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The global influence of local symmetry on entropy of the Universe

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Space and matter were created in the Big Bang. Since Big Bang, the Universe has been expanding continually by increasing its entropy. The fundamental forces broke their symmetries, making impossible to unify them together. Nevertheless, the symmetry of the Universe has not changed and interestingly will never. By analysing global and local symmetry, this paper will present a hypothesis on the future shape and energy expansion of the Universe. A new theory of point symmetry of the Universe will also be introduced.

Keywords: local symmetry, global symmetry, gravitational entropy, point symmetry

I. INTRODUCTION

The Universe around us is shaped by four fundamental forces [1]. These are - strong interaction, weak interaction, electromagnetic force, and gravitational interaction. The first and strongest force is the strong interaction, which occurs only between quarks, gluons and antiquarks. The second force is known as weak interaction which occurs between bosons. The third one is the electromagnetic force, which occurs between particles having an electrical charge. The fourth and weakest force of the Universe is the gravitational interaction. Despite the fact that gravitational interaction has the largest range of impacts, two objects need huge masses to "see" each other. This is because the force decreases with the square of the distance between them:

$$F_g = G\frac{m_1 m_2}{r^2} \tag{1}$$

where G is the gravitational constant, m_1 m_2 are the masses of two objects and r is the distance between the centres of masses of the objects.

At the beginning of the creation of the Universe (at about 10^{-43} s), all fundamental forces except the gravity have equal importance in the shaping of the Universe [2]. Symmetry occurred between these interactions, and hence, it is termed as the grand unification. The symmetry was broken at 10^{-35} s, when the temperature fell to 1.028 K. Then, the strong interaction was separated from the weak and electromagnetic interactions, and its power began to exceed the power of the other two, as it does today. The consequence of breaking of symmetry was the emission of the large amounts of energy. Energy released from 10^{-35} to 10^{-33} s has caused a rapid accelerating expansion of the Universe, which continues. This led to smooth out any major inhomogeneity that may have existed in earlier phases of Universe. Therefore, today in large scale, the Universe is homogeneous and isotropic, i.e. same in all directions.

Since the 10^{-33} s expansion became much slower. The density of the Universe was decreasing with the temperature. However, the temperature was so high that there were all types of quarks and antiquarks. After lowering the temperature, heavier quarks began to disintegrate, while lighter quarks began to combine into hadrons. All sorts of hadrons – including both most durable, such as protons, neutrons, hyperons, pions, kaons, and a lot of short-lived resonances - were present at the thermodynamic equilibrium. In addition to the particles, antiparticles were also in large quantities. Particle-antiparticle pairs were formed continually and were annihilated at the same time.

Despite the fact that symmetry of interaction has been broken, the Universe has retained its global symmetry and hence, it is homogeneous and isotropic. This paper will establish that lack of local symmetry of the Universe is not permanent and cannot be dominated in the scale of the Universe.

II. THE POINT UNIVERSE THEORY

In the event of Big Bang, the Universe was expanded from the point of unimaginable size, and what we see now is still expanding. When the entire matter was condensed in one point, i.e. singularity, the entropy of the "Point Universe" was equal to zero. This means that the matter in point had perfect order and entropy started to increase with the expansion of the Universe.

According to the second law of thermodynamics, any isolated system tends to equilibrium where the entropy is maximum. Assuming the Universe as a oneness in an isolated system, it should also tend to balance. Based on these assumptions, Hermann von Helmholtz hypothesized heat death of the Universe [3]. According to this theory, the Universe will finally come to the thermodynamic equilibrium, which will not allow conversion of thermal energy into work, so the Universe will stop its expansion. However, confirmation of this theory is relatively difficult to observe. It leads to much debate whether the Universe is an isolated system, or just closed the tend to balance as a whole. Opponents of this concept argue that the expanding Universe cannot be considered as an isolated system, because we cannot determine the area from which any radiation cannot came out. It is known that the entropy of the vast majority of the known isolated system is growing in the direction we call future. So, from this point of view, thermodynamics determines the direction of the passage of time (i.e. the thermodynamic arrow of time).

