Article

A New Farme Work of Thermodynamics, the Second Law of Thermodynamics Is Actrually a Law of Energy Circulation

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A New Farme Work of Thermodynamics, the Second Law of Thermodynamics Is Actrually a Law of Energy Circulation

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Abstract

This new frame work of thermodynamics contains three parts. （1）The traditional thermodynamics: relating to all the ordinary thermodynamical processes we meet in all of our life，work, and ordinary research, covering an extremely immense scope. Numerous and numerous human practices confirm that all these processes are irreversible, and entropy tends to increase, never decreases. (2）The thermodynamics of thermal electrons in a magnetic field: There are some new experiments of thermal electrons emitted from two identical and parallel Ag-O-Cs emitters (work function 0.8eV) in a vacuum tube. The tube is applied by a static magnetic field that bends the trajectories of the electrons, resulting in a weak asymmetry (to left or to right) in the motion of thermal electrons, and the tube can output a weak but stable electric current and a power. The internal energy of the tube decreases slightly, and the temperature of the tube follows to drop down slightly. Hence, the tube automatically attracts the waste heat from the ambient air to compensate the output power. The magnetic field here is an artificial demon. A nice brief video of one of these experiments is included in this article. (3）Cosmos thermodynamics: The universe is closed. There is naturally an extremely immense intrinsic ocean of thermal radiation in the central part of the closed universe. The temperature of the heat ocean, as discovered in 1965, is 2.73K. A big band and a big assembling constitute a big cycle. All the matter and energy in the closed universe are involved in the big cycles, entropy can either increase or decrease. Black holes are natural demons in the universe.

Keywords: traditional thermodynamics; thermodynamics of thermal electrons in a magnetic field; artificial demon; closed universe; the 2.73K heat ocean; matter shuttling and radiation shuttling; big band and big assembling; big cycle of matter and energy; black holes are natural demons

(I) Traditional Thermodynamics

At present time，we spend electric energy every day. One joule electric energy, as we use it, converts to one joule waste heat. There are numerous similar processes in all of them work converts to heat, such as various frictions, a stone falls down to the ground, wind or water whirling, and so on, covering an extraordinarily immense scope.

One joule electric energy converts to one joule waste heat exactly. Energy is conserved wherever and whenever. That is the first law of thermodynamics. It is a law of the universe.

Electric energy is **useful energy**, that means, it can be used to do work. Waste heat is **useless energy**, that means, **it can never be used to do work again**. All the **energy source** are useful energy that the nature grants us. **Every piece of the energy source we derived from the nature, can be used to do work once only.** And so on.

That is the second law of thermodynamics. According to this law, all the practical thermodynamical processes are irreversible, resulting in the monotonical increase of the entropy of the universe.

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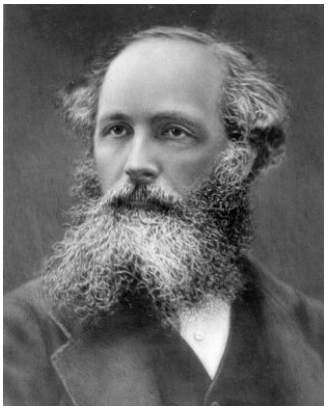
The second law of thermodynamics is always valid for almost all the artificial and natural processes known by mankind. The final fate of the universe is, as predicted by Clausius, all the energy in the universe changes to waste heat, and radiates to the infinitive vast cosmic space, leading to the Heat Death [1–3].

(II) Thermodynamics of the Thermal Electrons in a Magnetic Field

However, in the history of physics, there were a few outstanding people who doubted sharply and profoundly the absolute single-direction of all the physical processes described by the second law of thermodynamics. Among them, James Clerk



James Clerk Maxwell 1831-1879

Maxwell was the most genius and brave one.

From 1866 to 1871, Maxwell immersed himself in the searching for a way of converting waste heat back to useful energy again.

Limited by the historic level of science and technology of his era, he had not successfully designed and accomplished such an experiment. Nevertheless, he wrote down his thoughts and experiences of his exploration into his famous textbook *Theory of Heat* published in 1871. He hoped that in some future days this cherished wish of mankind would be realized by some inheritors [4,5].

In his exploration, Maxwell imagined to use a closed container filled up with air molecules. The container is divided by a separator into two parts, A and B, as shown in Figure 1. At the middle on the separator, there is a small door, which is controlled by an **intellectual being**. (Kelvin called Maxwell's "intellectual being" jokingly a **demon**.)

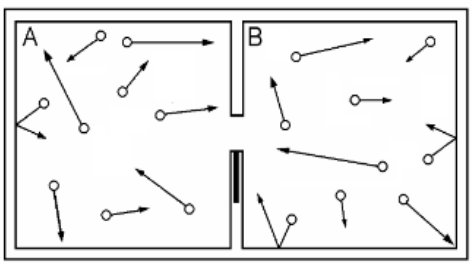


Figure 1. An air container of two parts, A and B. There is a small door at the middle of the separator, which is controlled by a small intellectual being. .

At the beginning, the air in the container is at a thermal equilibrium state. The temperature and pressure of the air are uniform everywhere in the container.

The demon has two typical work modes, described respectively as follows.

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In the first work mode, the demon permits the faster molecules to pass the door from A to B, and the slower molecules to pass the door from B to A, as shown in Figure 2. Gradually, the temperature in A drops down and the temperature in B rises up. A temperature difference between A and B emerges, enabling a part of the internal energy of the air in the container to be used to do work.

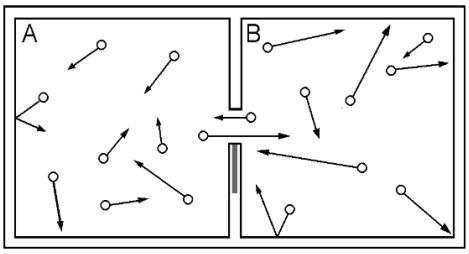

Figure 2. A temperature demon.

In the second work mode, the demon permits only the molecules of A to pass the door to B, and does not permit the molecules of B to pass the door to A, as shown in Figure 3. Gradually, the pressure in A drops down and the pressure in B rises up. A pressure difference between A and B emerges, enabling a part of the internal energy of the air in the container to be used to do work.

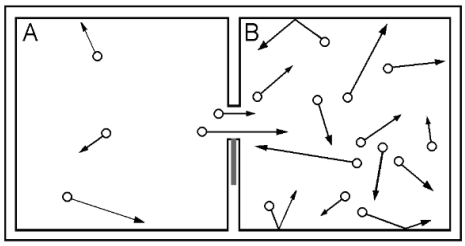

Figure 3. A pressure demon.

In the past one and a half centuries, many physicists and inventors, have made numerous efforts to design and execute various experiments, hoping to find such a demon. However, they all failed.

The two authors of this paper, in the past several decades (one since 1960, the other since 2000), following Maxwell's steps, insisted on searching for such an entropy reducing experiment. They replaced Maxwell's gas molecules in the container by the thermal electrons in a vacuum tube, which contains two identical and paralelll Ag-O-Cs thermal electron emitters [6–9]. Figure 4 (1) and (2) show an electron tube, FX8-24, used in one of the experments. The work function of Ag-O-Cs surface is only 0.8 eV, the least one among all known thermal electron emitters. They eject thermal electrons ceaselessly at room temperature (the so called "dark current" as in the photomultipliers or night vision devices). The experiment can be performed with the whole closed circuit at a same room temperater, that is a great advantage [6–13].

Of course, the expected output current and power are very tiny.

When no magnetic field is applied on the tube, there is no output current, as shown in Figure 4 (2).

