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Article

Belief of Entropy Increase, Fallacy of Black Hole Thermodynamics, and Its Development

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Abstract: Present research on black hole entropy is based on some similarities and the belief of the second law of thermodynamics. Essentially, the area increase theorem is only a necessary evolutional direction of back hole, and is independent of thermodynamics and statistics. We proposed that if various internal interactions exist in isolated system, entropy will possibly decrease. Black hole is a simplified and order process, in which entropy should decrease and it is opposite to gas diffusion with entropy increase, and is also the biggest internal interaction. Moreover, black hole cannot be an isolated system, and thermodynamics of black hole should be the theory of dissipation structure, whose entropy decreases possibly. Further, this is impossible that both contrary collection and evaporation of black hole are all entropy increase. For opposite black hole and white hole, one is entropy increase, so another must be entropy decrease. We propose that entropy decrease exists necessarily in self-assembly, and entropy decreases possibly for the molecular motor and some other preconditions.

Keywords: black hole, entropy, thermodynamics, theory of dissipation structure, self-assembly, molecular motor.

1. Fallacy of Black Hole Thermodynamics

Entropy is a great development in science, and applied widely many aspects. The second law of thermodynamics points out that entropy is always increase and tends to disorder in isolated systems. A

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special case is Boltzmann's famous formula $S=\ln W$, where W stands for the number of equally probable microstates of a particular macrostate.

Thermodynamics of black hole is origin of the similarities of equations [1], and Hawking (1942.1.8-2018.3.14) area increase theorem: the event horizon area of a black hole cannot decrease; it increases in most transformations of the black hole [2], which is analogous with entropy increase of isolated systems. Essentially, it is only a necessary evolutional direction of back hole, and is independent of thermodynamics and statistics. But, Bekenstein (1947.5.1-2015.8.16) believes the second law of thermodynamics [3-5], and he persists this similarity as the basis of a thermodynamic approach to black-hole physics, and entropy of black holes is namely its area, which is a concept with geometric root but with many physical consequences. Otherwise, black hole will derive entropy decrease. He obtained a huge Bekenstein number $10^{10^{79}}$.

Bekenstein proposed the generalized second law of thermodynamics [3-5]: The sum of ordinary entropy S_0 outside black holes and the total black hole entropy never decreases and typically increases as a consequence of generic transformations of the black hole. It is an equation:

$$\Delta S_0 + \Delta S_{BH} \geq 0. \tag{1}$$

Hawking had initially opposed Bekenstein's idea due to the grounds that a black hole could not radiate energy and therefore could not have entropy. Bekenstein's persist persuades many physicists [6,7], in order to be deep-rooted for belief of entropy increase. I think, science kisses good-bye a developed chance.

At present, entropy of black hole is:

$$S = \frac{Akc^3}{4\eta G}. \tag{2}$$

It is direct ratio with the surface area of a black hole (area of the event horizon), which increases necessarily along with mass increase.

A special example is the case of an evaporating black hole. Quantum radiation created by a black hole carries entropy to infinity, while the area of the black hole (and hence its entropy) is decreasing. Generally, it is contrary to Hawking's black hole evaporation theory [8-10], because this is impossible that both contrary collection and evaporation of black hole are all entropy increase.

Moreover, there are some strange conclusions in theory of black hole. For example, Hawking defines the temperature of black hole as:

$$T = \frac{\eta c^3}{8\pi kGM}. \tag{3}$$

His formula shown that bigger is mass of black hole, lower is its temperature, which is about 10^{-7} K for the smallest black hole. The temperature of black hole in centre of Galaxy should be very very low. But,

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we think, in contraction process of black hole huge potential energy will become kinetic energy, and should possess higher temperature. Physicists discussed already the primordial tiny black holes, and their hotter follow contraction and their final explosion.

We proposed that the infinite gravitational collapse of any supermassive stars should pass through an energy scale of the grand unified theory (GUT). After nucleon-decays, the supermassive star will convert nearly all its mass into energy, and produce the radiation of GUT [11]. It may probably overcome the singularity of black hole, and explain some ultrahigh energy puzzles in astrophysics, for example, gamma-ray bursts (GRB), etc. This is similar with a process of the Big-bang cosmology with a time-reversal evolution in much smaller space scale and mass scale. In this process the star seems be a true white hole.

