© Michael H. Sulman, 2009 (shulman@dol.ru)

Time, Entropy, and Universe

(Updated: March 01, 2011)

Abstract

A hypothesis is discussed where our Universe represents some hypermassive black hole in an external World which is inaccessible for any usual observer inside of the cosmic event horizon. Like a working medium of a heat engine, our Universe receives energy from the external heater at relatively high temperature and gives up a part of this energy to the internal black holes in the centers of galaxies (cooler) at relatively low temperature. Since both the black holes and active stars have a *negative* heat capacity, a difference of the temperatures (as well as deviation from the equilibrium state) in the galaxies increases (not decreases) during billions years.

1. Introduction

The thermodynamic processes are crucial in the life evolution on Earth as well as in Universe. We observe the evolution that is very distant from the thermal equilibrium rise.

In his famous work **[Schrodinger, 1955]** E. Schrodinger writes that metabolism or energy exchange in a living organism is not important as such, since any atom or calorie have the same value as another one. Further, he says that this organism increases continuously its own entropy, so it produces *positive* entropy and approaches to the dangerous state having maximal entropy that leads to the death. The organism may keep off by continuous extracting only some *negative* entropy from environment, by executing a work, and by dissipating a heat[1]. The negative entropy is what that the organism eats up.

When we consider the cosmic scales, the Second Law application to the whole World as closed system leads to the striking contradiction between the theory and the experience. Universe is not in the state of complete physical equilibrium, its real features have not any common with a feature of an equilibrium system. One notes also that the present state of Universe had to appear from a state with a lower entropy, etc. Hence, its initial state had the lowest entropy, i.e., a very small probability of realization that has not any explication until now, as the authors of the famous textbook **[Landau and Lifshitz, 1976]** write.

The goal of this publication is to propose a model of Universe that allows us to reconcile the observing evolution with the thermodynamics laws. This model is close to a some kind of heat engine concept in which a working medium receives energy from a heater at relatively high temperature and gives up a part of this energy to a cooler at relatively low temperature. So, this working medium represents an *open* system where the *output* entropy flow is *more* than the *input* one. Thus, the entropy *decreasing* and progressive evolution are possible. This process of the part energy using to transform it into work turns out to be stationary, it becomes possible due to the cooler presence only.

---

[1] We also may imagine a robot, which extracts an energy using a solar battery or external accumulator cell. In the last case our robot can use the received energy (may be, partially) to search for a new energy source and by this way to support its "vital activity".

.

2. Universe as open system

Such the model works at the level of the system "Sun-Earth-Space". In fact, the photons leave the solar surface at the temperature near to 6000 K, and then (after a range of transformations) are reemitted to the cosmic space having the temperature near to 3 K (present epoch). Differently from a typical heat engine, in this case a conditional thermodynamic cycle finishes every time in another point having the lower temperature that in initial one. Note, the solar photons energy is distributed between living organisms, climatic disturbances, and energy recourses creation (oil, gas, coal, uranium-ore deposits, etc.).

Our basic goal is to show that the heat engine model is applicable to whole Universe too. At first sight this problem seems to be insoluble, since it is very difficult imagine what could be a heater and what could be a cooler. In order to answer these questions, we have to do two radical assumptions that I going to develop and motivate.

The first assumption consists in that our Universe *is not a closed system*. Contrary, it represents a hypermassive increasing black hole (BH)[2] inside of some "maternal" World, which is in principle inaccessible for any usual observer inside of the cosmic event horizon. As it is well known, the mass increasing of a electrically neutral non-rotating BH is proportional to its size rise. If for such BH we will introduce a "parametric" time[3] using its radius dividing by the velocity of light, then we may **[Шульман, 2009]** find out for it a solution of the Einstein-Friedmann's equation that corresponds to the originally assumed mass increasing, and this "parametric" time is in principle the same as outside from BH as well as inside of it. The considered BH turns out just to be *expanding* Universe, and its expansion is exclusively due to a matter coming outside from it.