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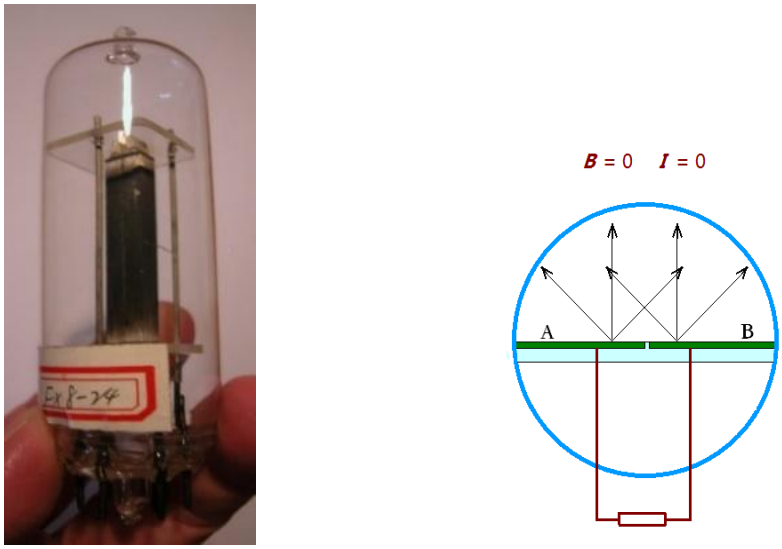
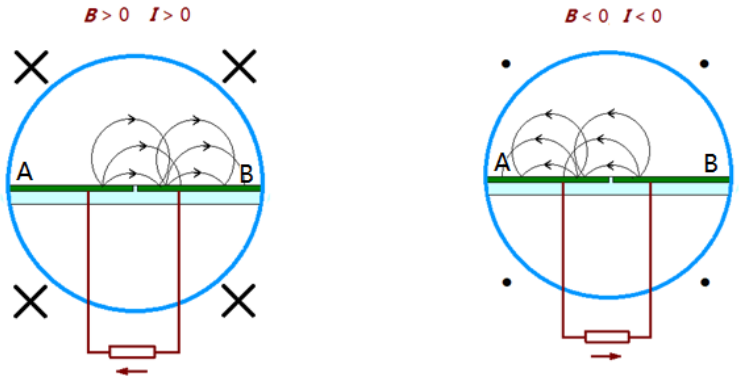


(1) a photo of electron tube FX8-24 （2）the cross section and the circuit

Figure 4. The electron tube FX8-24. Two identical and paralelll Ag-O-Cs thermal electron emitters A and B are settled in a vacuum tube, FX8-24.

Then a static and uniform magnetic field (that is provided by one or a pair of permanent magnets) is applied to the tube. For the first time, the magnetic field is in the direction pointing into the paper, and it bends the trajectories of the thermal electrons. A slight asymmetry in the electrons' thermal motion emerges. The number of electrons emitted from emitter A and fall down into B in each second is slightly greater than the number of the electrons emitted from B and fall into A, as shown in Figure 5 (1). A net transfer of electrons from A to B happens. Emiter A losing some net electrons continuously, is charged positively; and emitter B, receiving some net electrons continuously, is charged negatively. A potential difference between A and B emerges, enabling the electron tube to output a current and an electric power to an exterior load, e.g., a resistor *R*, or, a storage battery.



(1) （2）

Figure 5. (1) If the direction of the magnetic field is positive, the output current is positive. (2) If the direction of the magnetic field is negative, the output current is ngative.

In the second time, the direction of the static magnetic field is opposite, pointing out from this paper. The direction of the output current is also opposite, as shown in Figure 5 (2).

If the magnetic field keeps constant for a long duration (i.e., just keep the permanent magnet stationary), the electron tube can output a stable electric current and a stable electric power in the whole duration. For examples, 30 seconds, 3 minutes, 30 minutes, 1 hour, 3 hours, and so on, as long as the performers wish.

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As the electron tube ceaselessly outputs electric energy to do work on the exterior resistor, with a power $P = I^2 R$, the internal energy of the tube tends to decrease, though very slightly. And **the temperature of the tube follows to drop down**, also very slightly.

Thus, the tube can spontaneously attract the waste heat from the ambient air to compensate its energy loss due to the output of electric energy.

The experiment verifies that 1 joule waste heat is possible to convert back to 1 joule electric energy, without producing any other changes, violating the Kelvin-Planck statement of the second law of thermodynamics，realizing Maxwell's famous hypothesis [14–20].

The following is an experiment video of the vacuum tube FX8-24 (100 seconds):

20100802 FX8-24 100s.mp4

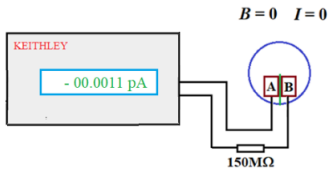
In this experiment, the whole closed circuit is desired to be kept at the same room temperature, say, $t = 20^{o}$C. However, the room the authors used to perform the experiment is not a fine thermostatic laboratory. It is just a common dwelling room. There are usually some 3^{o}C ~ 7^{o}C changes in temperature every day (in 24 hours). So, the temperature of the room is actually always changing, very slowly. There is temperature difference distributed along the closed circuit, of the magnitude of several 0.1^{o}C. The temperatures at all the connections of two different metals along the closed circuit are usually not exactly equal each other. The general Peltier-Seeback effect along the whole closed circuit is usually not zero, but very small, fluctuating ceaselessly, results in a background fluctuating current in the circuit.

The whole video lasts for 100 seconds.

(1) From $t = 0$ to $t = 10$ seconds

No magnetic field is applied to the vacuum tube in this duration. So, no real output current exists in the circuit. Only a small fluctuating background current as shown in the video, (see the simple drawing below)

$$I_o \approx (-7 \sim -15) \times 10^{-16} \text{ A} = (-0.7 \sim -1.5) \text{ fA}.$$



(2) From $t = 10$ to $t = 40$ seconds

Move in a permanent magnet of 2 kg at $t = 10$ seconds, as shown in the video. There appears a fundamental output current in the circuit (see the simple drawing below), fluctuating slightly.

$$I \approx (-150 \sim -190) \times 10^{-16} \text{ A} = (-15.0 \sim -19.0) \text{ fA},$$

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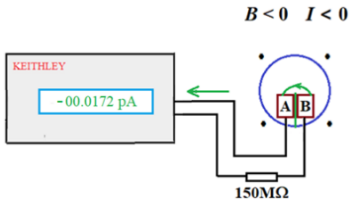
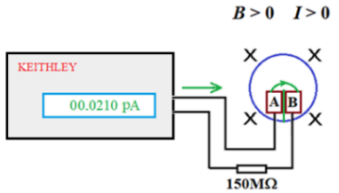


(3) From $t = 40$ to $t = 70$ seconds

Reverse the direction of the magnetic field at $t = 40$ seconds, as shown in the video. The direction of the output current also be reversed, the output current becomes (see the simple drawing below) also fluctuating slightly.

$$I \approx (+200 \sim +230) \times 10^{-16} \text{ A} = (+20.0 \sim +23.0) \text{ fA},$$



And so on.

Two clear photoes of the set up of the experiment

Keithley 6514（10^{-16}A） a copper shielding box a magnet

(a) The set up of the experiment (there is a box compass on the top of copper box)

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An electron vacuum tube, a resistor R = 150 M⊙, some connection lines, etc.

(b) The interior of the copper shielding box

(III) Cosmos Thermodynamics Introduction

Most astrophysicists today believe that the present universe was produced by a big bang. This article explores the big cycle of matter and energy in the universe: a big bang and a big assembling constitute a big cycle.

It is essentially a thermodynamic exploration.

First, the authors approve of the idea that the space of the universe is closed, and all the matter and radiations are impossible to fly off the closed universe.

Within the closed universe，naturally，there is an immense intrinsic heat ocean. The authors believe that it is just the 2.73K microwave background radiation discovered in 1965. It is not produced by the big bang.

The big bang drove the matter of more than 2×10^{12} galaxies to the remote space, with their potential energy getting higher and higher. They are flying farther and farther at present, until reaching their individual possible far-most positions. Then they will return back one after another, and fly back to the central region of the universe. They are impossible to return back together to their start point at the same time. They are also impossible to restore directly to the original state of **the primitive atom** (Lemaitre's word, the egg of the universe). They will fly through the central region with different tremendous kinetic energies to their individual far-most positions on the other sides of the central region. Due to the gravitational attraction, they will slow down and finally return back to the central region again. In such a way, they will keep shuttling through the central region repeatedly.

From the big bang to the big expansion, to the generations of numerous galaxies, to the generations of even more numerous stars with most stars release tremendous amounts of light and heat due to their internal nuclear fusion, and so on, all these different processes are irreversible, producing immense amount of entropy.

All these processes scatter tremendous amount of light and heat into the cosmic space. The light and heat also keep shuttling within the closed universe with extraordinarily greater amplitudes, and, after an extremely long, long relaxation time, mingle into the 2.73K heat ocean. The heat ocean plays a role of immense heat reservoir in the closed universe.

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In every galaxy, there are numerous stars and many black holes. Every black hole, since its birth, attracts all the matter and radiations that approach it, and gets larger. A black hole can annex any other celestial body that it encounters, including annexes another black hole.

By the shuttling, the numerous galaxies are passing through the central region repeatedly in the various directions in the 4π solid angle. Hence, they have many chances to meet each other in the central region. And the even more numerous stars and black holes in these galaxies also have numerous chances to meet each other. Annexation happens whenever a black hole encounters any other celestial body in the shuttling.

The core black hole of any galaxy is tremendously greater than a black hole of the star grade. Its chances of annexation with other celestial bodies are also tremendously greater.

