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Energy of the Objects in the Finite Universe

Alireza Emami Meybodi

ABSTRACT

In this article, we tried to examine the energy of an object under different physical conditions. We demonstrated that the outcome is different from what physicists has so far believed. Basically, we showed that the net energy of an object in this universe is fixed and is not affected by the environment.

Keywords: *Universe, Energy, Cosmology*

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I. Introduction

In a previous article titled 'The Shape of the Universe' [1], it was established that our universe is finite. This finite nature gives rise to several interesting phenomena familiar to scientists. Article [1] demonstrated that a finite universe can provide a solid rationale for the observed limitations on the speed of light and the equations underpinning the special theory of relativity. In the current article, we explore how the finiteness of our universe impacts the net energy of objects in different physical scenarios.

The rest of the paper is organized as follows: In section 2, we explore the relationship between the total energy of an object and its velocity. The total energy of an object under local gravitational field is described in section 3, and finally the paper is concluded in section 4.

II. Energy and Velocity

Let us assume that an object with mass of m is not moving and distant from any local gravitational fields. The net gravitational field which is exerted on this object from all the other objects in this universe is calculated as follows [2].

$$F_w = \frac{GM_o m}{R_o^2}, \tag{1}$$

where G is the gravitational constant, M_o is the mass of the whole universe, and R_o is the effective radius of the universe. The gravitational binding energy of this object to the universe is equal to:

$$E_w = \frac{GM_o m}{R_o}, \tag{2}$$

According to [2],

$$GM_o = R_o C^2,$$

Where C is the speed of light.

$$E_w = \frac{R_o C^2 m}{R_o} = mc^2 \tag{3}$$

As expected, the energy of an unmoving object which is far away from the local gravitational fields amounts to the product of its mass and the square of light speed which is in agreement with the famous equation of Einstein [3].

Now, assume that the same object is accelerated so as its speed reaches v. Due to the curvature of the universe the centrifugal force is exerted on that object whose direction is opposite of F_w and its magnitude is calculated as follows.

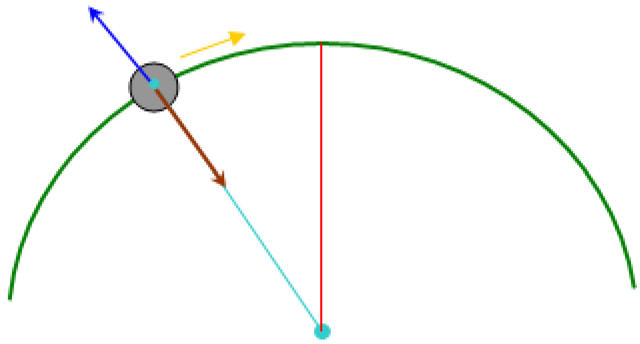

Fig.1. The forces exerted on a moving object in the universe.

$$F_v = \frac{mv^2}{R_o} \tag{4}$$

Hence the net force on the object is equal to:

$$F_m = \frac{mc^2}{R_o} - \frac{mv^2}{R_o} \tag{5}$$

In this scenario, the gravitational binding energy of the moving object to the universe is calculated as follows.

$$E_w = mc^2 - \frac{1}{2}mv^2 \tag{6}$$

We know that the kinetic energy of a moving object is equal to $\frac{1}{2}mv^2$. As a result, the total energy of the object is equal to:

$$E_m = \left(mc^2 - \frac{1}{2}mv^2\right) + \frac{1}{2}mv^2 = mc^2 \tag{7}$$

Therefore, we conclude that the total energy of an object is independent of its speed.

III. Energy and Gravity

Assume that an object with mass of m is on a planet – such as earth – the magnitude of the gravitational force exerted on that object is calculated as follows.

$$F_e = \frac{GM_e m}{R_e^2}, \tag{8}$$

where M_e and R_e are the mass and radius of the planet respectively. This force can be decomposed into two components (Fig. 2). The direction of one of these components (F_{u1}) is opposite of the universal weight of the object (F_w) and its magnitude is equal to:

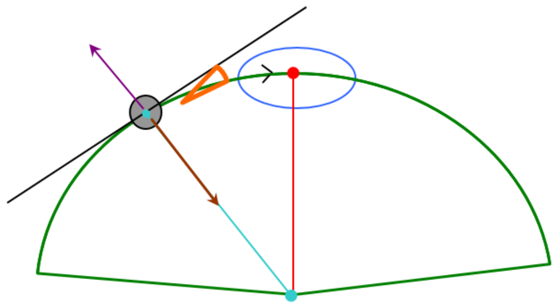

Fig.2. The forces exerted on an object under the influence of a local gravitational field.

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$$F_{u1} = F_e sin(\alpha), \tag{9}$$

where $\alpha = R_e/R_o$. Since α is very small, F_{u1} can be approximated as:

$$F_{u1} = \frac{GM_e m}{R_e^2} \times \frac{R_e}{R_o} = \frac{GM_e m}{R_e R_o} \tag{10}$$

Hence:

$$F_m = \frac{GM_O m}{R_O^2} - \frac{GM_e m}{R_e R_O} \tag{11}$$

The gravitational binding energy of the object to the universe is as follows.

$$E_w = \frac{GM_o m}{R_o} - \frac{GM_e m}{R_e} = mc^2 - \frac{GM_e m}{R_e} \tag{12}$$

It is also known that the gravitational binding energy of the object to the planet can be calculated as the following equation.

$$E_e = \frac{GM_e m}{R_e} \tag{13}$$

Thus, the total energy of the object is:

$$E_m = E_w + E_e = mc^2 \tag{14}$$

Therefore, we can conclude that the total energy of an object is independent of the gravitational field.

IV. Conclusion

In this paper, we have explored two scenarios where the net energy of an object remains constant, even when its kinetic or gravitational potential energy undergoes changes. In general, we can assert that the net energy of an object in our universe remains fixed under all circumstances, and it is equivalent to the product of its mass and the square of the speed of light. In other words, the net energy of an object can be visualized as the sum of angles of a triangle. As we decrease/increase one of the angles in a triangle, the other two angles are changed so as the sum always remains fixed. Likewise, decreasing/increasing one of the kinds of energy of an object leads the other kinds of energy in that object to change in a direction such that the total energy remains fixed.

V. Declarations

5.1 Funding

This paper has not received any funding.

5.2 Conflicts of interest

The author declares that he has no conflict of interest.

5.3 Availability of data and material

Not applicable

5.4 Code availability

Not applicable

5.5 Authors' contributions

A.E.M has done the entire work.

Reference

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