a wavelength λ in term of Planck's constant h as:

$$\lambda = \frac{h}{p} \tag{8}$$

For particles of nonzero rest mass m_0 such as electrons and neutrons, the momentum p is given by:

$$p = m_0 v \tag{9}$$

At non relativistic energies we can write the kinetic energy E as:

$$E = \frac{1}{2} m_0 v^2, v = \sqrt{\frac{2E}{m_0}} \tag{10}$$

From which the momentum is:

$$p = \sqrt{2m_0 E} \tag{11}$$

The particle wave length becomes:

$$\lambda = \frac{h}{\sqrt{2m_0 E}} \tag{12}$$

For the relativistic case the momentum p is given by:

$$p = \frac{1}{c}\sqrt{E_{total}^2 - E_{rest}^2} \tag{13}$$

and thus:

$$\lambda = \frac{hc}{\sqrt{E_{total}^2 - E_{rest}^2}} \tag{14}$$

The momentum for a particle of zero rest mass such a photon is given by the expression:

$$p = \frac{E}{c} \tag{15}$$

The wave length of a particle of zero rest mass such as the photon becomes:

$$\lambda = \frac{hc}{E} \tag{16}$$

In fact, for a photon:

$$E = h\nu$$

from which:

$$\lambda = \frac{hc}{E} = \frac{hc}{h\nu} = \frac{c}{\nu} \tag{17}$$

Notice that in the expression for the wave length of a non zero rest mass particle the square root of its kinetic energy E appears in the denominator, whereas for a zero rest mass particle it is the value of E itself that appears.

EXAMPLE

If an electron is accelerated to a velocity v under a potential V, its kinetic energy is:

$$E = \frac{1}{2} m v^2 = eV$$

where: e is the electronic charge = $4.80288\text{x}10^{-10}$ [esu],
m_0 is the electron mass = $9.1085\text{x}10^{-28}$ [gm].
The wave length associated with this electron would be:

$$\lambda = \frac{h}{\sqrt{2 m_0 E}} = \frac{h}{\sqrt{2 m_0 e V}}$$

For a difference of potential of V=100 [volts], the wave length would be:

$$\lambda = \frac{6.6252 \times 10^{-27}}{(2 \times 9.1085 \times 10^{-28} \times 100 \times 4.80288 \times 10^{-10})^{\frac{1}{2}}}$$
$$= 1.22 \times 10^{-8} [cm] = 1.22 \, Angstrom \, (A^0)$$

This wavelength is of the order of the distance between atomic planes in crystals such as nickel, so that they can be used as diffraction gratings. Davisson and Germer demonstrated the existence of these waves experimentally in 1927, in their electron diffraction experiments.

THE QUANTUM HARMONIC OSCILLATOR

The classical spring potential is:

$$V(x) = \frac{1}{2} k x^2 \tag{18}$$

where: the spring constant k is related to the angular frequency ω is given by:

$$\omega = \sqrt{\frac{k}{m}} = 2\pi\nu \tag{19}$$

where: ν is the frequency,

m is the mass.

The Schrödinger equation is:

$$-\frac{\hbar^2}{2m}\frac{d^2\Psi(x)}{dx^2}+V(x)\Psi(x)=E\Psi(x) \qquad (20)$$

For a harmonic oscillator with the classical spring potential it becomes:

$$-\frac{\hbar^2}{2m}\frac{d^2\Psi(x)}{dx^2}+\frac{1}{2}m\omega^2x^2\Psi(x)=E\Psi(x) \qquad (21)$$

The derivative of the wave function Ψ must give back the square of x plus a constant times the original function. The following Gaussian form for the wave function can be suggested as a solution:

$$\Psi(x)=Ce^{-\alpha\frac{x^2}{2}} \qquad (22)$$

The Gaussian function satisfies the requirement of going to zero at infinity, making it possible to normalize the wave function.