The processes of shuttling and annexations carry on and on. After an extremely long, long period, the total number of all the celestial bodies（stars, black holes, galaxy cores, and so on）in the closed universe will finally begin to decrease. By the annexations, the survived black holes become larger and larger, and their shuttling amplitudes become shorter and shorter. Due to these two factors, the general annexation processes in the universe will become faster and faster.

Finally, **all the matter in the universe** will inevitably assemble together to form a single and extraordinarily immense **central black hole.**

The central black hole has an astonishingly huge Schwarzschild sphere, absorbing the thermal radiation from the extremely immense 3K heat ocean ceaselessly in all the directions at the speed of light. Its internal energy will increase extremely rapidly and monotonically. That means, the **general repelling factor** within the core of the central black hole increases rapidly and monotonically. When some threshold value of the repelling factor is reached and exceeded, a new big bang breaks out.

1. Assembling of all the matter that scattered into the cosmic space by the big band

The authors, like most of today's astrophysicists, approve of the theory of the big bang established by Lemaitre, Hubble, Gamow, et al [21–24].

However, there is a major deficiency in the present theory of cosmology: Where did **the primitive atom** of the big bang, i.e., **the primitive egg of the universe，** come from? Most people just avoid this problem.

The authors assert that **this problem is a crucial one in cosmology. It should not be avoided, absolutely.** This article tries to answer this problem by a thermodynamical exploration.

The authors approve of that the universe is closed. All the matter and the electromagnetic radiations in the closed universe are involved in an extremely immense cycle in the closed universe.

For the first step, let us look back the current theory about the fundamental characteristics of the cosmic space.

According to the cosmology principle, adopt the Robertson Walker metric, Einstein's equation, the state equation, etc., one can finally derive the relation between the **cosmos scale factor** R and **time** t, $R = R(t)$, as shown by equation (1) and Figure 1.

$$t - t_1 = \int_{R(t_1)}^{R(t)} \frac{dR}{\sqrt{\Lambda(R)}} \quad (1)$$

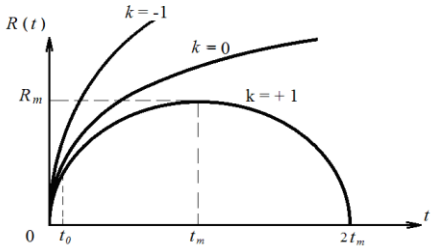

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Figure 1. Different space curve sign k result in different $R = R(t)$: $k = +1$, the space is closed, $k = 0$, the space is flat; $k = -1$, the space is open. The authors approve of $k = +1$.

$R = R(t)$ has three different situations, depending on the values of the **space curve sign *k***:

(1) $k = +1$，the cosmic space is closed.

In this situation, all the matter and radiation that scattered into the cosmic space by the big bang, may fly outward, getting farther and father, however, after reaching their individual far-most positions in the closed universe, all of them will fly back one after another towards the central region of the closed universe again.

(2) $k = 0$，the cosmic space is flat.

(3) $k = -1$，the cosmic space is open.

In these two later situations, all the matter and radiations that scattered into the cosmic space by the big bang just fly outward to the infinitely remote space. They can never return back.

The above descriptions of equation (1) and Figure 1 are strict and profound. However, they are really very abstract and difficult to perceive deeply and understand clearly. The authors think that this extremely profound and mysterious theory might be enriched by a brief and intuitional explanation as follows.

Whether the universe is closed is determined by two factors:

(1) **The total amount of the mass of the universe**. That is the attractive factor. The mass mentioned here, consists of common visible matter, dark matter, various electromagnetic radiations, and some other possible strange matter totally unknown to mankind today. At present, the dark matter seems very important, as is well known, it is about 5 times of the visible common matter.

(2) The total amount of the energy of the big bang. That is the repulsive factor.

If the attractive factor prevails over the repulsive one, the universe is closed.

If the two factors are “equivalent” or “balanced”, the universe is flat.

If the repulsive factor prevails over the attractive one, the universe is open.

As have mentioned above, the authors approve of the first situation, $k = +1$.

The authors also believe that in the middle of the closed universe, naturally, there should be an intrinsic and extremely immense ocean of equilibrium thermal radiation at an essentially stable temperature. The microwave background radiation at 2.73K discovered by Penzias and Wilson in 1965 should just be this extremely immense heat ocean [25].

More than 2×10^{12} galaxies produced by the big bang are now flying fiercely outward. Their individual immense kinetic energies derived from the big bang are converting to their individual potential energies. When the galaxies reach their individual far-most positions in the closed universe, they will return back one after another, and fly towards the central region with different tremendous kinetic energies. It is of course impossible for them to return back to the start point of the big bang at a same time. It is also impossible for them to restore directly to their initial state before the big bang, as so much entropy has been produced in the big bang and the numerous subsequent processes. All these galaxies will rush through the central region with different tremendous kinetic energies and fly towards their individual far-most positions on the other sides of the central region. Then, because of the gravitational attraction, they will slow down, and finally return back once again to the central region. In such a way, they keep shuttling through the central region of the universe repeatedly.

The directions of the shuttling of the numerous galaxies are various in the 4π solid angle. Hence, the ceaseless shuttling offers numerous opportunities for the 2×10^{12} galaxies to meet each other in the central region. And, the numerous and numerous various celestial bodies in all these galaxies (about 2×10^{23} stars and so on) will also have numerous and numerous chances to approach even meet each other.

There are numerous black holes of various sizes among all these celestial bodies. Annexation happens whenever a black hole meets another celestial body in the shuttling. Especially, the black

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holes of all the galaxy cores are extremely greater than the black holes of the star grade, they are extremely important in the general annexation processes in the universe.

After an extremely long period of shuttling and annexations, finally, the total number of the black holes and other celestial bodies in the universe will begin to decrease. The masses of the survived black holes will become larger and larger, meanwhile, their shuttling amplitudes will become shorter and shorter. These two factors will greatly increase the chances of the survived black holes to encounter with the other celestial bodies. The general annexation processes in the whole universe will thus become faster and faster. And, after an extremely long, long duration, eventually, **all the matter within the closed universe will inevitably be assembled together to form an extraordinary immense central black hole**.

In this assembling process, most of the kinetic and potential energy of all the celestial bodies in the 2×10^{12} galaxies are eventually assembled directly into the central black hole, preserving a great amount of precious energy for the next big bang.

At that time, the picture of the universe will become very simple: In the central part of the closed universe, there is an extraordinary immense and very dilute heat ocean at a temperature of about 2.73K; and at the center of the heat ocean, there is an extraordinary massive central black hole, having an even more massive central core containing all the real matter of the universe. The whole geometric picture of the universe at that time is rather similar to the one of a hydrogen atom.

The formation of the central black hole accomplishes the first preparation for the next big bang: the reassembling of all the real matter.

Next, how to overcome **the deadly obstruction of the second law of thermodynamics** to collect and assemble again the great amount of energy that has scattered in the form of light and heat into the vast 2.73K heat ocean due to all the irreversible processes of the big bang and all its subsequent processes to **accomplish the second necessary preparation** for the next big bang. In other words, **the reduction of the entropy that was produced during the big bang and all its subsequent processes.**

Fortunately, the black holes have a second important assembling function: They are natural black holes in the universe. They can collect and assemble spontaneously an extraordinary immense amount of energy in the form of thermal radiation from the extremely immense 2.73K heat ocean. How much energy in the form of light and thermal radiation a big bang and all its subsequent processes have scattered into the vast 2.73K heat ocean, how much energy in the form of thermal radiation will all the black holes, especially the extremely immense central black hole, collect and assemble back from the heat ocean again, leading to a new big bang.

2. The 3K background radiation is an extremely immense heat ocean, an intrinsic existence in the closed universe. It is not produced by the big bang.

(1) As is well known, in 1965, Penzias and Wilson unexpectedly discovered the 2.73K microwave background radiation coming from the remote space in all the direction [25]. The microwave background radiation shows two fundamental characteristics: (1) uniform, stable, and ideal isotropic, (2) its spectrum coincides with Planck's formula for the black body radiation at a temperature of about 3K (later, measured more accurately, 2.73K). They are actually the same fundamental characteristics of the equilibrium thermal radiation in the cavity within a solid at the same temperature. Accordingly, what Penzias and Wilson discovered is an extremely immense and stable ocean of equilibrium thermal radiation at a temperature of 2.73K. It is just the natural and intrinsic extremely immense heat ocean in the central part of the closed universe [25].

The existence of the stable ocean of 2.73K background radiation is a credible proof that the cosmos space is closed. If the space of the universe were not closed, the thermal radiation would have flied off, and mankind should not have observed it keeping undecayed so excellently for so long a duration.

