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Universal mass-energy equivalence for relativistic masses

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ABSTRACT*: In this short research communication, the universal mass-energy equivalence relation is derived for large and small relativistic moving masses.*
KEYWORDS:*Mass, Energy, Particles, Relativistic motion, Satellite.*

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I. INTRODUCTION

In this research paper the validity of differentiation of a moving or relativistic mass as a function of velocity is described in the theory section. Then, the formula for the universal mass-energy relation given as dE/E = dm/m is derived for large and small moving masses as the result, and discussed in section III. Here, E is the energy, and m is the mass. The above formula is also published and discussed elsewhere, applicable to semiconductor and insulator materials [1]. The applicability of the above formula to large relativistic or moving masses is shown with the example of a satellite motionwhich in the present research is new.

II. THEORY

A moving mass, big or small, increases its mass because of Einstein's relativity principle that makes mass effectively change from m_0 to $m_0/(\mathrm{sqrt}(1-v^2/c^2))$, where v is the speed of the mass and c is the speed of light equal to about 3 x 10^8 metres/second. Mostly, v/c <<1, but at any v other than zero, m will change, however small the change may be. The m_0 is the rest mass, and m is an effective mass or relativistic mass. Therefore, m can bedifferentiated as dm because it changes and it is a continuously increasing function of vin the interval [0, c], except for v = c when it becomes infinite.

III. RESULTS AND DISCUSSION

Artificial satellite motion above earth as a large mass can crudely represent motion of stars, planets and galaxies. Consider satellite motion 36000 kms above the centre of the earth. If it makes one revolution in 24 hrs, then the linear velocity is circumference divided by 24 hrs. It comes out to be nearly 2618 metres per second. The gravitational force on the satellite towards the centre of earth is given by $F=GMm/r^2$, where G is the gravitational constant, M is the mass of earth, m is the mass of the satellite, and r is the distance of the satellite from the centre of the earth. This force is the same as the centripetal force towards the centre of the earth. So, equating the gravitational force to the centripetal force which is mv^2/r, gives the square of the linear velocity as $v^2=GM/r$. Then the kinetic energy of the satellite given by $0.5mv^2$ will be 0.5mGM/r by substituting for v^2. Now, we have a formula for kinetic energy E=0.5mGM/r. The magnitude of the total energy is also the same as the positive kinetic energy. This formula can be differentiated based on the discussion on relativistic mass m above even though the 2618 metres/sec linear velocity of the satellite gives v/c as very small, but the mass still changes when the velocity of the satellite changes from zero to 2618 metres/sec. The differentiation and rearrangement lead to the formula:

$$dE/E = dm/m.$$

This is the universal mass-energy equivalence relation, first found out by Albert Einstein as $E = mc^2$.

Now, the equation dE/E equals dm/m is derived for a conduction electron or hole in Silicon due to a change in temperature [2]. Consider the equation for kinetic energy of an electron or hole in Si as:

$$E = \frac{1}{2}mv^2$$

Differentiating both sides gives:

$$dE = \frac{1}{2}v^2(dm) + \frac{1}{2}md(v^2)$$

The second term of the above equation is invalid, because the drift velocity for electrons is decreasing with increasing thermal energy due to increase in temperature [2]. Increased collisions between the travelling electrons causes reduction in drift velocity. The kinetic energy of the electrons increases with the temperature from the theorem of equipartition of energy. The mass of the electron therefore cannot be constant, but must increase.Therefore:

$$dE = \frac{1}{2}v^2(dm)$$

$$dE = E/m(dm)$$

$dE/E = dm/m$.

The above equation can also be derived from Einstein's mass-energy equivalence equation, as follows:

$$E = mc^2$$

$dE = c^2(dm)$

$\frac{dE}{E} = \frac{c^2(dm)}{mc^2}$

$dE/E = dm/m.$

Thus, for both large and small moving masses, dE/E =dm/m is the universal mass-energy equivalence relation which Einstein discovered first as E= mc^2. It was found to be applicable to energy transformations also, such as nuclear and chemical energies. A point to be noted is that both the eminent scientists of the past, namely Einstein and Newton are part of this differentiated form of universal mass-energy equivalence, given that Newton invented Calculus before Leibniz.

Believe it or not! Everything in the Universe is always moving from quarks in the neutrons and protons to stars, planets and galaxies, making the mass change effectively. Therefore, conservation of mass is absent. There is only conservation of momentum and energy in the Universe.The author also predicts that the quarks in the neutrons and protons are conducting simple harmonic motion.

IV. CONCLUSIONS

It is concluded that the formula dE/E = dm/m is a universal mass-energy equivalence formula where E is the energy and m is the mass. Its applicability to large moving mass like a satellite of earth is shown in the present research as new research. Due to the changing mass, the conservation of mass is concluded to be absent in the Universe.

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