ZERO POINT ENERGY AS THE GROUND STATE SOLUTION TO SCHRÖDINGER'S EQUATION

The first derivative of the assumed wave function solution is:

$$\frac{d\Psi}{dx}=-C\frac{\alpha}{2}e^{-\frac{\alpha x^2}{2}}.2x=-C\alpha xe^{-\frac{\alpha x^2}{2}} \qquad (23)$$

Applying he chain rule of differentiation we can get the second derivative as:

$$\frac{d\Psi}{dx}=-C\frac{\alpha}{2}e^{-\frac{\alpha x^2}{2}}.2x=-C\alpha xe^{-\frac{\alpha x^2}{2}} \qquad (24)$$

Substituting this function into the Schrödinger equation by evaluating the second derivative gives:

$$\frac{d^2\Psi}{dx^2}=-C\alpha e^{-\frac{\alpha x^2}{2}}+C\alpha^2x^2e^{-\frac{\alpha x^2}{2}} \qquad (25)$$

Substituting in Shrödinger's equation, we get:

$$-\frac{\hbar^2}{2m}[-\alpha+\alpha^2x^2]\Psi+\frac{1}{2}m\omega^2x^2\Psi=E\Psi \tag{26}$$

For this expression to be a solution to the Schrödinger's equation for all values of x, the coefficients of each power of x must be equal. That gives us a method for fitting the boundary conditions in the differential equation. Setting the coefficients of the square of x equal to each other:

$$-\frac{\hbar^2}{2m}\alpha^2+\frac{1}{2}m\omega^2=0$$

From which:

$$\alpha=\frac{m\omega}{\hbar} \tag{27}$$

The wave function becomes:

$$\Psi(x)=Ce^{-\alpha\frac{x^2}{2}}=Ce^{-\frac{m\omega}{2\hbar}x^2} \tag{28}$$

Equating the constant terms to each other gives for the energy:

$$-\frac{\hbar^2}{2m}\alpha=-\frac{\hbar^2}{2m}\frac{m\omega}{\hbar}=E_0$$

or:

$$E_0=\frac{\hbar\omega}{2}=\frac{h}{2\pi}\frac{2\pi\nu}{2}=\frac{h\nu}{2} \tag{29}$$

This is also the smallest energy level allowed by the uncertainty principle. It is a very significant physical result because it tells us that the energy of a system described by a harmonic oscillator potential cannot have zero energy. Physical systems such as atoms in a solid lattice or in polyatomic molecules in a gas cannot have zero energy even at absolute zero temperature. The energy of the ground vibration state is often referred to as the zero point vibration. The zero point energy is sufficient to prevent liquid He^4 from freezing at atmospheric pressure, no matter how low the temperature.

ZERO POINT ENERGY FROM HEISENBERG'S UNCERTAINTY PRINCIPLE

While the previous analysis shows that the zero point energy satisfies the Schrödinger equation, it does not demonstrate that it is the lowest energy. One interesting way to show this is to demonstrate that it is the lowest energy allowed by the Heisenberg's uncertainty principle.

The energy of the quantum harmonic oscillator in terms of the momentum and position uncertainties must be at least:

$$E = \frac{(\Delta p)^2}{2m} + \frac{1}{2} m\omega^2 (\Delta x)^2 \tag{30}$$

Taking the lower limit of the uncertainty principle:

$$\begin{aligned} \Delta x \Delta p &= \frac{\hbar}{2} \\ \Delta p &= \frac{\hbar}{2\Delta x} \end{aligned} \tag{31}$$

From which the energy is:

$$E = \frac{\hbar^2}{8m(\Delta x)^2} + \frac{1}{2} m\omega^2 (\Delta x)^2 \tag{32}$$

For minimum energy:

$$\frac{dE}{d(\Delta x)} = 0$$

Leading to:

$$-\frac{\hbar^2}{4m(\Delta x)^3} + m\omega^2 (\Delta x) = 0$$

This leads to the minimum value for the position uncertainty as:

$$\Delta x = \left(\frac{\hbar}{2m\omega} \right)^{1/2} \tag{33}$$

The minimum energy allowed or zero point energy becomes:

$$
\begin{aligned}
E_0 &= \frac{\hbar^2}{8m(\Delta x)^2} + \frac{1}{2} m\omega^2 (\Delta x)^2 \\
&= \frac{\hbar\omega}{4} + \frac{\hbar\omega}{4} \\
&= \frac{\hbar\omega}{2} \\
&= \frac{h\nu}{2}
\end{aligned} \tag{34}
$$

GENERAL SOLUTION FOR THE QUANTUM HARMONIC OSCILLATOR

The quantum harmonic oscillator is one of the foundation problems of quantum mechanics. It can be applied to the description of the vibration spectra of diatomic molecules. Beyond such a simple system, it is the foundation for the understanding of complex modes of vibration in larger molecules, the motion of atoms in a solid lattice, and the theory of heat capacity.