According to Boltzmann [4], actual entropy of the Universe is still very low. In comparison with "the target value" to which evidence was to be the high value of fluctuations of statistical

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phenomena observed in the cosmic scale – e.g. a very irregular distribution of stars in space. However, nowadays such an interpretation of entropy is considered to be completely unauthorized from the cosmological point of view.

The local processes of the connection of aggregations of matter can lead to the formation of local symmetry. But, this formation does not disturb the global symmetry of the Universe. However, local aggregations of matter e.g. planets, planetary systems are produced. From global point of view, the Universe is homogeneous and isotropic. Entropy of the expanding Universe is undoubtedly growing, i.e. with the increase of size of Universe, the disorder in it grows too. However, as a result of gravitational interactions, local symmetries can form, and thus, energy of the system decreases according to the gravitational potential (see Fig. 1):

$$E_p = -G\frac{m_1 m_2}{r} \qquad (2)$$

where G is the gravitational constant, m_1 m_2 are the masses of objects and r is the distance between the centres of masses of these objects. Therefore, in accordance with the principle that everything tends to the lowest possible energy, the gravitational interaction, which causes local aggregations of matter connecting to each other (creating local symmetries), reduces its entropy. With decrease in local entropy, the global entropy also begins to decrease. Due to the continuous, additive and the weakest interaction in the Universe under the influence of its entire weight, the energy will be equal to zero again, i.e. matter will collapse to a point. Gravitational potential will be required to balance the positive energy of expanding Universe, which will require all of its mass. Such a situation occurred before the Big Bang and the energy of the entire "Point Universe" was equal to zero at zero entropy.

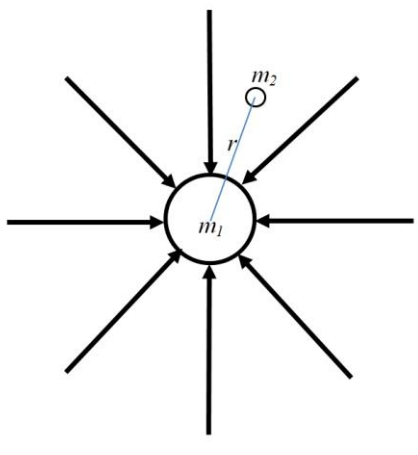

FIG. 1. (Colour online) Central gravitational field of mass m_1

III. THE SYMETRY OF THE POINT

The global picture of the Universe does not always show the details of the processes, which are taking place inside. Only consideration of local phenomena, provides sufficient data to be able to determine the trend of the entire Universe.

The formation of local symmetry seemingly disrupts global entropy by increasing disorder. Yet, the global symmetry is not impaired. The Universe is homogeneous and isotropic. The global energy of the Universe from the beginning till now is constant and is equal to zero which allowed and still allows its expansion. The potential energy must balance the energy of expanding Universe, by the formation of the local symmetries, i.e. homogeneous aggregations of matter. Knowing the mass of the Universe, it is possible to estimate the energy with which the Universe is expanding, and thereby determine when Universe will finish expansion.

Local symmetries are reducing the energy of the expanding Universe, thus reducing its entropy. The continuous formation of local symmetry causes a global symmetry, which in turn will tend to unify all the forces of nature. Processes that took place in the 1st second after the Big Bang will return and the Universe will be able to achieve the perfect order - point.

It is difficult to talk about symmetry of the point within the meaning a geometric because the point has no dimension or specific direction, i.e. dimensionless. However, such a thing may seem purely abstract, but it is a perfect example of symmetry. The point has no dimensions, thus an infinite number of axes of symmetry can be defined. All axes pass through the point and pass through it without dividing into symmetrical parts as the entire point is symmetrical. Fig. 2 shows a visualization of symmetry of the point.