The 2.73K microwave radiation is an equilibrium thermal radiation, so it is impossible to measure its depth by any direct astronomic observation. We cannot determine the size of the heat ocean this way.

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However, a certain part of researchers believed that the microwave background radiation at 2.73K was produced by the big bang.

Anyway, as well accepted by most astrophysicists, 380,000 years after the big bang, when the interior temperature of the expanding primitive fire ball dropped down to 3000K, the electrons and protons in the plasma within the expanding primitive fire ball combined to become neutral hydrogen atoms. The neutral hydrogen atoms no longer exchanged heat with the thermal radiation. The fireball decoupled. The interior of the fireball became transparent for the thermal radiation. All the thermal radiation within the expanding fire ball got free, and began immediately to fly off at light speed in all the directions (in the 4π solid angle) into the exterior extremely vast space. That is obviously a free ejection of the thermal radiation of the decoupled fire ball to the exterior vast cosmic space.

Because the universe is closed, the scattered thermal radiation should not fly to the infinitively far space. Like the galaxies' shuttling, the thermal radiation should return back to the central part of the universe and keep shuttling in the closed space of the universe with some extremely greater amplitudes. Then, after an extremely long relaxation time, through exchange heat with the cosmic atoms and molecules, the cosmic dusts and rocks (all of these matters are at the temperature of 2.73K) in the metagalaxy region, the shuttling thermal radiation should finally mingle into the extremely vast 2.73K heat ocean. The 2.73K heat ocean is the final destination of the ejecting decoupled thermal radiation.

However, there are a part of the researchers who alleged that, after flied off the decoupled fire ball, the thermal radiation kept "**expanding adiabatically**" for an extremely long time, and changed finally to the 2.73K background equilibrium thermal radiation of today. They alleged further that the 2.73K background radiation is a credible proof of the big bang.

They speak of an "adiabatic expansion". What do they mean by this terminology here?

The initial state of the "adiabatic expansion" was an equilibrium thermal radiation at 3000K in the decoupled fire ball, and the final state of it is an equilibrium thermal radiation at 2.73K occupying an extremely immense space. Then, how about the numerous intermediate states? Were they all equilibrium thermal radiations at a series of descending temperatures and occupying a series of expanding space? If so, the expanding should be a quasistatic adiabatic thermodynamical process. Such a scenario is totally impossible to be true.

The authors claim here again， the 2.73K microwave background radiation is just an extraordinarily immense heat ocean. It is a stable intrinsic existence in the central part of the closed universe. It is not the afterglow of the decoupled fire ball that emerged 380,000 years after the big bang; that means, it is not produced by the big band.

As soon as the fireball decoupled, all its internal thermal radiations got free, and immediately began to eject freely in various directions (in the 4π solid angle) at the speed of light to leave off the decoupled fire ball and travel straight forward to the extremely vast space. **Such a process was apparently a free ejection**, similar to the free ejection of the light and thermal radiation from the sun or any other star.

For example, the radiation of the light and thermal radiation of a star 10 million light years away from our earth are free ejection. When its light and thermal radiation reach our earth (obviously the process is not an "adiabatic expansion", just a free ejection), the energy intensity of the bunch of the light and thermal radiation is already extremely weak. However, the bunch would not have changed to be an equilibrium thermal radiation at some extremely low temperature. Actually, it is a bunch of parallel light and radiation travelling in the same direction from the mother star. The spectrum of the light and thermal radiation in the bunch is still the same spectrum as it just left the surface of its mother star, consistent with Planck's formular, and the temperature of the spectrum still keeps at the same very high temperature of the surface of the mother star. This is a common knowledge in the astronomy and astrophysics circle.

A similar thing happened to the decoupled thermal radiation. The ejection of the 3000K radiation of the decoupled fire ball was also a free ejection. Once decoupled, all the decoupled thermal radiation in the fireball began to fly off directly at light speed in all the directions to the exterior, and

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travelled straight forward all the directions to the farther vast space. The energy density of the bunch of this thermal radiation was weakened and weakened as the bunch got farther and farther. For a far observer, the decoupled fire ball can be regarded as a point source of light and thermal radiation. When the bunch reached a very far sites from the decoupled fire ball, it was still parallel light and thermal radiations of 3000k, very weak, however, it did not convert to an equilibrium thermal radiation at a lower and lower temperature. The bunch kept its spectrum unchanged, consistent with Planck's formula. The temperature of the spectrum keeps to be the original decoupled temperature of 3000K.

We come to the conclusion that the 2.73K background radiation is not the afterglow of the decoupled fire ball.

Accordingly, it was not produced by the big bang.

As we have mentioned above again and again, the 2.73K background radiation itself is an intrinsic existence in the closed universe, an extremely immense and stable heat ocean. It existed before the big bang. It exists now. It will exit in the future, mostly, forever.

(For more details about this topic, read the appendix of this article, please.)

(2) The extraordinarily immense 2.73 K heat ocean itself

Now, let us surmise briefly the structure and picture of the 2.73K heat ocean itself.

As a preparation, let us first make a calculation of the mass density of the 2.73K equilibrium thermal radiation.

From Stefan-Boltzmann's law, the radiation intensity from the surface of a black body (the energy emitted in unit time from unit area of the black body surface at a given temperature) at T = 2.73K is

$$J = \sigma T^4 = 3.15 \times 10^{-6}\, js^{-1}m^{-2}. \quad (2)$$

As is well known, the relation between the radiation intensity from the surface of a black body j and the energy density of the equilibrium thermal radiation in a solid cavity at the same temperature u is

$$J = \frac{1}{4}cu, \quad (3)$$

hence, the energy density of the thermal equilibrium radiation in the immense heat ocean at T = 2.73K, is

$$u = \frac{4}{c}J = 4.26 \times 10^{-14}\, Jm^{-3}. \quad (4)$$

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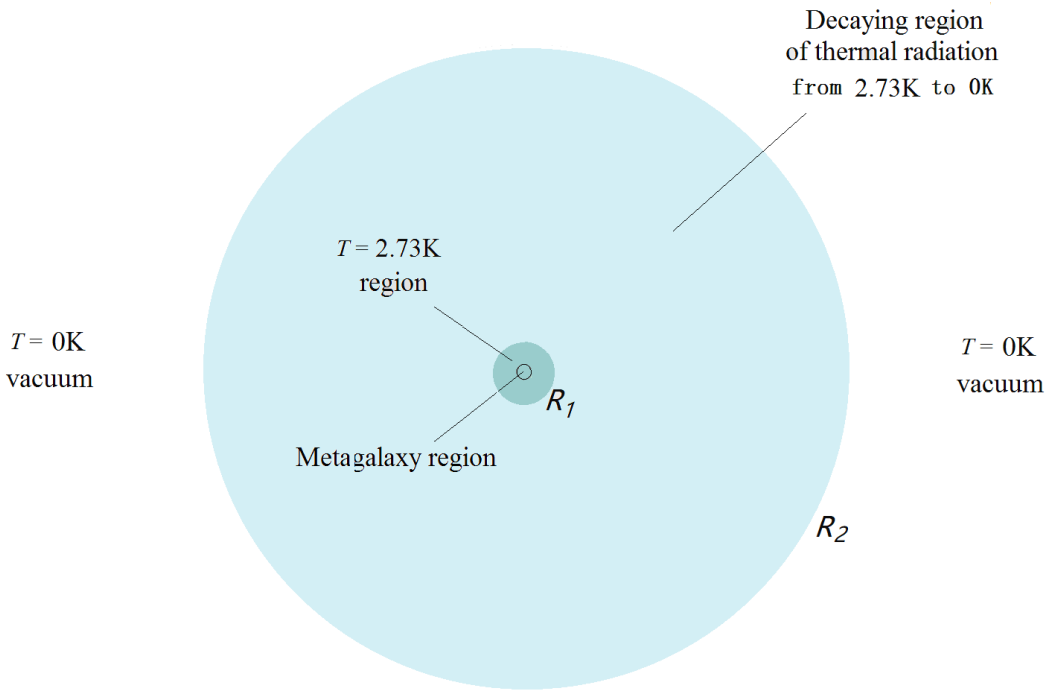

Figure 2. A heat ocean model. The central small circle is the metagalaxy region. The bigger blue circle with a radius R_1 is the 2.73 K region. Then, from R_1 to R_2, the thermal radiation decaying region, , with the temperature drops down from 3K to 0K, as shown by a light blue color. Out of R_2, is the infinitively vast cosmic vacuum, T = 0, ρ =0.

