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On the energy and momentum concept

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The fundamental concept associated with the notion of the energy and momentum, as well as their conservation laws are discussed.

1. Introduction

In 1842 the German researcher Julius Robert von Mayer sent to the physical magazine his paper. There he first pointed out to the equivalence between the work and the extracted heat; i.e., he discovered the energy conservation law. The magazine editor (the famous physicist Johann Christian Poggendorff) ejected this paper to the wastepaper basket; so, the scientists knew about it after Mayer death only **[Dukov, 2002]**.

In my paper I will try to show that in our Universe the conservation energy law is not *exact* one (though the relative error is in our epoch 10^{-10} per year only). And there is no doubt that any scientific magazine editor will eject it to the wastepaper basket. The unsuccessful "heretics" as well as successful ones are doomed to attack bastions that are build by the "orthodox persons". It is a very efficient mechanism of any ideology self-defense (including science).

In the now-day mechanics the energy E and the momentum components p_i of a particle are definite as the action S partial derivatives on time t and coordinates q_i:

$$E = -\partial S/\partial t, \quad p_i = \partial S/\partial q_i.$$

In the *quantum* mechanics operators acting onto a wave function correspond to physical quantities. So, differentiation operators on time and coordinates correspond to the energy and momentum. Also these operators are multiplied by the Planck constant that has the action dimension.

It is recognized and understood that the energy and momentum conservation laws are due to the spacetime uniformity (the Nother theorem), i.e., to its geometric features. However (in my opinion) there is no a clear answer to the next question: what does *action* mean, can we deduce this concept from simple geometric picture?

2. Energy and momentum in the new Universe model

Since 1993 I develop the new cosmological model of the Universe (see **[Shulman, 2006, 2007]**). It is based on the assumption that our Universe is an expanding 3D shell of a 4D sphere in some external world and represents a black hole in it. Because of that the Universe *irreversibly* absorbs external matter and energy; so, it is *thermodynamically* open system. On the other hand, such the Universe turns out to be *geometrically* closed because it has spherical metrics and positive curvature. Of course, at each time moment such the shell is specified by some perimeter L.

These source ideas allows us to construct purely geometrically the representations about energy and momentum like two famous analogy. The first one is the spherical shells vibration theory; as it is known, oscillation modes can appear in such the shells where the ratio "perimeter/wavelength" must be an integer number. The second one is

the electronic orbits elementary model that was proposed by Niels Bohr to determine a stable orbits of electron in atoms.

As it is known, a de Broglie wave corresponds to each quantum particle. As I believe, in the Universe new model the free quantum particle momentum is equal to the ratio "perimeter L/ de Broglie wavelength λ", and its energy is equal to the ratio "perimeter L/ de Broglie wave period τ". So, for a free particle we have:

$$E = L/\tau, \quad p = L/\lambda.$$

To get the known quantum relations $E=h/\tau$, $p=h/\lambda$ it is enough to identify (taking into account dimension of action) the Planck constant with the perimeter L. So, the action notion turns out to be practically the same as a current Universe perimeter.

3. Is Time uniform?

Remember, the energy and momentum conservation laws are due to the spacetime uniformity. The space uniformity is indisputable statement, at each time point the (expanding) 3D shell is isotropic and uniform. However, when we consider the time uniformity we have to discuss what happens.

In our epoch the relative increment of the Universe radius per year is negligibly small (near 10^{-10}). However, at the beginning of the Universe expansion (say, during first year) the radius and this radius increment had a similar order. Note, our world physics is hardly *depending* on its geometry. In fact, the gravity is determined by the values of the metric tensor components, i.e., of the Universe curvature radius. Because of that we cannot believe that Time in our Universe is uniform and energy is strongly constant.

4. Conclusion

Thus, the idea that our Universe is not thermodynamically close is really admissible. The Universe expansion wittingly *contradicts* to the Time uniformity concept and *inevitably* leads to the global non-conservation in the Universe (to the First Law of Thermodynamics violation) and, the more, to the Universe evolution (i.e., to the Second Law violation, see **[Shulman, 2011]**). Let us stress that we talk about Laws of Thermodynamics in the Universe scale, not in the scale of external world as well as in the scales of a small parts of the Universe.

The Universe energy increasing over Time surprisingly confirms the conjecture of the remarkable Russian astrophysicist N.A. Kozyrev which stated that "Time transforms to the energy"[1]. This energy increment is very difficult to reveal for "usual" bodies, but may be essential enough for Sun and other star since it is much larger than its radiative loss.

If really such the physical quantity as action quantum is proportional to the Universe perimeter, then the "Planck constant" is not a constant at all, it should be called "the Planck parameter". One can hope that such the inconstancy of this quantity and other ones may be revealed using experimental tests; it is very important to precise the evolution models of our Universe.

[1] I found out this result without any using of Kozyrev's "causal mechanics".

References

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