Usual black hole can not be an isolated system. This is an open system, and tries always to attract into more objects. From this the second law of thermodynamics should be different. Generally, it is a unilateral open system only input but no-output. Its mass only increases, but is not decrease. This is analogy with a half-open membrane, and corresponds to the arrow of time and hemigroup. But, Hawking combined general relativity, the thermodynamics of black hole and quantum mechanics, and derived the well-known Hawking black hole evaporation theory [8-10], in which mass will decreases. This black hole will be a two-direction open system with input and output. Therefore, thermodynamics of black hole should be the theory of dissipation structure, whose entropy decreases possibly. We researched the singularity of black hole and Big-bang cosmology, in this point the quantum fluctuation exists necessarily [11].

2. Possible Entropy Decrease in Isolated System

Statistics as basis of thermodynamics has a basic principle: statistical independence, i.e., the state of one subsystem does not affect the probabilities of various states of the other subsystems, because different subsystems may be regarded as weakly interacting [12]. It shows that various interactions among these subsystems should not be considered, so corresponding entropy is additive.

Based on the existence of various internal interactions in isolated system, we proposed that entropy decrease in an isolated system is possible [13,14], which includes physics [15-17], chemistry [18], biology [19], astronomy [20] and social sciences [21], and calculate quantitatively some examples [17]. We discussed various possible entropy decreases in astronomy, for example, in the evolution of celestial bodies [20].

Further, we proposed that a universal formula for any isolated system is [14]:

$$dS = dS^a + dS^i , \tag{4}$$

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where dS^a is an additive part of entropy and is always positive, and dS^i is an interacting part of entropy and can be positive or negative. Eq.(4) is similar to formula in the theory of dissipative structure:

$$dS = dS_i + dS_e . \tag{5}$$

Two formulae are applicable for internal or external interactions, respectively. In (5) $dS_i \geq 0$ is the entropy production inside the system, and dS_e is the entropy flow, which may be positive or negative, $dS_e = dS_e^+ - dS_e^-$. Such we proposed quantitatively a universal entropy theory on evolution of any natural and social systems [17]. The total formula of entropy change is:

$$dS = dS^a + dS_+^i - dS_-^i + dS_i + dS_e^+ - dS_e^- . \tag{6}$$

When

$$dS^a + dS_+^i + dS_i + dS_e^+ > dS_-^i + dS_e^- , \tag{7}$$

entropy increase dS>0, the system tends to disorder. When

$$dS^a + dS_+^i + dS_i + dS_e^+ < dS_-^i + dS_e^- , \tag{8}$$

entropy decrease dS<0, the system tends to order. Both differences are determined by the input negative entropy flow in open system and the internal attractive interactions in isolated system $dS_e^- + dS_-^i$.

In combinatorial mathematics, Ramsey's theorem states that one will find monochromatic cliques in any edge labelling of a sufficiently large complete graph [22]. T. S. Motzkin pointed out that Remsey theorem proved that complete confusion and disorder are impossible [23]. It is a mathematical negation for maximum entropy and heat death of Universe. In 1959 Paul Erdos and A. Renyi researched stochastic graph, and found that under the most stochastic state the order structure will be spontaneously produced. Further, S. Kauffman proposed the theory of life origin on spontaneously catalyzed network. It may also be applied to the origins of star and galaxy.

Although the total entropy for whole system is positive and should increase, but, so long as different entropy states for any systems exist, entropy should decrease in transformation process from a higher entropy state to a lower entropy state (in Fig. 1 from A to B) [17], for example, from chaos to order [24,25], from war to peace and so on. If this system is isolated, it will correct and develop the second law of thermodynamics. In a word, various evolutions, for instance, Earth and biology, etc., and human history cannot always be a disorder process. For attractive process, internal energy, system entropy, and nonlinear interactions, etc., an isolated system may form a self-organized structure with smaller entropy [13].

