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THE SENSE OF HUMAN EXISTENCE AND THE END OF THE UNIVERSE
THE ESSAY ON THE HISTORY OF PHILOSOPHY

1. The principle of the growth of entropy and the pessimistic vision of thermal death

The objects in the universe are diverse as far as their temperature is concerned. The temperature of the interiors of white and blue giants can probably reach as much as 20-50 million kelvins, whereas surfaces of stars have thousands of kelvins. On the other hand, the temperature in the vacuum is close to the absolute zero. According to the principle of the growth of entropy, heat always flows from the objects that have higher temperature to the cooler ones. The aim of all the objects in the universe is to level their temperatures. Hot celestial bodies cool down radiating their heat into space and, conversely, cool objects warm up absorbing the heat. The principle of entropy determines the direction of the processes in the universe: the attempt to reach thermal equilibrium, to the point of a tepid and equal temperature of every object. Entropy is growing and it is bound to reach the maximal value in the future. Finally, the total energy of the universe will turn into thermal energy. The flow of heat as well as other processes will not be possible anymore, as they are all dependent on the growth of entropy. Thus, there will be no birth or extinction of stars, galaxies or living creatures. The temperature of matter will be hardly any higher than the absolute zero. The universe will terminate, or in other words, it will reach the state that is called thermal death.

W. Thompson was the first who drew such conclusions from the Second Law of Thermodynamics. Shortly afterwards, the founder of the concept of entropy, **R. Clausius**, started to share this opinion. Moreover, **L. Boltzmann** also assumed the demise of the universe in his original studies. However, nowadays he is regarded a first physicists who objected to such a presumption.

The conviction of the inevitability of thermal death of the universe was popular not only among physicists and philosophers; this idea was also manifested in numerous literary works and paintings.

"The world commenced without man, and it will end without him [...]", wrote Claude Levi-Strauss in Tristes Tropiques, "man is a machine [...] working on the deconstruction of the primary order and directing the organized matter towards the constantly increasing inertia which will become ultimate. Since man started breathing and eating, he has been occupied with nothing but careless decomposing of milliards of structures (reproduction is the only exception) until they are not able to integrate anymore. Instead of <anthropology> one should use the term <entropology> [...]" (Levi-Strauss, 1960: 445).

The conclusions concerning the end of the universe are responsible for the pessimism and decadent weariness of the end of the 19^{th} century and for the reason the atmosphere of the pointlessness of the human existence and hopelessness of human beings.

At the same time, there were scientific attempts to negate the concepts of the inevitable end of the universe. One could that scholars succeeded in refuting these theories, however, the general growth of entropy is still treated as a declaration of the pessimism of Nature.

2. The negation of the thermal death theory

Physicists criticized the Second Law of Thermodynamics in the form proposed by Clausius as well as the conclusions that can be drawn from this law. Philosophers regarded these conceptions as idealistic. Moreover, the advocates of dialectical materialism fought against this approach. It was claimed that if the existence of the maximal entropy was possible (thermal death – the end of the universe), there must have been the state of minimal entropy, which is recognized as the commencement of the universe. This fact was often interpreted as the evidence in favor of the creation of the universe.

Scientists often undermined this approach. It was questioned whether the universe as a whole could be perceived as an isolated system to which the laws of gases in closed containers can be applied. It was also noticed that the principle of the growth of entropy refers to every object and its surrounding regarded as a whole (e.g. a biological system exchanges energy with the environment).

H. Poincare put forward a hypothesis that there are no irreversible phenomena. He claimed that the phenomena that are considered to be irreversible simply return to the initial state within a long period of time. In Nature, certain preference concerning the course of phenomena can be observed. However, this preference is not absolute; some phenomena take reverse courses.

L. Boltzmann proposed a statistical approach to phenomena: the growth of entropy in the universe is more probable than its decrease. On the other hand, the decrease of entropy cannot be excluded. The universe as a whole has reached the state of thermal equilibrium. Nevertheless, some parts of the universe can deviate from this rule. Boltzmann called this phenomenon **fluctuation** and put forward the fluctual hypothesis of the emergence of worlds. The universe, which in his opinion is eternal, is in the state of thermodynamic equilibrium. The states of low probability, that is smaller or greater fluctuations, can be distinguished in some places. The example of such a state is the part of the universe observed by man, where the low probability of the distribution of energy was prerequisite for the birth of life. Other regions of the universe are in thermal equilibrium and neither the birth of stars nor rational beings is possible. Similarly, "our" fluctuation will cease to exist sooner or later, giving the place for the state of equilibrium. This is how some worlds emerge and others disappear.