The general solution to the Schrödinger equation leads to a sequence of evenly spaced energy levels characterized by a quantum number n:

$$
E_n = (n + \frac{1}{2})\hbar\omega \tag{35}
$$

In real systems, the energy spacings are equal only for the lowest levels where the potential is a good approximation of the mass on a spring type harmonic potential (Fig. 2). The anharmonic terms which appear in the potential for a diatomic molecule are useful for mapping the detailed potential of such systems.

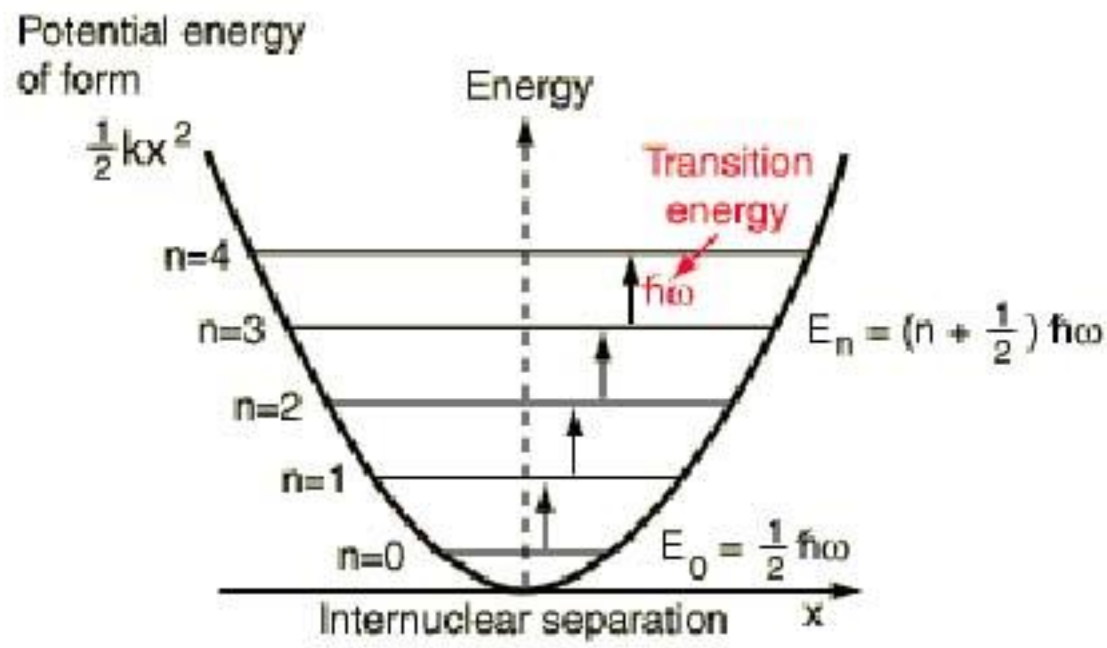

Figure 2. Energy levels for a parabolic potential energy with the harmonic quantum oscillator.

The wave functions for the quantum harmonic oscillator contain the Gaussian form which allows them to satisfy the necessary boundary conditions at infinity. In the wave function associated with a given value of the quantum number n, the Gaussian is multiplied by Hermite polynomials of order n as.

$$\Psi_n(x) = \left(\frac{\alpha^{1/2}}{x}\right)^{1/4} \frac{1}{\sqrt{2^n n!}} H_n(\alpha^{1/2}x) e^{-\alpha\frac{x^2}{2}} \tag{36}$$