The absorption of the external matter and energy is connected with the increasing of the "external" BH's entropy (i.e., of its event horizon surface). So, the "maternal" World can play the role of *heater* for our Universe.

The second assumption is connected with the searching for a *cooler*. Here, it is useful to remember that the supermassive BHs having a mass near 10^6 solar mass are usually disposed at the center of galaxies. As it is known **[Bekenstein, 2003]**, one can evaluate the BH's event horizon temperature using the relationship $T_{BH} \sim 10^{26}/M$, where M is the mass (expressed in grams), temperature T is expressed in Kelvins. As the solar mass is near to 10^{33} g, then the supermassive BH temperature is very close to the absolute zero and supports very high efficiency of such cooler for its galaxy.

Recently, the very interesting paper **[Egan and Lineweaver, 2009]** appeared that contains a detailed budget of different components Universe's entropy. The "external" entropy (i.e., entropy of the cosmic event horizon) is near to 10^{123} *k* (where *k* is the Bolzmann constant), while the "internal" entropy does not exceed $10^{103}k$. The main contribution into internal entropy is due just to the largest supermassive BHs at the center of galaxies, while the solar mass BHs have total entropy near $10^{95}k$, photons and relic neutrinos near $10^{88}k$, etc.

The difference between the "external" and "internal" entropy is nearly 20 orders. It is interesting that the difference between the Sun's entropy and the BH's entropy having the same mass is also the 20 orders **[Bekenstein, 2003]**. With such difference of the

---

[2] If the hypothesis is correct, then the Big Bang should be identified with the gravitational collapse that led to the our Universe birth. Some analysis of the event dynamics could allow us to precise details of the first time moments of its evolution.

[3] The concept of parametric Time as measure of an arbitrary object variability was formulated in the works of prof. A. Levich (See, for example, **[Levich, 1988, 1995]**).

values one can assume that the tendencies of these two types of entropy may sometime be opposite, i.e. an increasing of the total entropy of the cosmic event horizon and internal BHs the entropy of the remaining Universe part can decrease. Note, the stars formation and nuclear energy accumulation in them is very similar to the accumulation processes of the organic and mineral resources on our planet.

Finally, both the BHs and active stars are strongly gravitating systems and have the *negative* heat capacity. In other words, the stars *emit* their energy and *warm*, while the BHs absorb the energy and their temperature *decreases*. Thus, a difference of the temperatures (as well as deviation from the equilibrium state) in the galaxies increases (not decreases) during billions years.

References:

[Egan and Lineweaver, 2009] Ch. Egan and Ch. Lineweaver. A larger estimate of the entropy of the universe, arXiv:0909.3983v1 [astro-ph.CO] 22 Sep 2009

[Landau and Lifshitz, 1976] Landau L.D. and Lifshitz E.M., Statistical physics, part 1. Moscow, Nauka,1976 (in Russian).

[Levich, 1988] Levich A.P. Metabolic time of natural systems // System Studies. Annual edition. 1988. Moscow: Nauka. 1989. Pp.304-325 (in Russian). Pp.117-126 (in Russian).

[Levich, 1995] Levich A.P. Time as Variability of Natural Systems: Ways of Quantitative Description of Changes and Creation of Changes by Substantial Flows // On the Way to Understanding the Time Phenomenon: the Constructions of Time in Natural Science. Part 1. Interdisciplinary Time Studies. Moscow: Singapore, New Jersey, London, Hong Kong: World Scientific. 1995b. Pp.149-192. Available at: http://www.chronos.msu.ru/EREPORTS/levich1.pdf

[Schrodinger, 1955] Schrodinger E. What is Life? The Physical Aspect of the Living Cell. 1955.

[Shulman, 2009] Shulman M.H. Time and Black Holes. Available at (http://timeorigin21.narod.ru/eng_time/Time_and_BH_eng.pdf)