

Matter & Antimatter Generation & Repulsive Gravity force

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Abstract :

Generalized special relativistic energy relations shows that velocity as well as field potential affect the energy . These relations were used to find vacuum energy by minimizing energy . The minimization shows that vacuum energy consists of photons having energy that can produce particle and anti particle pair . It also shows that the mass of antiparticle is negative , thus it repel ordinary particle . Another expression of vacuum energy shows that vacuum decays and transform may be to ordinary matter as proposed by scientists .

Keywords : generalized special relativity , vacuum energy , anti matter , repulsive force .

1-Introduction :

The existence of anti matter was first proposed by Dirac , when solving his Dirac relativistic equation . The solution of his equation gives an energy term with negative mass . He suggest that this negative mass term indicates the existence of anti matter [1] . later on Anderson found anti electron (positron) in cosmic rays that he detected on 1933 [2] . This important discovery opens a new era in the physics of elementary particles .

It was experimentally observed that a particle and its anti particle can be produced by photons . This pair production was explained easily on the bases of Max plank quantum hypothesis and Einstein mass energy relation [3]. It was also observed that when a particle and its anti particle meats they annihilate and produce a photon .

On the other hand the physics of the early universe shows that at very early stages elementary particles plays an important role in the universe evolution [4]. It is generally accepted that at the early universe , inflation takes place [5] . During this stage some scientists propose the existence of repulsive gravitational field that causes inflation [6] . The inflation of the universe solve some of the long standing problems

like horizon, flatness and entropy problem [7]. This repulsive gravity force was proposed by many scientists, and some of them claim that they result from interaction of particles and anti particles [8,9,10]. This repulsive force between matter and anti matter can help in explaining the particle and anti particle asymmetry and the abundance of particles in our universe. It can also explain the stream of anti particles that leaves galaxies and escape [11,12].

The repulsive gravitational force and the origin of particles and anti particles and their production will be discussed in this research namely in sections (2) and (3). Sections (4) and (5) are devoted for discussion and conclusion.

2- Production of particles and anti particles on the basis of Generalized special Relativity and the Repulsive nature :

The energy relation according to Einstein generalized relativity is given by

$$E = \frac{m_0 c^2 \left(1 + \frac{2\Phi}{c^2}\right)}{\sqrt{1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}}} \quad (2.1)$$

When m_0, Φ, v stands for rest of mass, potential and velocity respectively

Thus

$$E = m_0 c^2 \left(1 + \frac{2\Phi}{c^2}\right) \left(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}\right)^{-\frac{1}{2}} \quad (2.2)$$

To find vacuum minimum energy, the energy one minimizes E to get

$$\frac{dE}{d\Phi} = m_0 c^2 \left[\left(1 + \frac{2\Phi}{c^2}\right) \times \frac{-1}{2} \left(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}\right)^{-\frac{3}{2}} \times \frac{2}{c^2} + \left(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}\right)^{-\frac{1}{2}} \times \frac{2}{c^2} \right]$$

Thus

$$\frac{dE}{d\Phi} = \frac{2m_0 c^2}{c^2} \frac{\left(\frac{1}{2} + \frac{\Phi}{c^2} - \frac{v^2}{c^2}\right)}{\left(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}\right)^{\frac{3}{2}}} \quad (2.3)$$

$$\frac{2m_0 c^2}{c^2} \frac{\left(\frac{1}{2} + \frac{\Phi}{c^2} - \frac{v^2}{c^2}\right)}{\left(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}\right)^{\frac{3}{2}}} = 0 \quad (2.4)$$

Hence

$$\frac{1}{2} + \frac{\Phi}{c^2} - \frac{v^2}{c^2} = 0$$

Therefore

$$\frac{\Phi}{c^2} = \frac{v^2}{c^2} - \frac{1}{2}$$

$$\Phi = c^2 \left(\frac{v^2}{c^2} - \frac{1}{2} \right)$$

Thus the value of Φ which make E minimum is given by

$$\Phi = v^2 - \frac{c^2}{2} \quad (2.5)$$

Due to the wave nature of light

$$c_e = \frac{c_m}{\sqrt{2}}$$

$$c_m = \sqrt{2} c_e \quad (2.6)$$

Let

$$c = c_m = \sqrt{2} c_e \quad (2.7)$$

$$\Phi = v^2 - c_e^2 \quad (2.8)$$

When $v = 0$

$$\Phi = -c_e^2 \quad (2.9)$$

Thus the potential is given by

$$V = m_0 \Phi = -m_0 c_e^2 \quad (2.10)$$

In this case the vacuum constituents are at rest ($v = 0$).