The expressions are simplified by making the substitution:

$$y = \alpha^{1/2}x,\ \alpha = \frac{m\omega}{\hbar} \tag{37}$$

The general form for the normalized wave functions becomes:

$$\Psi_n(y) = \left(\frac{\alpha}{y}\right)^{1/4} \frac{1}{\sqrt{2^n n!}} H_n(y) e^{-\frac{y^2}{2}} \tag{38}$$

SEMI CLASSICAL ZERO POINT ENERGY DENSITY

We consider a semi-classical approach combining the constraints of relativity to those of quantum mechanics to reach another perspective to the concept of zero point-field power. In a circular orbit, the centrifugal force F on a mass m_1 is:

$$F = \frac{m_1 v^2}{r} \tag{39}$$

implying an acceleration of the mass m_1 of magnitude:

$$a = \frac{v^2}{r} \tag{40}$$

A gravitational force F of equal magnitude due to a mass m is:

$$F = \frac{G m_1 m}{r^2} \tag{41}$$

where G is the gravitational constant, generates an acceleration:

$$a = \frac{Gm}{r^2} \tag{42}$$

Equating the accelerations in Eqns. 40 and 42 we get a rotational radius r as:

$$r = \frac{Gm}{v^2} \tag{43}$$

As the speed v of the particle approaches the speed of light c, we obtain the Schwarzschild radius under the condition of maximum acceleration for a given mass m as:

$$r_s = \frac{Gm}{c^2} \qquad (43)$$

The Heizenberg's uncertainty principle specifies that the product of the uncertainties in momentum and position should be:

$$\Delta x \Delta p \geq \frac{\hbar}{2} = \frac{h}{4\pi}$$

If we let the uncertainty in momentum tend to mc in the last equation:

$$\Delta p \to mc$$

$$\Delta x \geq \frac{h}{4\pi}\frac{1}{mc}$$

This suggests an expression for the Compton radius r_C, which would be the minimum quantum size for an object of mass m:

$$r_c = \frac{h}{4\pi}\frac{1}{mc} \tag{44}$$

If we equate this to the Schwarzschild radius in Eqn. 43, which is the radius corresponding to the maximum possible acceleration; we arrive at Planck's mass m_P:

$$m_p = \left(\frac{ch}{4\pi G}\right)^{1/2} \tag{45}$$

This is of the order of 10^{-5} gram.

The Compton radius of the Planck's mass is called the Planck's length l_P and can be obtained by substituting from Eqn. 45 into Eqn. 44:

$$l_p = \frac{h}{4\pi}\frac{1}{m_p c} = \left(\frac{hG}{4\pi c^3}\right)^{1/2} \tag{46}$$

This is of the order of 10^{-33} cm.

The fastest oscillations that space-time can sustain is constrained by the speed of light to be the Planck frequency, which is assumed to be the highest frequency that the space time continuum can sustain:

$$\nu_p = \frac{c}{l_p} = \left(\frac{4\pi c^5}{hG}\right)^{1/2} \tag{47}$$

This is of the order of 10^{-43} Hz.

Due to the uncertainty relation, one can think that a Planck mass cannot be compressed into a Planck's volume V_P that is smaller than the cube of the Planck length:

$$V_p = l_p^3 = \left(\frac{hG}{4\pi c^3}\right)^{3/2} \tag{48}$$

The maximum density of matter that can exist without being unstable to collapsing space time fluctuations can be written as:

$$\rho_{Pm} = \frac{m_P}{V_P} = \frac{4\pi c^5}{hG^2} \tag{49}$$

Expressed in terms of energy density of matter, a semi-classical zero point energy density for matter would be:

$$\rho_{Pe} = \frac{m_P c^2}{V_P} = \frac{4\pi c^7}{hG^2} \tag{50}$$

IMPLICATIONS

The vacuum energy has a number of interesting theoretical implications.

Vacuum fluctuations are thought to be created as particle/antiparticle pairs (Fig. 3). The creation of these virtual particles near the event horizon of a black hole has been hypothesized by theoretical physicist Stephen Hawking to be a mechanism for the eventual evaporation of a black hole. The net energy of the universe remains zero so long as the particle pairs annihilate each other within the Planck time. If one of the pair is pulled into the black hole before this, then the other particle becomes real and energy/mass is essentially radiated into space from the black hole. This loss is cumulative and could result in the black hole's disappearance over time. The time required is dependent on the mass of the black hole, but could be on the order of 10^{100} years for large solar-mass black holes.