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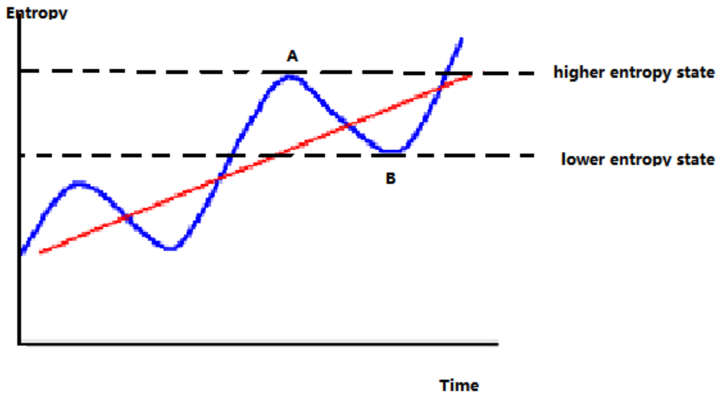

Fig.1: Transformation processes between states with higher entropy and lower entropy

At present, some physicists already identified with its viewpoint, for example, Tabti, et al., discussed melting of argon cluster [26], and Quarati, et al., researched negentropy in the many-body quantum systems and energy from negentropy of non-Cahotic systems [27,28].

3. Necessity of Entropy Decrease in Self-Assembly, and Molecular Motor

Self-assembly (SA) is a process in which a disordered system of pre-existing components forms an organized structure or pattern as a consequence of specific, local interactions among the components themselves, without external direction. Therefore, it must be entropy decrease [29].

When the constitutive components are molecules, the process is termed molecular self-assembly. Molecular self-assembly is an autonomous process that forms molecules or polymer under non-external influence is nanostructure technology. Crane (1950) proposed two basic principles of molecular self-assembly [30]. Self-assembly can be classified as either static or dynamic. In static self-assembly, the ordered state forms as a system approaches equilibrium reducing its free energy. In dynamic self-assembly, patterns of pre-existing components organized by specific local interactions are not commonly described as "self-assembled".

Self-assembly in the classic sense can be defined as the spontaneous and reversible organization of molecular units into ordered structures by non-covalent interactions. The self-assembled system is the spontaneity of process: the interactions responsible for the formation of the self-assembled system act on a strictly local level, i.e., nano-structure. This arises in the strong non-equilibrium conditions. The most famous example of self-assembly is the occurrence of the life on Earth. Another example is the phenomenon of electrostatic trapping, in which an electric field is applied between two metallic nano-electrodes. The particles present in the environment are polarized by the applied electric field. Due to dipole interaction with the electric field gradient the particles are attracted to the gap between the electrodes [31]. Self-assembly of crystals works well [32].

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Self-assembled monolayer and molecular self-assembled film are molecules pass through chemical bond, and interact spontaneously to form stable order film with the lowest energy [33]. Any chemical reaction drives atoms and molecules to assemble into larger structures. An important feature of SA is the key role of slack interactions. Another distinctive feature of SA is that the building blocks are not only atoms and molecules, but span a wide range of nano- and mesoscopic structures, with different chemical compositions, shapes and functionalities [34]. Recent examples of novel building blocks include polyhedra and patchy particles, and include microparticles with complex geometries, such as hemispherical [35], dimer [36], discs [37], rods, molecules [38], as well as multimers. These nanoscale building blocks (NBBs) can in turn be synthesised through conventional chemical routes or by other SA strategies.

Important examples of SA in materials science include the formation of molecular crystals, colloids, lipid bilayers, phase-separated polymers and self-assembled monolayers [39,40]. The folding of polypeptide chains into proteins and the folding of nucleic acids into their functional forms are examples of self-assembled biological structures. Adleman [41], Winfree, et al. [42] and Ignatova, et al. [43] discussed the self-assembly of DNA structures by the molecular and DNA computation. Recently, the three-dimensional macroporous structure was prepared via self-assembly of diphenylalanine derivative under cryoconditions, the obtained material can find the application in the field of regenerative medicine or drug delivery system [44].

Chen, et al., demonstrated a microscale self-assembly method using the air-liquid interface established by Faraday wave as a template. This self-assembly method can be used for generation of diverse sets of symmetrical and periodic patterns from microscale materials such as hydrogels, cells, and cell spheroids [45].

Another characteristic common to nearly all self-assembled systems is their thermodynamic stability. For SA to take place without intervention of external forces, the process must lead to a lower Gibbs free energy, thus self-assembled structures are thermodynamically more stable than the single, unassembled components. The driving force is capillary interaction, which originates from the deformation of the surface of a liquid caused by the presence of floating or submerged particles [46]. Uskoković researched that every self-assembly process in reality presents a co-assembly, which makes the former term a misnomer of a kind [47]. The thesis is built on the concept of mutual ordering of the self-assembling system and its environment. Further, we discuss the nonlinear self-assembled theory.

