THE CYCLIC EVOLUTION OF UNIVERSE AND SYMMETRICAL THERMODYNAMICS

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The second principle of thermodynamics asserts that in an isolated system the energetical transformations develop in such a way that the entropy increases (Katchalscky & Curran, 1965).

The entropy was associated with two essential aspects of evolution: 1) The increase of entropy shows the decrease of the free energy and the growth of the bound energy. 2) The increase of entropy indicates the decrease of order and the growth of disorder (Boltzman, cited by Atlan, 1972).

The application of the second principle of thermodynamics is cosmology has generated some contradictions:

1) According to the second principle, starting from the origin of universe and going to present, the cosmological entropy and the disorder have increased. However, the astrophysical and cosmological data have revealed that the complexity of organization has increased both in microcosmos, as well as in macrocosmos (Weinberg, 1984).

2) From the origin of universe until present, the temperature of cosmos has decreased. This is in contradiction with the second principle of thermodynamics, which indicates that the increase of the entropy is correlated with the growth of the temperature.

On the other hand, the astrophysical and cosmological data indicate that with 15-20 billion years ago, the matter and energy of universe were concentrated in a sphere which had a much smaller radius than the actual radius of universe (Einstein, 1955; Tolman, 1962; Ionescu-Pallas, 1980). Then, at a certain moment the "big bang" was produced and the expansion of universe developed.

According to the theory of generalized relativity, there are two possibilities for the future evolution of universe: a) If the average density of matter in the framework of universe is smaller than a certain critical density (0.5×10^{-29} – 2×10^{-29} g/cm^3), then the expansion of universe will continue for ever. b) If the average density of matter is greater than this critical density, the expansion of universe will stop in the future and it will be followed by a compression phase.

Until now, the average density of matter has not been determined with a sufficient precision to clarify this dilemma (Robinson, 1980; Rubin, 1983; Maddex, 1984; Thuan, 1987). However, the cosmological observations show the existence of non-luminous matter arround the galaxies and the fact that neutrinos probably have a resting mass. In this case, the density of matter in universe is closely situated nearby the critical density.

On the other hand, when the temperature of universe will reach zero absolute degree, because of the expansion of space, the photons will probably acquire a resting mass. In this moment, the density of matter within the universe will surpass the critical density. Subsequently, the expansion of matter will stop and it will be replaced by a compression phase. This possibility suggests the existence of a cyclical evolution of universe.

The cyclical evolution of universe requires the application of the thermodynamics of dual tendencies (a symmetrical thermodynamics).

This thermodynamics is characterized by the following aspects: in the framework of universe two kinds of forces work: a) Forces which support the expansion of matter and energy in cosmos; b) Forces which determine the compression of matter and energy.

During the expansion phase, in the universal space the forces of expansion are predominant, while during the compression phase the forces of compression will be more important.

2) In relation with the expansion forces it is necessary to define a value of free energy and one of bound energy. Some similar values must be introduced in relation with the compression forces. During the expansion phase, the free energy of expansion forces diminishes and that of compression forces increases.

At the limit of expansion, the free energy of expansion will attain its minimum, while that of the compression forces will reach its maximum, and so on.

3) During the evolution of universe, two kinds of order arise. The first order was achieved in the primary nucleus of universe. It was characterized by the division of space in two compartments: a) the sphere of the primary nucleus, which included all the matter and energy; b) the potential space, free of matter and energy, situated around the primary nucleus. I suggest to name this order Planck's order.

The second order will be accomplished at the limit of expansion. It will be characterized by a homogeneous distribution of matter and energy in the interior of black holes and stars of neutrons. The temperature of the universal space will be about zero absolute degree (Dicus et al., 1983). I suggest to name this situation Nernst's order.

4) In relation with these aspects, two kinds of entropies can be defined: a) the entropy of expansion forces (Planck's entropy). b) The entropy of compression forces (Nernst's entropy).

When Planck's entropy attains its maximum, the free energy of the expansion forces is at minimum and the order is that of Nernst's type. This situation will be achieved at the limit of the expansion phase. When Nernst's entropy is at maximum, the free energy of compression forces is at minimum and the order is that of Planck's type. This situation was in the primary nucleus of universe (at the origin of the universal cycle) and it will be again achieved in the end of the universal cycle.

These entropies always develop in opposition with one another.

We may consider the Planck's entropy as being positive and the Nernst's entropy as being negative.

The thermodynamics of dual tendencies (the symmetrical model) is in perfect agreement with the modern data of science. The classical thermodynamics is valid for the analysis of the processes developing in the physico-chemical systems having non-cosmological dimensions. In these systems, the force of gravitation can be neglected, because its interactions are 40 times smaller than the electromagnetic interactions.

From the point of view of the dual thermodynamics, the heat is not a degraded form of energy, because it can be totally utilized in order to produce the expansion of universe by means of the impulses of photons and elementary particles. During the expansion phase, the heat is transformed in potential gravitational energy. During the compression phase, in proportion as the space will diminish, the gravitational energy will be again transformed in heat.

In conclusion, the classical thermodynamics is a peculiar case of the dual (symmetrical) thermodynamics. The classical thermodynamics is valid for the analysis of the small chemical and physical systems, while the dual thermodynamics is necessary for the interpretation of the cosmos and universe.

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