The hypothesis of Boltzmann seemed to be the rescue from inevitable thermal death. Nevertheless, it did not change the ideas concerning the existence of our world and the meaning of human life. Why think of the birth of other worlds if our "deviation from the norm" is temporary and its end is inevitable. The contradiction regarding the observation of the universe occurred: if everything that we observe is a deviation from "normal" thermodynamic equilibrium, where should we seek "normality". An additional issue appeared nowadays: there are many indications that the observations can reach as far as the end of the universe. We are able to detect quasars, which are the objects distant billion light years from Earth and which emerged during the initial stage of the universe. Does it mean that our fluctuation encompasses the whole universe? Then, one cannot call it fluctuation. Boltzmann himself was troubled with the interpretation of his theory and he stated that he is not studying metaphysics and later on he committed suicide.

The alternative to thermal death was searching for anti-entropy processes. Let us imagine the system in the state of maximal entropy: the molecules of a gas are equally spread in the whole volume (either in a container or universe). According to the Second Law of Thermodynamics such a state would be constant because it corresponds to the maximal entropy and, thus, it is the most probable state. In such a case, the whole volume of a gas should be of constant density. However if take into consideration the collisions of molecules it turns out that such a constant state is impossible: collisions cause the fluctuations of gas density when it is close to reach the average value. The qualitative alternation is important: processes aim at minimizing entropy.

Already in 1827, the English botanist, **Brown**, noticed that every microscopic molecule floating in a liquid moves in an irregular way, which can be observed under the microscope. Such movements proved the existence of atoms their collisions. The fluctuations predicted by Boltzmann were confirmed by **M. Smoluchowski's** experiments. He based his assumptions on the Poincare's hypothesis according to which the return to the state prior to the growth of entropy demands longer period of time. Smoluchowski attempted to shorten the time by transition from macro- to micro-systems. In fact, microsystem often acts in a way that entropy, instead of growing, decreases. **A. Einstein** put forward an independent explanation of the Brownian motions.

3. The timeline of the universe and irreversible processes

The discovery of fluctuation and the fact that entropy can decrease within a long period of time did not change the concept of the timeline determined by entropy (the so-called thermodynamic timeline). On the one hand the observation of the phenomena like: particle disintegration, degeneration, dispersal and the superiority of these phenomena over the processes of consolidation makes us intuitively accept such a course of passing the time that is compatible with the processes of disintegration and the growth of entropy. On the other hand, it is necessary to realize that extrapolation into the past leads us to the beginning of the World. This World is in the state of the highest possible order and from the beginning consequently strives to reach the state of dispersal and chaos. This idea is contradictory to the archetypal human belief manifested in all religions and mythologies claiming the World was created from chaos.

The concept of the " clock of entropy" of the universe led to the conviction that in the moment of thermal death (maximal entropy) times stops to fly. This is regarded to be the end of the world.

Apart from the thermodynamic, some scholars, e.g. **S. Hawking**, identify other timelines. For instance, *cosmological* and *psychological* timelines can be distinguished. The first one is determined by the expansion of the universe, and the latter one refers to the fact that we have the ability to remember the past and not the future.

The processes in the universe are considered to be irreversible. However nonlinear thermodynamics altered the approach of physicists to these processes. A thermodynamic stimulus is the reason and condition of an irreversible process. Such a stimulus can be a gradient of temperature, speed, chemical potentials, and the forces effecting a system and chemical affinity. The process manifests itself in a chemical reaction, as well as the transfer of energy, mass or momentum in such a direction that the stimuli (differences) can be minimized or reduced to zero. A single stimulus in the system can give rise not only to one *conjugated* flow but it induces *adjoint flows*. For example: a gradient of temperature brings about not only the flow of energy (aiming at equating temperatures) but also *adjoint flow* of elements (thermodiffusion). These processes take reverse courses: the first brings the system to equilibrium, whereas the other causes the gradient of concentration and carries the system away from the state of equilibrium. The first process induces entropy and as the result of the latter process, entropy is reduces. The system is directed *asymptotically* into the state of equilibrium.

The **Prigogine** and **Glansdorff's** principle of the source of minimal entropy means that the systems that are close to the state of equilibrium tend to dissipation (dispersal) of free energy. In equilibrium, entropy is of maximal value, whereas the source of entropy decreases with time when the process is irreversible.

Entropy continually grows. However, the process of increase becomes slower. Thus, if thermal death of the universe were inevitable, this peril would be postponed ad infinitum.

4. Relative thermodynamics and the evolution of the universe

Relative thermodynamics is the concept created by **R. C. Tolman** in the thirties. Tolman based his thesis on the theory of relativity. According to this conception, thermodynamic equilibrium is dependent not only on temperature but also on gravitational potentials of bodies. Thus, thermal equilibrium does not implicate thermal death. As long as the differences of gravitational potentials exist, entropy will constantly increase, however, it will never reach maximum. The universe drifts towards maximal entropy. Nevertheless, the end of the worlds is postponed ad infinitum. Tolman postulated the oscillating cosmological model: during expansion entropy grows, whereas it decreases during contraction. Subsequent stages have constantly higher amplitude and last longer. Moreover, entropy of following expansions also increases.