Self-assembly processes can be observed in systems of macroscopic building blocks, which can be externally propelled [48] or self-propelled [49]. Groß, et al., discussed self-assembly at the macroscopic scale [50].

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Self-assembly is related closely with self-organization. Halley and Winkler discussed consistent concepts of self-organization and self-assembly [51]. Self-organization is a non-equilibrium process where self-assembly is a spontaneous process that leads toward equilibrium. Self-assembly requires components to remain essentially unchanged throughout the process. Moreover, self-organization is related with the memory alloy.

Present the second law of thermodynamics uses the entropy S to identify the spontaneous changes. S is a measure of the molecular disorder of a system. But, when internal interaction in an isolated system exists, i.e., the kinetic energy is transformed to the potential energy, then the order increases, the kinetic energy and entropy decrease.

The molecular motor takes a very important role for keeping high order in biologic systems. We think, the molecular motor corresponds to $dS<0$, in which the chemical energy of cell translates into mechanical energy, whose efficiency is almost 100%. In the microtubule the motor proteins have kinesin and dynein. Their moving way is hand-over-hand [52]. The kinesin moves matter of cell nucleus to cell membrane, and dynein moves matter of cell membrane to cell nucleus. Their transport direction is just opposite, but, both are not competition [53]. Moreover, many motors may work together, and produce speed with 10 time unit motor. It is namely order cooperative action [54].

The rotary motor is composed of biologic macromolecule, whose volume is small, and efficiency is very high almost 100%, and they may converse rotate. Its type is ATPase, which is a core enzyme for biologic energy translation in organism. The entire process of cell upgrowth and metabolism need energy, which is obtained from the chemical energy hydrolyzed by ATP under the most cases, and ATP is synthetized from ATPase. The molecular motor of ATPase may hydrolyze ATP, and may also synthetize ATP. This is similar with membrane and Maxwell demon.

4. Discussions and Conclusion

Based on the Dirac's negative energy state, we proposed the negative matter [55-59], which is the simplest dark matter, and a huge repulsive force between the positive matter and negative matter shows dark energy, and creates inflation cosmos. Further, various theories of the negative matter are researched, and corresponding black hole and relative problems are also discussed.

Based on the nonlinear physical theory, we applied extended chaos theory, and described the multiparticle production and the extensive air showers at high energy. From the nonlinear equations of the density wave theory, we derived the evolutionary direction and the observable conditions on spiral galaxies by the qualitative analysis theory [60]. Further, combined general existence of dark matter in galaxy, spiral arms are probably origin of repulsive force between the positive matter and negative matter

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as dark matter, and more dark-negative matters exist and clearer spiral arms at more borders. This is possibly related with the density wave theory.

We discussed general nonlinear astronomy, and nonlinear theory of black hole [61]. We think that black hole cannot collapse to singularity, because when it collapses to 10^{-15} cm, weak interaction will appear, and it will decay and produce repulse force. This corresponds probably to Hawking black hole evaporation [8-10]. When radius decreases continuously and achieves a limit, it passes perhaps through weak interaction to induce burst, as gamma-ray bursts (GRB), etc. Conversely, if these do not appear, theory will be big change. For example, Pauli Exclusion Principle will be possible violated, etc. It reflects difference between quantum mechanics (weak interaction) and general relativity (black hole).

At present, Micadei, et al., researched coherent measurements in quantum metrology [62], experimental rectification of entropy production by Maxwell's Demon in a quantum system [63], and Reversing the thermodynamic arrow of time using quantum correlations [64]. These are great work, which shows development of second law of thermodynamics, and in which the correlations are namely internal interactions.

In a word, some discussions are completely based on the belief of entropy increase for black hole entropy. But, black hole derives a simplified and order system, which only has three parameters (total mass M, total electric charge Q and total angular momentum J). This means that when black hole is formed, all other properties of the collapsing material are lost, and many possibilities are degenerated, such entropy and disorder should decrease. This is also the biggest internal interaction, and can forms a center, and is opposite to gas diffusion of entropy increase. Further, this is consistent with our viewpoint on [13-17]. For opposite black hole and white hole, one is entropy increase, so another must be entropy decrease.

Moreover, if there is thermodynamics of black hole, we will be able to discuss thermodynamics of time and life, in which time is uniform and conservation according to Noether's theorem, and time increases always.

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