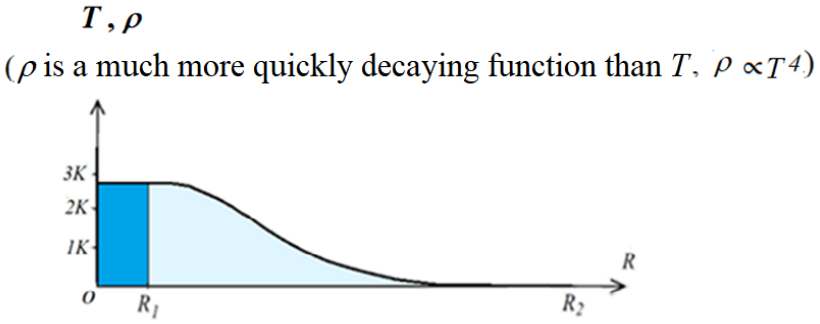

Figure 3. We suppose the central part of the heat ocean is a spherical region of radius R_1, filled up with 2.73K thermal radiation. Stretched outward from R_1 to R_2, the temperature of the thermal radiation decreases gradually from 2.73K to 0K, while the density of the thermal radiation decreases much more quickly to zero. Beyond R_2 is the infinitively vast cosmic empty space.

And , the mass density of the thermal radiation in the heat ocean is ,

$$\rho = \frac{u}{c^2} = 4.73 \times 10^{-31} kg/m^3 \quad (5)$$

Let us imagine to have a look at the picture of the 3K heat ocean.

The whole heat ocean in the central part of the closed universe should be a very large sphere, as shown in Figure 2. Our metagalactic region is located at the center of the vast heat ocean, represented by a very small circle.

Containing the metagalactic region and within the radius of R_1, is the T = 2.73K region, as shown by the blue part in Figure 2.

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Then, from R_1 to R_2, is the thermal radiation decaying region, as briefly and roughly shown by the light-blue part in Figure 2; the corresponding temperature falls down gradually from 2.73K to 0K,

$$T = T(R) \quad (6)$$

together with a decaying mass density that decays much more quickly

$$\rho = \rho(R) \quad (7)$$

as shown in Figure 3.

Finally, out of R_2, is the infinitively vast cosmic space, the infinitively vast vacuum.

In the 2.73K region, and, also in the thermal radiation decaying region, all the outward flying photons undergo red shift. Strictly to say, few of the outward flying photon is precisely along the radius of the closed heat ocean. So, guided by their tangential kinetic energy (mostly extremely tiny), all the out flying photons will eventually turn back and fly towards the central part of the heat ocean again, undergoing blue shift.

Passing through the central region, the blue shifted photons will fly to their individual far most sites on the other side of the central region, undergoing red shift again.

In such a way, all the photons will keep shuttling ceaselessly in the various directions in the 4π solid angle, all with extraordinarily great shuttling amplitudes, and the whole closed heat ocean keeps fundamentally stable and equilibrium.

The heat ocean is extraordinary immense, and its mass may be extraordinary great, which might also contribute considerably to the gravitational close of the universe.

(3) The big bang and its subsequent processes are all extraordinarily great irreversible processes, resulting in immense increase of entropy. They deliver immense amounts of energy (light and heat) into the 3K heat ocean, which is a waste heat reservoir, and can also be regarded as an energy reservoir.

(a) The big band is a tremendously great explosion. It scattered tremendous amount of light and heat (energy) into the space of the closed universe. These scattered light and heat also cannot fly off the closed universe. They also keep shuttling in the closed universe ceaselessly, however, with extremely greater amplitudes. After an extremely long relaxation time, finally, mingle into the 3K heat ocean.

(b) As have mentioned above, about 380,000 years after the big bang, the interior temperature of the expanding primitive fire ball dropped down to about 3000K. The whole fire ball was decoupled, became transparent. All the light and thermal radiations in the decoupled fire ball (it has an immense volume and at a high temperature of 3000K, should have an extraordinary immense amount of energy) got free, began immediately to fly off the fire ball at the speed of light in all the directions, and scattered quickly into the farther and farther vast space. They should also keep shuttling in the closed universe, and finally mingle into the 3K heat ocean.

(c) In the further expansion, all the real matter (mainly hydrogen and helium) within the primitive expanding fire ball changed into numerous nebulae, into galaxies, and developed into even more numerous stars and other celestial bodies. All these processes are also irreversible, sending immense energy (light and heat) into the heat ocean, producing immense entropy.

(d) Then in a very long period, there formed early or late, extremely numerous and numerous stars in all the galaxies. Like the sun, most of these stars have averagely a lifetime of about 10^{10} years, ejecting ceaselessly light and heat into the vast space due to the energy produced in their internal nuclear fusions of hydrogen and helium. All these light and heat scattered into the closed universe, and finally mingle into the 3K heat ocean.

And so on.

All the processes described in the above paragraphs increase the entropy in the closed universe tremendously. In the same time, they deliver immense amount of energy (light and heat) into the heat ocean, that is an immense heat reservoir, and also, an immense energy reservoir.

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Although the 2.73 K heat ocean is very thin and dilute, its volume and total mass might both be extraordinary great. Hence, we guess (may be incorrect), all the above discussed large amount of energy of the light and heat that scattered into the heat ocean, just raise the temperature of the heat ocean very slowly and slightly. Mostly, the temperature of the 2.73K heat ocean is essentially stable.

3. The collection and assembling of energy from the heat ocean by the black holes, leading to a new big bang

In the heat ocean, the 2.73K thermal equilibrium radiation travels everywhere randomly and ceaselessly at the speed of light. Every black hole in the metagalaxy region is immersed in the 2.73K vast heat ocean, hence it takes in the 2.73K thermal radiation at the speed of light from all the directions since its birth and throughout its extremely long lifetime. Meanwhile, any black hole never delivers any thermal radiation to its exterior. Such a process is distinctly **a single way collection of the thermal energy** from the extremely cold 2.73K heat ocean to the black hole that is at an extremely high latent temperature, as it contains an immense amount of internal energy. The process apparently violates the Clausius's statement of the second law of thermodynamics. **Black holes are natural demons in the closed universe.**

Let us see 3 typical examples of black holes of different grades.

1. A black hole with a mass 10 times of the sun.

As shown in Figure 4 (a)，its mass is

$$M_1 = 10\,M_\odot = 10\times(2\times10^{30}) = 2\times10^{31}\,\text{kg}. \quad (8)$$

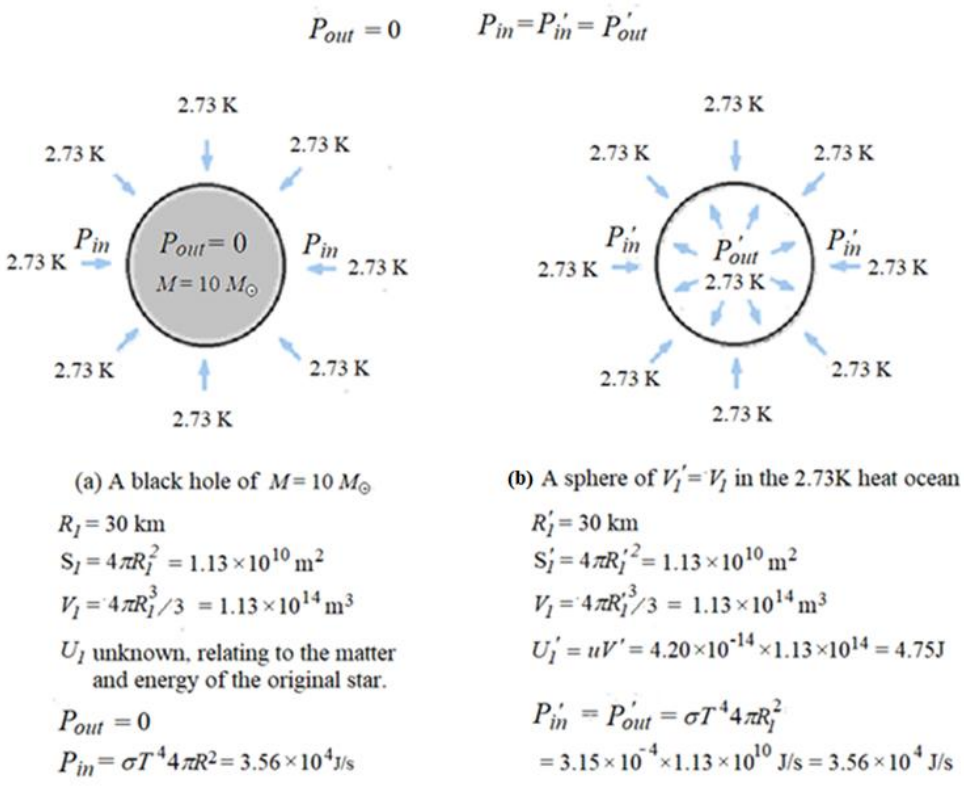

Figure 4. (a) A black hole of M = 10$M_\odot$, R_1 = 30km, V_1 = 1.13×10^{14}m^3, its internal energy is considerably great; b) In the heat ocean, in a same volume $V_1'=V_1$, the energy of the 2.73K thermal radiation is only U_1'= 4.75J. .