The discovery and studies of lensing gravitation give hope for establishing Hubble constant, proposing more precise value of the universe average density and more accurate cosmological model describing the universe. The recent reports seem to prove that the average density of the universe is relatively small, which implies that the universe expands ad infinitum (*Korpikiewicz*, 1997).

The vision of the thermal death of the universe seemed to be negated or postponed ad infinitum. However, the tendency of the general growth of entropy did not deny or excluded such a scenario.

It is said that the universe is evolving from now on to the point of maximal entropy. Entropy in the past (at the very beginning) is mysterious and not debated upon. Some cosmologists, however, postulated the original order of the universe basing on the principle of the growth of entropy.

In 1915, **A. Einstein** formulated the theory of general relativity, which included the equations predicting the motions of galaxies in space (their moving away and approaching each other). If Einstein had believed in his theory, he would have been regarded as the one who discovered the expansion of the universe. However, Einstein's conviction of the static universe made him add a famous "cosmological constant" to his equations, which was to counterbalance the motions of galaxies.

The discovery of **V. M. Slipher** (1912) of the red shift of galaxies and Hubble's interpretation of dependencies related to Doppler effect led to the conviction that all galaxies are moving away from each other (with the exception of the few in the vicinity of the Milky Way which are approaching each other). Despite different interpretation of the red shift, Hubbles discovery was regarded to be the evidence in favor of the universe expansion.

If the universe is expanding, the density if matter decreases (under the condition that there is no creation of matter, as it was postulated by the adherents of the theory of static universe). The dilution of matter must be connected with its cooling down. Thus, through extrapolation into the distant past, we end up with the extremely hot universe.

As it was speculated by **G. Gamow** in the 1950s, or even earlier by **C. E. Guillaume,** there must be remnants of the extremely hot phase of the life of the universe. The predicted *relict radiation* was discovered in 1965. This radiation seemed to be isotropic. The differences of temperatures did not exceed one ten thousandth degree, which was not the consequence of the observable anisotropy but of the annual motion of Earth.

The discovery of relict radiation led to the conviction that in the initial stage the universe was filled with isothermal and homogenous gas of the temperature circa 3 000 K. In this phase, the universe seemed to be in the state of hot chaos and high entropy that was incomparably higher than the present.

5. The velocity of the growth of entropy in the universe

In the moment of big bang, the relict radiation had the temperature of 3 000 K. After about 20 billion years it cooled down to 3 K. In another 15-20 billion years it is bound to reach even a lower value of 1.5 K. Without any doubts, the amount of photons in the universe rises with time. However, space is expanding as the time passes. As a result entropy in a particular volume remains constant. Volume increases with the cube of distance, so the density of molecules decreases with the cube of distance, $n=1/R^3$. The amount of photons is proportional to the cube of temperature (T^3). On the other hand, according to the cosmological model temperature is inversely proportional to the velocity of expansion $T \sim 1/R$. One could draw a conclusion that the amount of photons in the unit of volume does not change with time. Expansion does not "*create entropy*" (Reeves, 1994:89). Conversely, if we count its value in a constant unit of volume, it turns out that expansion thwarts entropy.

This effect is not significant. The decrease of entropy during the creation (organization) of a structure (e.g. the birth of a star) results in the emission of radiation into space, which increases entropy of the whole universe. It can be estimated that all photons emitted by all the stars in the universe, from the moment of its emergence, amount to less than one per mill of the initial value. The amount of photons per one nucleon also increased one per mill (*Reeves, ibid.pp.85*). Although entropy seems to increase with the extremely high speed specific to the phenomena of dissipation and disintegration, it turns out in practice that in the vast universe entropy does not change.

The forces of Nature are also the source of photons (entropy). Gravitational, electromagnetic, nuclear and Fermi's forces bind the cosmic elements, transforming some of their mass into energy, according to Einstein's $E=mc^2$, which is emitted into space in the form of photons.

The first three forces have the ability to create permanent structures. Gravitation attracts massive celestial objects of the universe forcing them to the circular motion around the centers of their masses. Electromagnetic force binds atoms and particles, whereas nuclear force joins parts of atomic nuclei.

Let us imagine that forces of Nature are unrestricted. Operating only in one direction (e.g. constantly bringing the elements of the world together), these forces tend to build as permanent structures as possible. Noble gases and some molecules, e.g. water, are the most permanent structures as far as electromagnetic forces are concerned. When it comes to nuclear forces, iron nuclei are most permanent.

