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THE ESSENTIAL RELATIONSHIP BETWEEN MASS AND ENERGY

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This paper introduces the essences of mass, time, length and energy, as well as their standard measurement units, analyzes mass-velocity relationships in different theories, and comments on these relationships. Also the paper negates the mass-velocity equation and the mass-energy equation in the special relativity; analyzes the source and generating mechanism of atomic energy. The author deems that mass is mass, energy is energy; mass cannot be transformed into energy and energy cannot be transformed into mass. These two concepts can't be converted into each other. There are mass conservation and energy conservation, individually.

Keywords: special relativity, mass, energy, velocity of light, mass-velocity equation, mass-energy equation

In Newtonian mechanics, the mass, time, length and energy are respectively independent concepts; but in the special relativity, these four quantities all have something to do with speed, and mass and energy can be converted into each other, which makes the physics academia in a great mess. Therefore, there is a need to clean up the mess from the angle of philosophy, to discuss the original relationship between mass and energy, and eliminate the negative and confusing influence of the special relativity.

1. MASS, TIME, LENGTH AND ENERGY

The definition of mass: mass is one of the material's essential attributes. Mass is referred to the amount of matter that an object contains. There is nothing in the world whose mass is zero. As long as it is matter, its mass is greater than zero. The standard unit of mass is kilogram. In the international unit system, "kilogram" is set by the mass of platinum- iridium etalon in BIPM, which locates near Paris. Some people believe that the mass standard of "kilogram" in different countries grows at a 0.5 gamma rate annually and this kind of change has already exceeded "kilogram's" accuracy of the international comparison. Now, people are looking for a better way [1].

T*he definition of time*: time is one of the forms of matter's existence. Time is the persistence and sequentiality of matter's moving procession, the objective existence that dose not depend on people's consciousness, and eternal. Time is unidirectional, evenly passing and having no start point and no end point. The standard unit of time is second. The 13th International Calculating Conference (1967) made the definition for TA second: the time unit second is the lasting time of 9,192,631,770 periods which are radiated by the transition caused by Cs -133 atomic basic state's two hyperfine energy levels". Before 1960, time unit second referred to UT0 second. Adding whole year's true solar days together and then divided by 365, people can get the true solar day, which is usually called "mean solar day", and fairly partitioning it into 86,400 parts provides second, where one of the parts is one second. Afterwards, people discovered that there are slim differences between earth's revolution and rotation speed, which would cause deviations in the measurement of seconds. Later research discovered that Cs -133-transition speed was much steadier, so scholars adopted this new definition. The purpose is to minimize the variation of the length of a second [2-3]. According to the view of materialistic philosophy, the transition between the atomic basic state's two hyperfine energy levels must be affected by temperature, pressure and other field factors. As the relevant research being deepened, the definition of a second will be more precise and more scientific.

The definition of length: Space is one of the forms for matter's existence. The physical space is infinite and boundless. Space is three dimensional and isotropic. The coordinates of the three-dimensional space can be expressed in length. The length is the extensive property in some direction. Its standard unit is meter. The 17th International Calculating Conference, held in 1983, decide that the unit meter for length adopts the definition of the velocity of light in the vacuum. In particular, "meter is the distance light travels in a vacuum in 1/299,792,458 second interval ". The velocity of light c becomes a conventional value in this definition, and as an exact value, the uncertainty is zero. Meter was initially worked out by French Academy of Sciences during the French Revolution. At that time a meter was referred to the distance that is 1/10,000,000 of that from the equator to Paris and then to North Pole of the Earth meridian. Then it later evolved into the distance between the two scales on the meter standard located in BIPM near Paris. Afterwards, people discovered that this distance would suffer from small variations along with the changing environment. So they adopted the more stable length that is the above-mentioned definition. Some researchers point out that each vacuum is not empty, there are fields in the vacuum, and the velocity of light in the vacuum changes along with some factors. Some people can even stop photons from moving. Therefore, the definition of length should be more strict and scientific.

The definition of energy: Energy is used to show an object's working ability, is a state attribute of the object. Energy has various forms of existence, such as the kinetic energy, potential energy, heat energy, chemical energy, electromagnetic energy, atomic energy, etc. In nature, energy always keeps on spreading from an object to another, or transforms from one form to another. In the transformation process, an object loses energy, while other objects acquire the lost energy. Potential energy reduces and kinetic energy increases; chemical energy reduces and heat energy increases; atomic energy reduces then kinetic energy and potential energy increase. When one object loses energy, others must acquire the lost energy, and the total amount of energy stays constant. These are the theorem of conservation and transformation of energy. The unit of energy is joule, a derived unit. One joule equals to the work that one Newton force makes the object to move along its direction in one meter's distance.