Its Schwarzschild radius is

$$R_1 = \frac{2GM_1}{c^2} = 2.96\times10^4 \approx 30km. \quad (9)$$

When this M_1 = 10 $M_\odot$ black hole was formed, most of the matter and energy of its original star was collapsed down into the new formed black hole. The great amount of the gravitational potential

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energy of the matter of the original star first converts to kinetic energy and heat step by step, and finally concentrates into the small new formed black hole. So, there is a great amount of internal energy in the black hole that is now highly concentrated in a very small volume. Hence, the newly formed black hole can be regarded to be equivalent at some extremely high latent temperature, see Figure 4 (a).

(A common bomb contains a great amount of chemical energy, that can be used to do a great amount work. From the point of view of the second law of thermodynamics, the bomb is equivalent to be at a (latent) extremely high temperature.)

Let us make some calculation. The volume and surface area of the black hole of the $M_1 = 10\ M_\odot$ are

$$V_1 = (4\pi/3)R_1^3 = 1.13\times10^{14}\text{m}^3, \quad (10)$$

$$S_1 = 4\pi R_1^2 = 1.13\times10^{10}\text{m}^2 \quad (11)$$

Respectively, as shown in Figure 4 (a).

For comparison（to compare their temperature）, imagine a sphere in the 2.73K heat ocean of a same volume and a same surface area as shown in Figure 4 (b),

$$V_1' \ (= V_1\ ) = 1.13\times10^{14}\text{m}^3\ , \quad (12)$$

$$S' \ (= S_1) = 4\pi R_1^2 = 1.13\times10^{10}\text{m}^2, \quad (13)$$

The internal energy of the 2.73K thermal radiation in the spherical volume V_1' is

$$U_1' = u\ V_1' = 4.20\times10^{-14}\times1.13\times10^{14} = 4.75\text{J}. \quad (14)$$

The (latent) temperature of the $M_1 = 10\ M_\odot$ black hole (V_1) is extremely high. But it does not emit any thermal radiation to the surrounding extremely cold 2.73K heat ocean. Contrarily, it takes in the thermal radiation at the speed of light in all the directions from the extremely cold 2.73K heat ocean ceaselessly with a power

$$P_{\text{in}} = \sigma T^4 4\pi R_1^2 = 3.15\times10^{-6}\times1.13\times10^{10} = 3.56\times10^4\text{J/s}. \quad (15)$$

In each second, suppose the $M_1 = 10\ M_\odot$ black hole takes in the 2.73K thermal radiation of a volume N_1V_1' from the heat ocean, the number N_1 should be

$$N_1 = P_1 / U_1' = 3.56\times10^4 \div 4.75 = 7494 \approx 7500. \quad (16)$$

In one day, the corresponding number of the energy U_1' collected from the heat ocean by the $M_1 = 10\ M_\odot$ black hole is

$$N_{day} = 86400\times7500 = 6.5\times10^8. \quad (17)$$

In one year, the corresponding number is

$$N_{year} = 365\times6.5\times10^8 = 2.37\times10^{11}. \quad (18)$$

In one million years, it is

$$N_{10^6\ years} = 2.37\times10^{11}\times10^6 = 2.37\times10^{17}. \quad (19)$$

One million years is a twinkle of an eye in the long, long lifetime of a black hole.

We conclude that, the 2.73K thermal radiation pouring ceaselessly at the speed of light from all the directions into the $M_1 = 10\ M_\odot$ black hole is **a typical process of spontaneous heat transfer from an extremely low temperature region (at 2.73K) to an extremely high temperature region (a great amount of internal energy concentrated in a small volume)**. Such a process is apparently in contradiction to the Clausius statement of the second law of thermodynamics.

Black holes are Maxwell's demons in the Nature.

Numerous and various such black holes of the star grade in all the millions over millions of galaxies ceaselessly absorb a very great general amount of thermal radiation from the vast heat ocean

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throughout their individual extremely long, long lifetimes. That is a great process of energy collection.

(2) the central black hole of a galaxy

Such a black hole usually has approximately a mass of about 10^{10} times of M_1, i.e.,

$$M_2 \approx 10^{10} \times M_1 = 10^{10} \times 10\ M_\odot\ , \quad (20)$$

The radius of its Schwarzschild sphere is

$$R_2 \approx 10^{10} \times R_1 = 10^{10} \times 30\text{km} \quad (21)$$

and the area of its spherical surface S_2 is 10^{20} times of the area of S_1. It absorbs the 2.73K thermal radiation from the heat ocean at a much greater power,

$$P_{2\text{in}} = \sigma T^4 4\pi R_2^2 = (3.15\times10^{-6}\times1.13\times10^{10}) \times10^{20} = 3.56\times10^{24}\ \text{J/s}. \quad (22)$$

If we still take $U_1' = u\ V_1' = 4.75\text{J}$ as an energy counting unit, the corresponding number N_2 of the absorbed energy by M_2 in each second is

$$N_2 = P_{2\text{in}} / U_1' = 3.56\times10^{24}\ \text{J} \div 4.75\text{J} = 7.49\times10^{23} \quad (23)$$

The thermal radiation collected by the M_2 black hole from the heat ocean is extremely higher than the $M_1 = 10\ M_\odot$ black hole. The process reduces a much greater amount of the entropy of the universe in each second.

The total rate of the collections of energy from the heat ocean by all the numerous black holes of galaxy cores in the metagalaxy region is of course tremendously greater, and the corresponding decrease of the entropy of the universe is extraordinarily larger.

As all these two kinds of black holes unite step by step (together with all the other celestial bodies in the galaxies) through shuttling and annexations to form eventually the **central black hole**, they should carry all the energy that they have collected from the heat ocean in their individual long, long lifetimes to enter the central black hole.

（3）The central black hole of the universe

The central black hole contains all the real matter of the whole universe, having an extraordinarily and extraordinarily immense amount of mass. Its radius is proportional to its mass. The area of its Schwarzschild sphere is proportional to the square of its radius. Hence, it has an extremely and extremely immense spherical area. That will absorb the 2.73K thermal radiation from the extremely vast 3K heat ocean ceaselessly from all the directions at the speed of light. Hence, the power of its absorption of the thermal radiation from the immense heat ocean will be extraordinarily and extraordinarily great. **The internal energy of the central black hole will rise extraordinarily and extraordinarily fast, and, monotonically.**

Notice please, at that time, all the real matter in the universe have already been concentrated into the central black hole. There will be no longer any new mass of real matter fall into the central black hole. The average energy possessed by per unit mass of the real matter in the central black hole will just rise and rise, very quickly and monotonically. **The interior matter should happen a series of endothermic changes.** By the end of all these endothermic changes, the energy possessed by per unit mass of the interior matter of the central black hole will reach an extremely high level. The authors assert that the matter in such an extreme state is closely identical to the “primitive matter” or “ylem” described by Gamow et al in their theory of **the thermal big bang**.

Nevertheless, the central black hole will continue to absorb energy extremely fast from the heat ocean ceaselessly. Its total internal energy will continue to increase. That means, **its internal repulsive factor will continue to increase**, **extremely fast and monotonically**. Such a unidirectional process should not go on and on without an end, when a threshold value of the repulsive factor is reached and exceeded, a new big bang breaks out!

So far, we have accomplished the description of an extraordinarily big cycle of matter and energy in the universe. A big bang and a big assembling constitute a big cycle [26–32].

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(IV) The New Second Law of Thermodynamics

In the above discussions, we have first described and demonstrated by an experiment video of a special test of an artificial entropy reducing process, the experiment of thermal electrons in a magnetic field. It is very interesting and enlightening. It means a very tiny cycle of energy in the macroscopic world. It challenges and shakes the traditional thermodynamics for the first time.

We also discussed the extraordinarily immense big cycle of matter and energy in the closed universe. A big bang and a big assembling constitute a big cycle. Entropy can either increase, or decrease, both in an extraordinarily immense scale. Essentially, the increase and decrease of entropy in a big cycle match each other. The entropy of the universe would never reach a Maximum value, Clausius's "Heat Death" is an excessive anxiety.