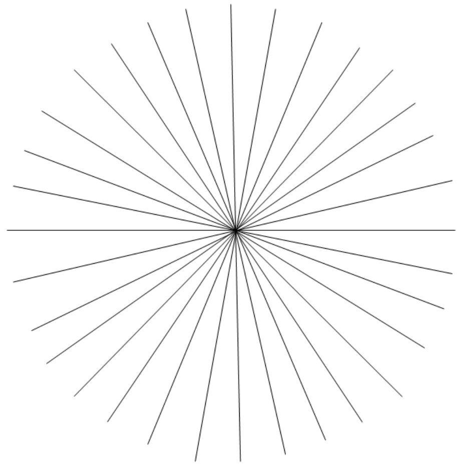

FIG. 2. Point and some of the infinite number of axes of symmetry

The Universe, which is located at the point must have an infinite number of axes of symmetry. It is also the initial and final stage of the Universe. A small fluctuation can destroy this balance, where all matters have no dimension.

As any fluctuation may destroy the symmetry of Point Universe, each subsequent fluctuation may impact on the shape of the Universe. The shape of the Universe, does not have any effect on the global symmetry, because mass of the matter can compensate for irregular expansion, while maintaining the global symmetry. Fig. 3 shows a compensation of the space using mass. On the both side of the figure, the area is same. As can be seen, the mass extends the space around, compensating for the irregular growth on a global scale. In this way, if the Universe achieves an irregular shape, it will not have any impact on its symmetry. Knowing the exact position of all masses in the Universe, it will be possible to determine the exact shape of the Universe.

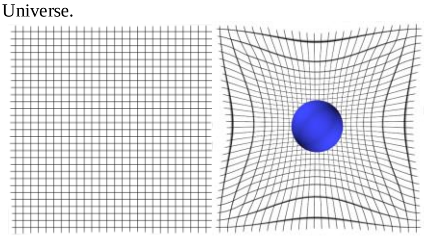

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FIG. 3. (Colour online) Stretching of the time space by the mass. On the left side - space stretched evenly, on the right side - space stretched unevenly, compensated by the mass.

IV. CONCLUSIONS

During the whole period of existence the Universe was changing undoubtedly. Starting from the point, Universe has expanded and cooled down till now. Interestingly, all this time, its energy was constant and equal to zero. Knowing the mass of the entire Universe, it will be possible to determine the energy of the expansion of the Universe. Due to the expansion of the Universe, the entropy of the Universe is still growing, which means disorder in the Universe is growing too. However, the symmetry of the Universe is conserved, thanks to the weakest fundamental force - the gravitational interaction. Gravity stretches the space around a mass and compensates the irregular growth of the Universe. Hence it can be concluded that knowing the exact distribution of masses in the space, it will be possible to predict the shape of the Universe.

Can we talk about the symmetry of the Universe when its entire matter was at the point? Of course, because the point is the most perfect example of a symmetric system. Each line passing through the point is its axis of symmetry.

Despite the existence of a global symmetry of the Universe, local symmetry can form and it does not affect the global symmetry; but reduces global entropy. Due to the gravity, entropy is reduced locally. In a small scale, gravitational interaction begins to dominate over the global entropy and starts to reduce it again towards zero. Thus, the Universe will tend to go back to perfect order, which can be achieved only in point.

Everything in the Universe tends to the smallest energy. Due to the gravitational force, the matter reaches lower energies. It is the driving force for the inevitable event, which is the collapse of the Universe. The matter will bend the time space and then, will absorb it into the singularity.

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[1] P. Davies, The Forces of Nature, Cambridge Univ. Press 2nd ed. (1986)
[2] S. Weinberg, The First Three Minutes: A Modern View of the Origin of the Universe, Basic Books. (1993)
[3] B. H. Lavenda A New Perspective on Thermodynamics. Springer. Sec. 2.3.4. (2009)
[4] M. I. Kalinin, S. A. Kononogov, Boltzmann's constant. *Measurement Techniques* **48**: 632–636. (2005)