2. THE RELATIONSHIP BETWEEN MASS AND SPEED

2.1. The Newtonian Theory

The Newtonian theory holds that mass is a build-in attribute of an object, and it doesn't change with object's velocity.

2.2. The Special Relativity [4]

Albert Einstein supposed that mass is a function of an object's speed defined as follows:

$$m = \frac{m_0 c}{\sqrt{c^2 - v^2}} \tag{1}$$

where m_0 is the object's static mass; m its moving mass, v the velocity of motion. This is a result of the special relativity, whose premise is absurd.

2.3. The Open System with Inputting Momentum

Supposes that there is an object whose rest mass is m_0, if the outside world injects into the object with a mass of momentum density Q along a certain direction, then the increment in the system's momentum is given by

$$\mathrm{d}P = Q\,\mathrm{d}m \tag{2}$$

where P is the total momentum of the system.

By using $P = mv$ and $m\big|_{v=0} = m_0$, we have

$$m = m_0 \frac{Q}{Q - v} \tag{3}$$

That is, the momentum injected into the system equals the total momentum of the system.

Equ. (3) can be used to explain the phenomenon that the mass of charged particles increases, while the velocities of the particles are always smaller than that of light, when an electromagnetic filed speeds up the charged particles. In fact, since the velocity of motion of the electromagnetic waves in relation to the generation device is that of light, we have $Q = c$. So, $m = m_0 \dfrac{c}{c - v}$. The reason why the mass of the charged particles increases is because the particles absorb the photons that apply forces on the particles. No matter how long time it takes, because the pushing speed is that of light, the velocity of the objects being pushed is always smaller than that of light.

2.4. The Open System with Inputting Kinetic Energy

Reference [5] introduces a kind of open systems with their own masses and entering kinetic energy. Suppose that there is a system whose rest mass is m_0. If the outside world injects into this system with kinetic energy of density K along certain direction, then the increment in energy of that system is given by

$$\mathrm{d}E_\mathrm{k} = K\,\mathrm{d}m \tag{4}$$

where E_k stands for the kinetic energy of the system and m the mass of the system.

According to the Newtonian mechanics, we have

$$\mathrm{d}E_\mathrm{k} = F\,\mathrm{d}x = Fv\,\mathrm{d}t = v(F\,\mathrm{d}t) = v\,\mathrm{d}(mv) = v^2\,\mathrm{d}m + vm\,\mathrm{d}v \tag{5}$$

Combining with equ. (4) leads to

$$\frac{\mathrm{d}m}{m} = \frac{v\,\mathrm{d}v}{K - v^2} \tag{6}$$

Integrating equ. (6) and inserting $m\big|_{v=0} = m_0$ into the resultant expression produce:

$$m = m_0 \sqrt{\frac{K}{K - v^2}} \tag{7}$$

Its form is similar to that of equ. (1).

It can be verified that the value $K(m - m_0)$ of the inputting kinetic energy is greater than the system's total kinetic energy $\frac{1}{2}mv^2$. The premise for the deduction is the conservation of kinetic energy. However, the consequence is not conservative. A contradiction. The reason for the appearance of the contradiction is that the perfectly inelastic collision means the formation of one combined entity right after the collision and the combined entity moves at a unified speed. And, this end does not satisfy the conservation law of kinetic energy. So, this formula cannot be employed.

The Newtonian theory shows the essence that mass has nothing to do with the velocity. The theory of open systems with inputting momentum can be applied to plausibly explain the phenomenon of the mass increase of charged particles and why these particles' velocity is always smaller than that of light in a particle accelerator. Though Einstein's theory and that of the open systems with inputting kinetic energy are of similar forms, both of these theories disagree with the objective reality.

3. THE TRANSLATION KINETIC ENERGY OF OBJECTS

Each moving object possesses kinetic energy, where energy is a scalar. When observed from different coordinate systems, the same object might possess different amounts of kinetic energy.

In a certain coordinate system, an object of rest mass m_0 starts to move from its initial resting state under the influence of external force. When the speed of motion is v, the translation kinetic energy of the object is E_k.