But when a photon, which constitute vacuum move with speed c , thus

$$v = c \quad (2.11)$$

Substitute in (5) to get

$$\Phi = c^2 - \frac{c^2}{2} = \frac{c^2}{2} \quad (2.12)$$

When inserting equation (2.7) , one gets

$$\Phi = c_e^2 \quad (2.13)$$

But the potential energy is given by

$$V = m_0 \Phi$$

Thus from (2.13) and (2.1) the potential is given by

$$V = m_0 c_e^2$$

The vacuum energy can be found by inserting (2.11) and (2.12) in (2.1) to get

$$E = m_0 c^2 (1 + 1) = 2m_0 c^2 \quad (2.14)$$

Thus one can imagine vacuum energy levels as shown below

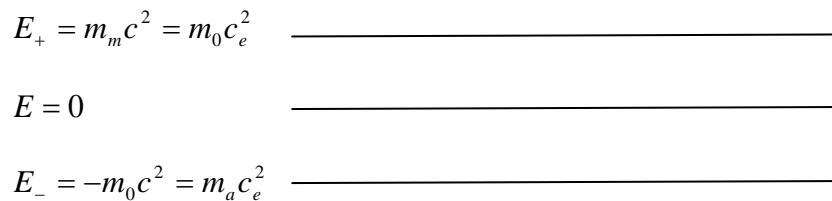


Figure (1) : vacuum states as consisting of photons producing and destructing particles and anti particles with rest masses m_0 .

The production of pair particles can be regarded as due to electron transfer from state the lower to the upper state after absorbing a photon .

Where

$$\begin{aligned} m_m &= \text{matter mass} = m_0 \\ m_a &= \text{anti matter mass} = -m_0 \end{aligned} \quad (2.15)$$

The energy diagram is shown in figure (1)

According to Newton's laws the potential is given by

$$\Phi = -\frac{G m}{r} \quad (2.16)$$

For matter

$$m_m = m_0$$

Thus

$$\Phi_m = \text{matter potential} = -\frac{G m_m}{r} = -\frac{G m_0}{r} \quad (2.17)$$

This is an attractive force .

For anti matter

$$m_a = -m_0$$

$$\Phi_a = \text{anti matter} = -\frac{G m_a}{r} = +\frac{G m_0}{r} \quad (2.18)$$

This is a repulsive force

When matter and anti matter interact with each other the potential is given by

$$V = -\frac{G m M}{r} \quad (2.19)$$

Where the force is given by

$$F = -\nabla V$$

$$= -\frac{\partial V}{\partial r} = +G m M \frac{\partial r^{-1}}{\partial r}$$

Hence the force is given by

$$F = -\frac{G m M}{r^2} \quad (2.20)$$

For matter and anti matter reaction

$$m = m_m = m_0$$

$$M = m_a = -m_0 \quad (2.21)$$

Thus the force between matter and anti matter is given by

$$F = -\frac{G (m_0)(-m_0)}{r^2} = \frac{G m_0^2}{r^2} \quad (2.22)$$

Thus there is repulsive force between matter and anti matter .

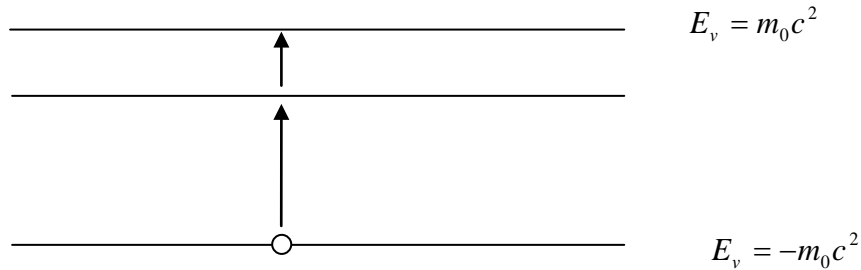


Figure (2) : vacuum energy levels

3-Generation of particle and anti particle on the basis of conservation law

In this work it is shown that; the energy conservation requires

$$E = mc^2 + 2m\Phi \quad (3.1)$$

The GSR mass was proposed by some authors to be

$$m = \frac{m_0}{\sqrt{\left(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}\right)}} \quad (3.2)$$

From (3.1) and (3.2) one gets

$$E = \frac{m_0 c^2}{\sqrt{\left(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}\right)}} + \frac{2m_0 c^2}{\sqrt{\left(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}\right)}}$$

$$E = m_0 c^2 \left(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}\right)^{-\frac{1}{2}} + 2m_0 c^2 \left(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}\right)^{-\frac{1}{2}}$$