Hence, the original second law of thermodynamics needs to be reformed. We put forward **a new theoretical system for thermodynamics** as follows.

（The first law keeps unchanged. The second law changes considerably.）

1. **The first law of thermodynamics is energy conservation.**

Energy is conserved, wherever and whenever. It is a law of the universe.

The total amount of energy of the universe keeps constant (Clausius's word).

And so on.

2. **The second law of thermodynamics is energy circulation.**

All the matter and energy in the closed universe are involved in a big cycle. Entropy can either increase, or decrease. In general, the increase and the decrease of entropy match each other in a big cycle. The black holes are natural demons in the universe.

Nevertheless, the traditional second law of thermodynamics should not thus be

discarded. It is still valid in almost all of the numerous ordinary thermodynamical processes that we meet in our life, work, and ordinary research.

The situation is rather similar to the one in mechanics.

Einstein's special relativity reveals profoundly that Newton's mechanics is no longer valid in some special situations. However, for almost all the practical mechanical problems we meet in our life, work and ordinary research, Newton's mechanics is still valid, it is still accurate to an extremely high extent.

Similarly, for all the numerous ordinary thermodynamical processes we meet in our life, work and ordinary research, the traditional second law of thermodynamics is still valid and correct, covering an extremely wide scope.

More ever, like energy, entropy is also a real physical quantity. It has many different forms, for examples, heat temperature quotient entropy, volume expanding entropy, phase change entropy, chemical entropy, and so on.

Entropy is conserved in all the reversible processes. This is actually a theorem. The theorem provides a way to find the accurate and credible equivalent relations between the different forms of entropy.

Nevertheless, unlike energy, entropy tends to increase spontaneously in numerous and numerous ordinary processes that we meet wherever and whenever.

Fortunately, entropy can also decrease in the big cycle of matter and energy in the closed universe. We need not to worry about the Heat Death as predicted by Clausius.

The special artificial processes, the experiment of thermal electrons in a magnetic field, results in some very tiny decrease of entropy. Although it is a very tiny process, its output current is already a macroscopic direct current (DC). Such a peculiar and interesting experiment challenges sharply and shakes the base of the traditional thermodynamics. It has raised up the authors' determination for a long duration to explore the cosmic entropy reducing possibility.

Some ending word

(1) The universe is extraordinary immense and mysterious. There are so many, many things in the universe still keep totally unknown and totally mysterious to mankind. This article is just a

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tentative thermodynamical exploration of the cycle of the matter and energy in the closed universe. Mistakes and deficiencies are of course inevitable in such a primary exploration. Any criticism and suggestion to this article are warmly welcome.

(2) In our discussion, we claimed that the black holes are natural Maxwell's demon in the universe. A black hole just ceaselessly takes in the thermal radiation of the 2.73K heat ocean in all the directions at the speed of light, reducing the entropy of the heat ocean, reducing the entropy of the universe, ceaselessly. Some people might argue that, according to Bekenstein, the "area entropy" of the event horizon of the black hole should increase in such a process, and the general change of entropy for the process is still an increasing one, and so on.

The authors claim here that Bekenstein's "area entropy" of a black hole is an incorrect idea. Actually, there are several major physical mistakes in Bekenstein and Hawking's "black hole thermodynamics". Limited by space, we do not discuss these problems in this article. We have another article *On Bekenstein and Hawking's Black Hole Thermodynamics*, discussing these problems in details. The article can be found through the Preprints ID: preprints-166919. The website of the article is: https://www.preprints.org/manuscript/202507.0621/v1.

The pdf file of this article cannot demonstrate our experiment video of tube FX8-24. The readers who are interested in such a video can find it through the Reference [15] of this article.

Appendix

How did the thermal radiation of the decoupled fire ball fly off and eject freely into the vast cosmic space and their final destination.

As mentioned above, in our opinion, the 2.73K background radiation is an immense heat ocean, a natural and intrinsic existence in the closed universe.

Some researchers' opinions are different from ours. They believe that the 2.73K background radiation is produced by the big bang. And they believe further that the 2.73K background radiation is the afterglow of the thermal radiation in the decoupled fire ball, 380,000 years after the big bang. From the decoupled thermal radiation to the 2.73K background radiation, there was an "adiabatic expansion" of a long, long duration.

We have explained that their idea of the "adiabatic expansion" is not correct, the actual process should be a free ejection.

Now, let us show further how the remnant 3,000K thermal radiation in the decoupled fire ball ejected freely to the exterior vast cosmic space and their final destination.

First, as shown in Figure 1, the small ball with the diameter ab in the central part of the figure represents the decoupled fireball, 380,000 years after the big bang. Its radius is approximately oa ≈ 10^{22} m = 5×10^5 light years. (For convenience of discussion, we make up a round number for the radius here, oa ≈ 5×10^5 light years, and the diameter is ab ≈ 1×10^6 light years.)

When the decouple happened, the fire ball became transparent. All the thermal radiation in the fireball immediately started to fly off in all the directions at the speed of light into the exterior cosmic space, and travels straight forward farther and farther. Obviously, it is just a free ejection, not an "adiabatic expansion". Let us see how the thermal radiation flied to the infinitively vast space.

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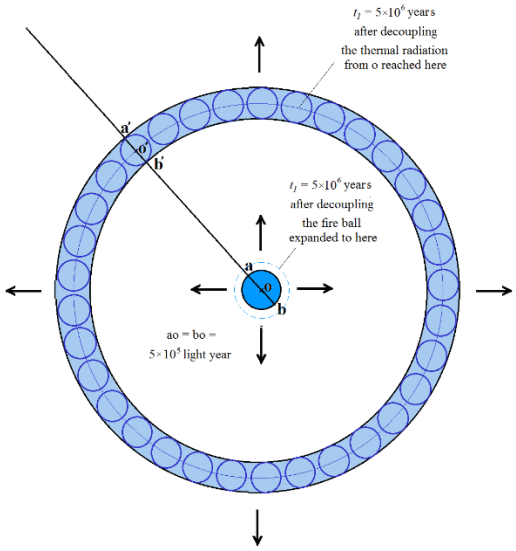

Figure 1. The radius of the decoupled fire ball was about ao ≈ 5×10⁵ light years, 380,000 years after the big bang. The diameter is ab ≈ 10⁶ light years. All the thermal radiation within the whole decoupled fire ball aob began to fly off at the speed of light to leave it in all the directions. 5×10⁶ years later, the radiations from the whole sphere aob in the direction of oo′ reached a new place of a sphere a′o′b′, within the spherical layer a′b′ ≈ 10⁶ light years′. And all the thermal radiation from the decoupled fire ball in all the directions in the 4π solid angle all reached the spherical layer a′b′ with a thickness of a′b′ = 10⁶ light years, the big blue spherical layer in this figure.

5×10⁶ years later, the thermal radiation from point o, and in the direction of oo',

reached point o', oo' = 10 oa = 5×10⁶ light years, as shown in Figure 1. The thermal radiation from point a reached point a', the thermal radiation from point o reached point o', the thermal radiation from point b reached point b'. All the thermal radiations in the direction of oo' from all the points of the decoupled fire ball aob now reached the corresponding points of an equal ball a'o'b', which lay in the spherical layer a'b' = 10⁶ light years.

And all the thermal radiations ejected from the decoupled fireball aob **in all the different directions** in the 4◎ solid angle now all reached points within the whole spherical layer a′b′, as shown in Figure 1. The thickness of the spherical layer a′b′ equals the diameter of the small ball ab.

$$a'b' = ab = 10^6 \text{ light years.} \quad (1)$$

5 ×10⁷ years after the decouple, all the thermal radiation from point o arrived at the spherical surface of the radius of oo'' = 5 ×10⁷ light years (oo'' = 100 oa), as shown in Figure 2. And in the direction of oo'', the thermal radiation from point a reached point a'', the thermal