3.1. The Newtonian Theory

The Newtonian theory holds that when the external force makes the object speed up, the mass of the object stays invariant and the translation kinetic energy of the object equals the force's work on the object:

$$\begin{aligned} E_{kn} &= \Delta E = \int_0^x F\,\mathrm{d}x = \int_0^x m_0 \frac{\mathrm{d}v}{\mathrm{d}t}\mathrm{d}x \\ &= \int_0^x m_0 \frac{\mathrm{d}x}{\mathrm{d}t}\mathrm{d}v = \int_0^v m_0 v\,\mathrm{d}v = \frac{1}{2}m_0 v^2 \end{aligned} \tag{8}$$

where E_{kn} is the translation kinetic energy of the Newtonian theory, E the total energy, F the force acting on the object, and x the distance over which the force acts on the object.

3.2. The Einstein's Theory [4]

Albert Einstein supposed that the mass of the object is a function of its velocity of movement:

$$m = \frac{m_0 c}{\sqrt{c^2 - v^2}} \tag{9}$$

So, we have

$$E_{\mathrm{kA}} = \Delta E = \int_0^x F \,\mathrm{d}x = \int_0^x \frac{\mathrm{d}(mv)}{\mathrm{d}t}\mathrm{d}x = \int_0^v v\,\mathrm{d}(mv) = \int_0^v v\,\mathrm{d}\left(\frac{m_0 cv}{\sqrt{c^2 - v^2}}\right)$$
$$= \frac{m_0 cc^2}{\sqrt{c^2 - v^2}} - m_0 c^2 = mc^2 - m_0 c^2 \tag{10}$$

Suppose that $E_{\mathrm{v}} = mc^2$ is the energy of the object when it is moving and $E_0 = m_0 c^2$ the rest energy. Expanding equ. (10) further produces:

$$E_{\mathrm{kA}} = \frac{1}{2} m_0 v^2 + \frac{3}{8} m_0 \frac{v^4}{c^2} + \ldots \tag{11}$$

Because of this equation, the Einstein's theory thinks that the translation kinetic energy E_{kn} of the Newtonian theory is a first-order approximation of the translation kinetic energy E_{kA} of the Einstein's theory at low speed ($v \ll c$).

3.3. Some Comments

(1) The Newtonian theory is correct, since up to now no paradox has been found.

(2) There are following problems in the Einstein's theory: (i) the formula: $m = \frac{m_0 c}{\sqrt{c^2 - v^2}}$, which is originated from the special relativity, disobeys the law of indestructibility of matter, and its deduction premise is absurd. (ii) Even if equ. (9) is correct, it still cannot be substituted into equ. (10), because in the deduction process of equ. (9), Einstein supposed that the object moves uniformly along a straight line without any external force. When calculating the kinetic energy, the object is under the influence of an external force and accelerating. So, the conditions applied are inconsistent and cannot be mixed up. (iii) As for the fact that the first term in equ. (11) agrees with equ. (8), it might either be so purely by chance or be so by purposeful pieced together.

4. THE SOURCE AND RELEASE PRINCIPLE OF ATOMIC ENERGY

The discovery and application of atomic energy are one of the greatest achievements of science and technology. Some scholars credited Einstein and his special relativity for this achievement. As a matter of fact, the discovery of atomic energy has nothing to do with the special relativity. Einstein used the incorrect special relativity, and scored a lucky hit on pushing the application of atomic energy.

4.1. F. Hasenohrl's Theory

Before 1905 when the special relativity was initially published, Thomson, Kaufman, and others made a great contribution to the experimental research and theory of the relationship between mass and energy. The famous Austrian physicist F. Hasenohrl confirmed in 1904 through experiments that mass increase is directly proportional to the increase in the radiation energy, and deduced the well-known relationship: $\Delta E \propto \Delta mc^2$.

4.2. The Einstein's Theories

(1) The Special relativity [4]

When explaining atomic energy, Einstein believed that $E_0 = m_0 c^2$ was the rest energy of materials. After disappearance, energy can be converted into mass. After disappearance, mass can be converted into energy. And, energy and mass can be converted into each other. Suppose that after a nuclear reaction occurs, the loss of mass is Δm_0 , and the converted energy ΔE_0, then $\Delta E_0 = \Delta m_0 c^2$.

There are two major problems in this theory. One is that the assumptions and the deduction process are wrong. The other is that it disobeys the conservation law of matter and the conservation law of energy.