To find vacuum state , the energy E need to be minimized W.r.t to Φ , to get

$$\frac{dE}{d\Phi} = -\frac{1}{2} m_0 c^2 \left(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}\right)^{-\frac{3}{2}} \times \frac{2}{c^2} + 2m_0 \left[\Phi \times \frac{-1}{2} \left(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}\right)^{-\frac{3}{2}} \times \frac{2}{c^2} + \left(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}\right)^{-\frac{1}{2}} \right]$$

Thus

$$\frac{dE}{d\Phi} = \frac{-m_0}{\left(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}\right)^{\frac{3}{2}}} - \frac{2m_0\Phi/c^2}{\left(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}\right)^{\frac{3}{2}}} + \frac{2m_0}{\left(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}\right)^{\frac{1}{2}}}$$

$$= \frac{-m_0 - 2m_0\Phi/c^2 + 2m_0\left(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}\right)}{\left(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}\right)^{\frac{3}{2}}} \quad (3.3)$$

This equation can be satisfied , when

$$2m_0\left(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}\right) = \frac{2m_0\Phi}{c^2} + m_0$$

$$1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2} = \frac{\Phi}{c^2} + \frac{1}{2}$$

$$\frac{\Phi}{c^2} = \frac{v^2}{c^2} - \frac{1}{2}$$

$$\Phi = v^2 - \frac{c^2}{2} \quad (3.4)$$

If vacuum particles are at rest $v = 0$, thus equation (3.4) become

$$\Phi = -\frac{c^2}{2} \quad (3.5)$$

Substituting this value in (3.1) and (3.2) yield

$$m = \frac{m_0}{0} = \infty \quad (3.6)$$

Thus from (3.1)

$$E = \infty \quad (3.7)$$

Thus condition (3.3) is the condition for maximum E .

Now one can use equation (3.1)

$$E = mc^2 + 2m\Phi$$

But the mass term is in the form

$$m = \frac{(1 + \frac{2\Phi}{c^2})m_0}{\sqrt{1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}}} \quad (3.8)$$

Inserting (3-8) in (3-1) yields

$$E = \frac{(1 + \frac{2\Phi}{c^2})m_0c^2}{\sqrt{1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}}} + \frac{2m_0\Phi(1 + \frac{2\Phi}{c^2})}{\sqrt{1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}}}$$

$$E = m_0c^2(1 + \frac{2\Phi}{c^2})(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2})^{-\frac{1}{2}} + 2m_0(\Phi + \frac{2\Phi^2}{c^2})(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2})^{-\frac{1}{2}}$$

The differentiation of E w.r.t to Φ requires

$$\frac{dE}{d\Phi} = m_0c^2 \left[(1 + \frac{2\Phi}{c^2}) \times \frac{-1}{2} (1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2})^{-\frac{3}{2}} \times \frac{2}{c^2} + (1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2})^{-\frac{1}{2}} \times \frac{2}{c^2} \right]$$

$$+ 2m_0 \left[(\Phi + \frac{2\Phi^2}{c^2}) \times \frac{-1}{2} (1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2})^{-\frac{3}{2}} \times \frac{2}{c^2} + (1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2})^{-\frac{1}{2}} \times (1 + \frac{4\Phi}{c^2}) \right]$$

$$= \frac{-m_0(1 + \frac{2\Phi}{c^2})}{(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2})^{\frac{3}{2}}} + \frac{2m_0}{(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2})^{\frac{1}{2}}} - \frac{2m_0/c^2(\Phi + \frac{2\Phi^2}{c^2})}{(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2})^{\frac{3}{2}}} + \frac{2m_0(1 + \frac{4\Phi}{c^2})}{(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2})^{\frac{1}{2}}} \quad (3.9)$$

Where for minimum energy one has

$$\frac{dE}{d\Phi} = 0 \quad (3.10)$$

$$\frac{-m_0(1 + \frac{2\Phi}{c^2}) + 2m_0(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}) - 2m_0/c^2(\Phi + \frac{2\Phi^2}{c^2}) + 2m_0(1 + \frac{4\Phi}{c^2})(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2})}{(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2})} = 0$$

$$(1 + \frac{2\Phi}{c^2}) + 2(1 + \frac{2\Phi}{c^2}) - \frac{2v^2}{c^2} - \frac{2\Phi}{c^2} - \frac{4\Phi^2}{c^4} + 2(1 + \frac{4\Phi}{c^2})(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}) = 0 \quad (3.11)$$