Why do forces of Nature not use their full potentials? In other words, why all atoms do not turn into iron and cosmic objects in one superhole. But for the intensive background radiation during the first moments of the existence of the universe, the extremely abrupt reactions would have caused the creation of heavy elements. In the final stage, heavy elements would have turned into the most permanent element, which is iron. However, the radiation, which had high temperature and short length of wave, had the energy that was able to tear apart heavy nuclei as soon as they were being created. Nuclear particles are free and unbound in the temperature above 1 billion K. Below this temperature, which is the *barrier of nucleosynthesis* (one minute after big bang), the nuclear force binds them into nuclei and radiation does not have sufficient energy to tear them apart. Why then, when the temperature fell below 1 billion K., nuclear forces did not transfer all particles into atomic nuclei – iron nuclei in particular? The answer is that they did not have enough time since the velocity of the universe expansion was too great. Spatial geometry depends on the density of matter in this space. Consequently it influences the velocity of expansion, as well as cooling of the universe. The velocity of expansion of our universe was determined by the amount of matter. If expansion had taken place in a slower manner all nuclear particles would have been embedded in iron nuclei. It would have led to the state, which was stable and permanent, however, not creative and had no maximal entropy.

Gravitational forces also have a tendency to reach maximal entropy. Stars, the masses of which are five times larger than the mass of the Sun, end their lives sinking into their interiors as a consequence of their own gravity. When they have not exhausted their radiation, they become black holes. Einstein's theory describes a black hole as an object of such strong gravity that nothing that enters can escape from it, even light. The name of this body originates from this property. It means that this object does not emit radiation but it absorbs it. The mass of a black hole is being constantly enlarged. However, a spherical black hole emits particles like a perfect black body, which is a consequence of quantum effect. This process is known as *Hawking process (pair production)*. The higher the temperature of a black hole, the larger the emission.

Black holes are the largest containers of entropy in the universe. However, the result of gravitation is not ultimate. A black hole does not enlarge its entropy ad infinitum but it emits insignificant amounts of energy, or in other words, it "evaporates". Black holes are not permanent and they do not reach maximal entropy. They evaporate faster and faster to the point of explosion.

6. Why does Nature not realize its potential?

The following considerations allow to draw a conclusion that the universe attempts to reach equilibrium, permanency and maximal entropy. However, for some reasons, these attempts are not fully realized.

Thermodynamic instability is the cause of creating fluctuations that cannot be predicted, because apart from the state of equilibrium, the events are unpredictable. Besides, fluctuations are unique, as the same conditions not necessarily give rise to same fluctuation. Thus, it should be assumed that they are not definitely determined; the laws describe the general direction and possibility of development. The tendency to thermodynamic equilibrium moves along asymptotes. As a result, "thermal death" is postponed ad infinitum. Gravitational forces, though capable of creating reservoirs of entropy, also do not fully realize their potentials. In this case, all black holes in the universe would melt into one huge superblack hole. This would be the end of the universe. The result of pair production proves that the end is not likely to occur.

The existence of two contradictory forces in Nature: the tendency to increasing entropy versus gradual accomplishment of evolutionary complexity gives us faint hope for discovering the sense of the universe and its structure. Maybe the fact that the tendency to achieving maximal entropy is not realized constitutes the natural property of the universe. This property gives the possibility to answer the question concerning the point of the insignificant human existence on the tiny planet Earth. Any other attempts to negate the conclusions considering the maximal growth of entropy ended up with, at best, postponing the death of the universe as well as human being into the unspecified future or ad infinitum.

H. Reeves, the famous astrophysicist and cosmologist, in his erudite book about the beginning and end of the universe gives the answer to the question considering the point of existence in the transient universe: *"This is man who should define the sense of reality" (Reeves, 1994: 185).* To illustrate his viewpoint, he quotes *Spleen de Paris* by Baudelaire: *"Revel if you do not want to be a tormented slave of Time! Delight yourself constantly! In what? In wine, poetry, or virtue – the choice is yours. Just delight yourself. (Reeves, ibidem, pp. 207).*

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Summary

In this paper, the author considers the history of some philosophical implications resulting from one of the basic laws of physics, called the law of the growth of entropy. For the past two centuries, scholars have been debating whether this law determines the

end of the existence of the perceptible universe or whether it is feasible only in statistics. The author presented numerous attempts to circumvent or postpone the danger of thermal death of the universe (or the contemporary conception of gravitational death) ad infinitum. Such understanding of this law of Nature forces man to ask a crucial question about the sense of the human existence. Although physical theories, including suggestions of nonlinear thermodynamics, have been further elaborated on, the attempts to answer these questions are not devoid of pessimism. Decadent attitude is present both in the sociological divagations of C. Levy-Strauss from the beginning of the century as well as in the contemporary astrophysical works of H. Reeves.