(2) Radiation pressure theory [6]

In January 1956, Einstein published his paper, entitled "Primary exploration on mass and energy," in Technion Journal of New York. The paper supposes that there is an object B, whose two sides are subjected to the radiation pressure of momentum $E/2c$, then according to the law of conservation of momentum, the radiation pressure formula, and the aberration expression of light, then the formula $E = mc^2$ is deduced. Let us quote some of the relevant materials below:

I. "*Before absorption, suppose that M is the mass of B (the object), then Mv stands for the total momentum of B (according to the classical mechanics). The radiation energy on each side is E/2. Therefore, from a famous conclusion of Maxwell theories, it has the momentum* $E/2c$ *. ... So, before absorption, the total momentum of this system is* $Mv + \frac{E}{c^2}v$ *.*

II. *After absorption, suppose that M' is the mass of B (the object). The supposed possibility is that: the mass increases along with the absorption of energy E (it is necessary for making the observed result consistent). The system's momentum after absorption, as a result, is* $M'v$ *.*

Now suppose that the law of conservation of momentum holds true, and let us use it in the direction of Z (Z coordinate axis), then the equation follows:

$$Mv + \frac{E}{c^2}v = M'v \quad or \quad M' - M = \frac{E}{c^2}$$

This is the law of mass and energy, where the amount E of energy increase is connected with the amount E/c^2 *of mass increase.... then,* $E = mc^2$ *."*

The falsehood of this theory lies in that when the two sides of the object B are subjected to the same radiation pressure, the pressures from the opposite directions cancel out each other, and the total momentum before absorption is Mv instead of $Mv + \frac{E}{c^2}v$.

From this discussion, it can be seen that Einstein's explanations on the two relationships between mass and energy are invalid and incorrect.

4.3. The Newtonian Theory

The atomic energy comes from the energy from within the atom. The release of atomic energy is that the photon transfers together with its mass and energy. The mass of the object that releases energy reduces, so does its level of energy. The energy of the object that receives energy increases, so does its mass. The process an object gives off its atomic energy is just as to use a gun to shoot a bullet, and the bullet is shot and leaves the gun along with its mass and energy together. The relationship between the energy and mass transferred is $\Delta E = \frac{1}{2}\Delta mc^2$.

5. VERIFICATION OF THE MASS-ENERGY RELATIONSHIP

5.1. The Newtonian Mechanics

The relationship between mass and energy of the Newtonian mechanics has already been applied to a wide range of areas. And, no problem has been found as of this writing.

5.2. The Einstein's Theories

There are obvious mistakes in the mass-energy relation of Einstein's special relativity and radiation pressure theory in their course of deductions. They disobey both the law of conservation of mass and the law of conservation of energy. Although many scholars declare that experiments have already proved the special relativity and mass-energy transformation formula, if one observes carefully, it is easy to find that these experiments are all invalid or forged [7-8].

6. CONCLUSIONS

Mass is mass, energy is energy. The two cannot be converted into each other. There individually exist mass conservation and energy conservation.

References

1. Yang Jianping. Basic Physical Constant and Basic Measurement Unit [J]. *HuBei Institute for Nationalities Journal (Natural Science Edition)* , 2003,21(2):69-71.
2. Ni Guangren, He kangyuan and Yang Tinggao. Time Unit- the Origin and Evolution of Second Definition (first volume) [J]. *Chinese Measurement,* 2003, (9):47-48.
3. Ni Guangtrn, He kangyuan and Yang Tinggao. Time Unit- the Origin and Evolution of Second Definition (last volume) [J]. *Chinese Measurement*, 2003, (10):45-48.
4. Cheng Shouzhu, Jiang Zhiyong. *General Physics* [M]. Beijing: People's Education Publishing House, 1978: 231-132 .
5. http://www.dyntm.com.cn/htm/21cn/21sjndlx.htm.
6. Lei Yuanxing. *Comment on mass-energy formula* [A], Afterthought on Theory of Relativity [M]. Beijing: Earthquake Publishing House, 2002:210
7. Huang Zhixun. Study on Theoretical Development and Experiment Verification of the Theory of Special Relativity [J]. *Chinese Engineering Science*, 2003, 5(5):8-12.
8. Simon Rainville, James K. Thompson et al. A direct test of $E=mc^2$ [J]. *Nature*, 2005, 438(7071):1096-1097.