$$(1 + \frac{2\Phi}{c^2}) - \frac{2\Phi}{c^2} - \frac{2v^2}{c^2} - \frac{4\Phi^2}{c^4} + 2(1 + \frac{2\Phi}{c^2}) - \frac{2v^2}{c^2} + 4\Phi(1 + \frac{2\Phi}{c^2} - \frac{v^2}{c^2}) = 0$$

$$3\left(1 + \frac{2\Phi}{c^2}\right) - \frac{2\Phi}{c^2} - \frac{4v^2}{c^2} - \frac{4\Phi^2}{c^4} + \frac{4\Phi}{c^2} - \frac{8\Phi^2}{c^4} - \frac{4v^2\Phi}{c^4} = 0$$

$$3 + \frac{8\Phi}{c^2} - \frac{4v^2}{c^2} + \frac{4\Phi^2}{c^4} - \frac{4v^2\Phi}{c^4} = 0 \quad (3.12)$$

For stationary vacuum constituents

$$v = 0 \quad (3.13)$$

Equation (3.12) reads

$$\frac{4\Phi^2}{c^4} + \frac{8\Phi}{c^2} + 3 = 0$$

$$4\Phi^2 + 8\Phi c^2 + 3c^4 = 0$$

Solving for Φ

$$\Phi = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad (3.14)$$

$$\Phi = \frac{-8c^2 \pm \sqrt{16c^4 - 48c^4}}{8} \quad (3.15)$$

Substituting (3.15) in the energy E relation (3.1) gives

$$E = \pm \sqrt{-2} mc^2 \quad (3.16)$$

Consider now a vacuum is full of photons . this means that

$$\frac{4\Phi^2}{c^4} + \frac{8\Phi}{c^2} - 1 = 0 \quad (3.17)$$

Using (3-14)

$$\Phi = \frac{-4c^2 \pm \sqrt{16c^4 + 16c^4}}{8}$$

$$\Phi = \frac{-4c^2 \pm 4\sqrt{2}c^2}{8} = -\frac{1}{2}c^2 \pm \frac{1}{\sqrt{2}}c^2 \quad (3.18)$$

Inserting equation (3.18) in equation (3.1) the energy is given by

$$E = mc^2 + 2m\left(-\frac{1}{2}c^2 \pm \frac{1}{\sqrt{2}}c^2\right)$$

$$E = \pm\sqrt{2} mc^2 \quad (3.19)$$

4-Discussion

The vacuum energy is found by minimizing GGR energy relation (2.1), together with the velocity and potential given by (2.11) and (2.12). One here assumes the vacuum consisting of photons, where we assume v to be equal to c in (2.11). In this case vacuum energy is given by equation (2.14) to be

$$E_v = 2m_0c^2 \quad (4.1)$$

According to figure (1), one can assume vacuum as consisting of photon of energy

$$E_p = hf = 2m_0c^2$$

Beside matter and anti matter particle with energies

$$E_m = m_0c^2, \quad E_a = -m_0c^2$$

Thus the total vacuum energy is

$$E_v = E_p + E_m + E_a = 2m_0c^2 \quad (4.2)$$

Where the particle exists in the energy state $= m_0c^2$

This is equivalent to the existence of the particle and anti particle representing this lower state, together with non interacting photon. When the photon is incident on this particle in the lower state ($-m_0c^2$) it gives it an energy ($2m_0c^2$). This the particle transfer itself to the state of energy (m_0c^2) appearing as a particle and leaving a vacancy in the state ($-m_0c^2$) which appears as an anti particle, with numerical masses m_0c^2 . The photon of energy $2m_0c^2$ disappear producing a particle and anti particle pair of total numerical mass $2m_0c^2$.

Using also Mubarak energy conservation expression (3.1), vacuum energy is again obtained by minimizing E and assuming vacuum to constitute stationary particles to get relation (3.16)

$$E = \sqrt{2} m_0c^2 i = \hbar w = i\hbar w_0$$

$$w = iw_0 \quad w_0 = \sqrt{2} m_0c^2 \quad (4.3)$$

The wave function of vacuum particles takes the form

$$\psi = Ae^{\frac{iE}{\hbar}t} = Ae^{iwt} = Ae^{-w_0t} \quad (4.4)$$

Thus the number of vacuum particles is given by

$$n \sim |\psi|^2 \sim A^2 e^{-2w_0t} \quad (4.5)$$

This means that vacuum particles decay and transform to other forms like elementary particles. This result conforms with what proposed by cosmology physicists at the early universe.

5- Conclusion

The energy expressions of GSR shows that vacuum fluctuation produces particles and anti particles and photon periodically. It shows also that vacuum decays to produce matter.

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