The Grand Unification Theory predicts a non-zero cosmological constant from the energy of vacuum fluctuations. Examining normal physical processes with knowledge of these field phenomena can lead to an interesting insight in electrodynamics. During discussions of perpetual motion, the topic of vacuum energy usually encourages passionate discussions about the possibility of extracting the zero point energy for uses of energy generation or space propulsion.

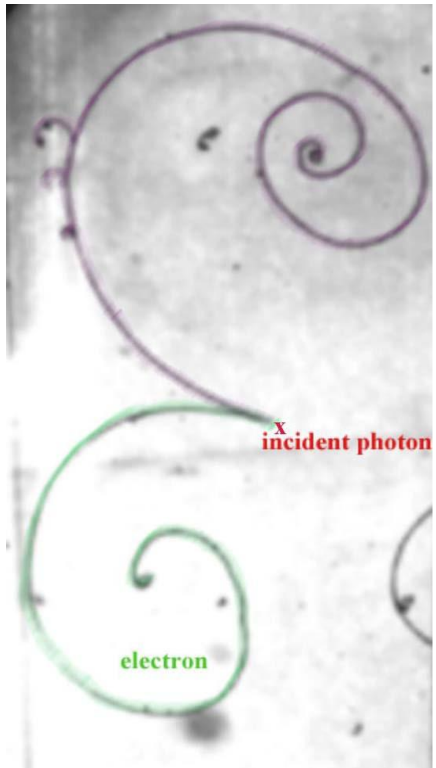

Figure 3. Electron positron pair formation from an incident gamma ray photon.

GERMAN ANTIGRAVITY EXPERIMENTS

A peculiar structure is located outside the village of Nowa Ruba in Poland's Owl Mountains. It consists of a dozen concrete pillars arranged in a circle with a ring around the top. No one has ever been able to come up with a definitive explanation of what the Germans during World War II used it for, prompting conspiracy theorists to allege it was used in a so-called Haunebu project involving “torsional fields” research.

Haunebu, is one of several names for an alleged antigravity engine project, also referred to as Reichsflugscheiben or Reich flying discs, Vril discs or V-7s. Those disks would have been up to 71 meters or 230 feet in diameter and could reach speeds of up to 5,000 kilometers per hour or 3,100 miles per hour. The Vril 1 Jäger or Hunter would have been constructed in 1941 and first flown in 1942. It would have been 11.5 meters in diameter, had a single pilot, and could achieve speeds of between 2,900 kilometers or 1,800 miles per hour and 12,000 kilometers per hour. They were given a role in supposed Nazi Germany secret societies such as the Order of the Black Sun or the Vril Society.

Figure 4. Structure located outside the village of Nowa Ruba in Poland's Owl Mountains. Conspiracy theorists allege it was used in German antigravity experiments during World War II.

SEEKING GRAVITY SHIELDING, TORSIONAL FIELDS

An international collaboration of cosmologists in Finland, called the High-z Supernova Search Team, suggested that empty space may be filled with a repulsive force of as yet unknown origin. In support of this antigravity theory, the group cites data on supernovae. The researchers maintain that the seeming brightness of these distant, exploding stars suggests that the universe is expanding at an ever increasing rate, an acceleration that the standard Big Bang model could not account for.

Eugene Podkletnov supported the idea with work on superconductivity, the ability of some materials to lose their electrical resistance at very low temperatures. He carried out tests on a rapidly spinning disc of superconducting ceramic suspended in the magnetic field of three electric coils, all enclosed in a low temperature cryostat.

He reports: “One of my friends came in and he was smoking his pipe. He put some smoke over the cryostat and we saw that the smoke was going to the ceiling all the time. It was amazing, we couldn't explain it.”

His tests showed a small drop in the weight of objects placed over the device, as if it were shielding the object from the effects of gravity; an effect deemed impossible by most scientists. Podkletnov explained: “We thought it might be a mistake, but we have taken every precaution.” Yet the bizarre effects persisted. The team asserted that even the air pressure vertically above the device dropped slightly, with the effect detectable directly above the device on every floor of the laboratory.

In recent years, many so-called antigravity devices have been put forward by both amateur and professional scientists.

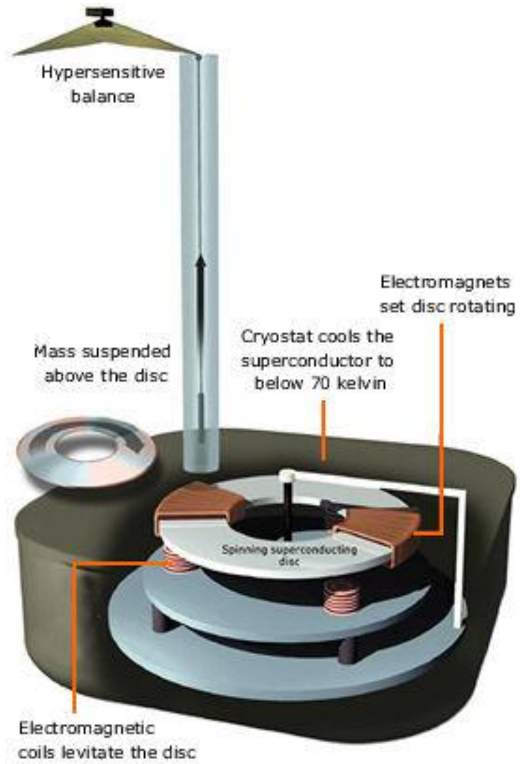

Figure 5. Configuration of Podkletnov magnetically levitated spinning superconducting disc experiment.

Some scientists suspect the anti gravity effect is a long sought side effect of Einstein's general theory of relativity, by which spinning objects or so called torsional fields can distort the space time continuum and consequently gravity. Until now it was thought the effect would be far too small to measure in the laboratory.

Ning Li, a research scientist at the University of Alabama, suggested that the atoms inside superconductors may substantially magnify the effect. Her research was funded by NASA's Marshall Space Flight centre at Huntsville, Alabama. Whitt Brantley, the chief of Advanced Concepts Office there, explains: “We are taking a look at it, because if we don't, we shall never know.”

The Finnish team reported a two per cent drop in the weight of objects suspended over the device, and double that if one device is suspended above another. If the effect can be proven to be real, the implications are substantial for improved launch vehicles designs, energy production and rocket propulsion systems for interstellar travel.

DISCUSSION

The concept of zero point energy shares the same problem with the Dirac Sea: both are potentially infinite. In the case of zero point energy, there are reasons to believe that a cutoff does exist in the zero point spectrum corresponding to the Planck scale. Even this results in an enormous amount of zero point energy whose existence is assumed to be negated by the claim that the mass equivalent of the energy should gravitate, resulting in an absurdly large cosmological constant, contrary to observations.

The relation between zero-point fluctuations and gravitation is a contentious issue. If we ascribe an energy hv/2 to each mode of the vacuum radiation field, then the total energy of the vacuum is infinite. It would clearly be inconsistent with the original assumption of a background Minkowski space time continuum to suppose that this energy produces gravitation in a manner controlled by Einstein's field equations of general relativity.

The space time of the real world approximates closely to the Minkowski state, at least on a macroscopic scale. It would be expected that zero point energy differences would gravitate. The negative Casimir energy between two closely held plane parallel perfect conductors would be expected to gravitate, otherwise the relativistic relation between a measured energy and gravitation would be lost.

It is precisely localizable differences in the zero-point energy that may prove to be of some practical use and that may be the basis of explanation of dark energy phenomena. It has been found that asymmetries in the zero point field that appear upon acceleration may be associated with certain properties of inertia, gravitation and the principle of equivalence as suggested by Haisch, Rueda, Puthoff and Tung. Insight may be generated on certain quantum properties such as the Compton wavelength, the de Broglie wavelength, spin, and on the mass energy equivalence if it proves to be the case that zero point fluctuations interact with matter through a phenomenon identified by Erwin Schrödinger as "zitterbewegung."

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