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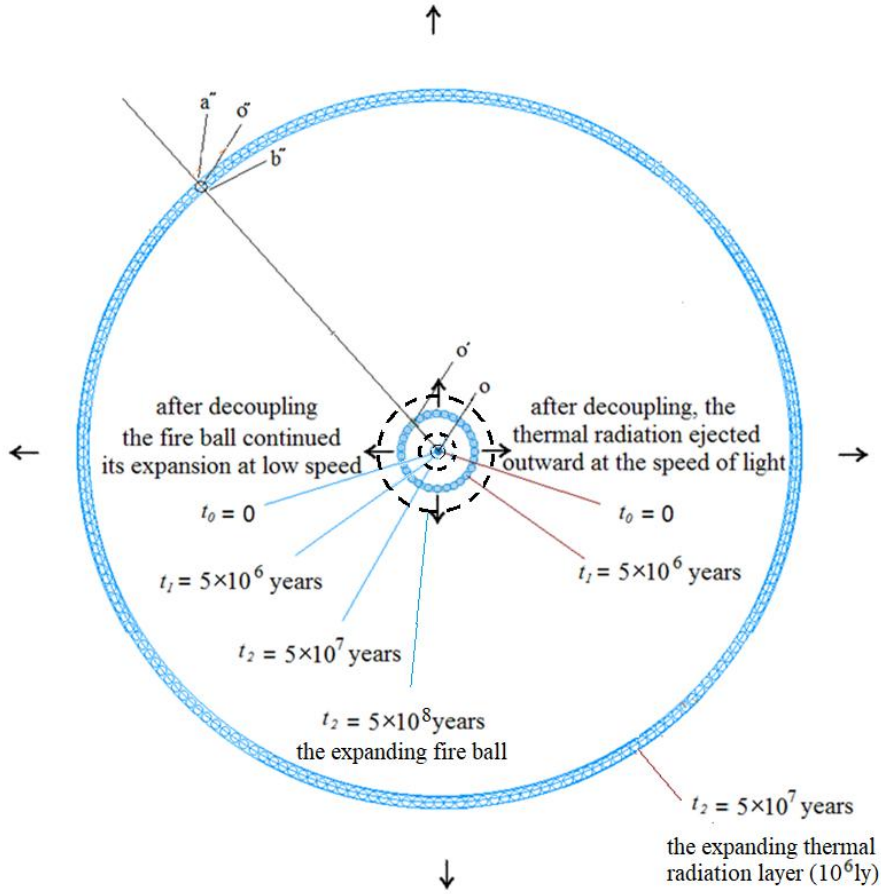

Figure 2. 5 ×10^7 years after the decoupling, in the direction of oo'', the radiation from o reached point o'',and the radiation from a reached a'',the radiation from b reached b''. The radiation from all the points of the decoupling ball aob reached the corresponding points of ball a''o''b''. And, the radiation from all the points of the ball aob in all the directions in the 4π solid angle reached the spherical layer a''b'',.

a''b'' = a′b′ = ab =10^6 light years. （2）

radiation from point o reached point o'', the thermal radiation from point b reached point b''. All the thermal radiations in the direction of oo'' from all the points of the decoupled fire ball aob now reached the corresponding points of an equal ball a''o''b'', which lay in the spherical layer a''b''. And, all the thermal radiations from all the points of the small ball aob (the whole decoupled fire ball, 380,000 years after the big bang) **in all the different directions** in the 4π solid angle now all reached the points within the whole spherical layer a'' b''. Obviously,

$$a''\ b'' = a'\ b' = ab = 10^6 \text{ light years} \quad (3)$$

5 ×10^8 years later，all the radiations from all the points of the small ball aob (i.e., from the whole decoupled fire ball at t = 380,000 years) and **in all the different directions** in the 4π solid angle, all reached the correspondent points within the whole spherical layer a'''b'''. Obviously,

$$a'''b''' = a''\ b'' = a'b' = ab = 10^6 \text{ light years} \quad (4)$$

And, 5 ×10^9 years later, 5 ×10^{10} years later，and so on, as the thermal radiation ejected freely from the decoupled fireball aob, flied outward continuously at the speed of light, it always keeps within a spherical layer with a thickness of 10^6 light years,

$$\cdots = a''''b'''' = a'''b'''= a'''b''' = a''b'' = a'b' = ab = 10^6 \text{ light years} \quad (5)$$

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The expanding of this spherical layer of the thermal radiation of a thickness of 10^6 light years, (ab), a′b′, a''b'', a'''b''', a''''b'''' ……, and so on, should not go on and on at the light speed to the farther and farther space without an end. Because the space of the universe is closed, when some utmost possible position is reached, the thermal radiation layer of a thickness of 10^6 light years will no longer fly away further. It will return back to the central region of the universe, and passing through the central region, travel to their far most positions on the other side of the central region. In such away, the layer of the 10^6 light years will keep shuttling in the closed universe ceaselessly, meanwhile, getting more and more dispersive.

Finally, after an extremely long relaxation time, by interactions (exchange heat) with the cosmic atoms or molecules, cosmic dusts or rocks, and so on, in the metagalaxy region, these thermal radiation from the decoupled fire ball will eventually mingle into the 3K heat ocean, That is their final destination.

So, the authors behold that, the 2.73K background radiation discovered by Penzias and Wilson in 1965 is not the afterglow of the decoupled fire ball. It is not produced by the big bang. It itself is just an extremely immense intrinsic 3K vast heat ocean in the closed universe. It existed before the big bang, it exists now, and it will exist in the future.

In the above discussion, for the sake of concise, we postponed a detail about the process of the light and heat ejected from the surface of the expanding fireball from the time of the big bang to the decouple time, i.e., from t_1= 0 to t_2= 380,000 years. Now we make it up as follows.

Please have a look at Figure 3.

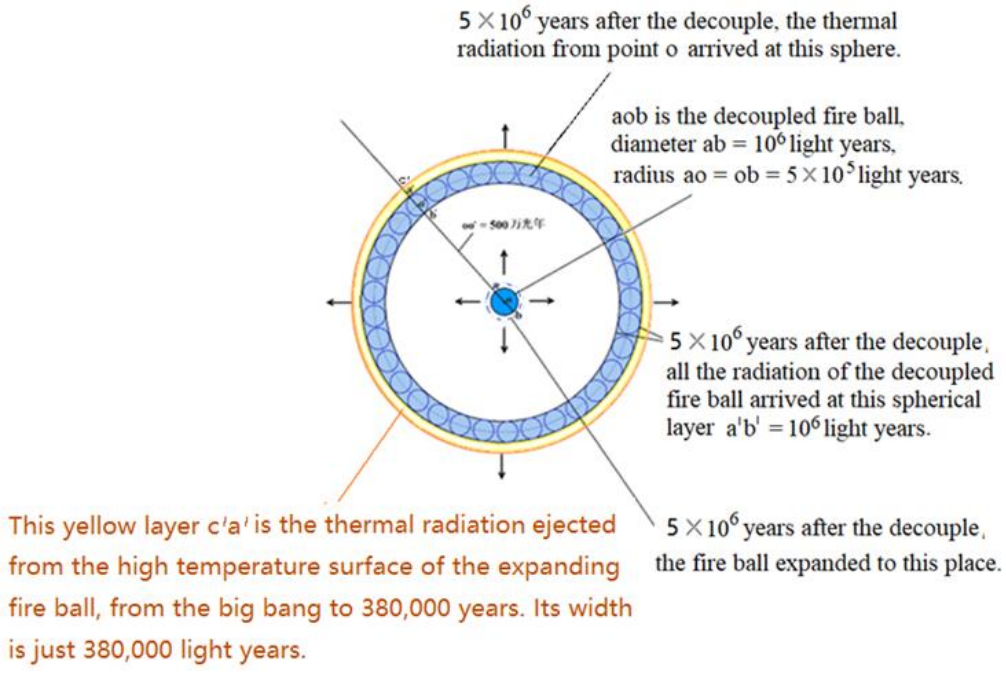

Figure 3. Another spherical layer with a width of c'a' = 380,000 light years (shown as a "yellow" one in the figure) just out the spherical layer of 10^6 light years (the "blue" ones a′b′, a''b'', a'''b''', ……).

After the big bang, the expanding fireball was initially at an extremely high temperature. The temperature descended step by step very rapidly as it expanded. In this process, the whole interior of the fireball was plasma at extremely high temperature, which was totally opaque for the interior thermal radiation. So, the thermal radiation within the expanding fireball could not eject outward freely to leave the fireball.

However, in the same duration, the surface of the expanding fire ball was also plasma at a rather lower and also descending temperature, but its temperature was still very high. This surface of the expanding fire ball, exposed to the exterior vast space, should eject thermal radiation ceaselessly.

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Let us make a compare: as is well known, the temperature at the central part of the sun is about 15000K, and the temperature at the surface of the sun is about 6000K. The interior thermal radiation of the sun cannot fly off the sun, because its interior plasma is totally opaque for the thermal radiation. Only the surface of the sun, which is exposed to the vast exterior space, would eject light and heat ceaselessly, and the temperature of the ejected light and heat is about 6000K.

Similarly, the descending temperature at the surface of the expanding fire ball in the duration from the big bang to the decouple time was also still be extremely high. The surface kept being plasma until the decouple happened, and it was exposed to the vast exterior space. Like the surface of the sun, the surface of the expanding primitive fire ball should eject thermal radiation continuously, from $t_1 = 0$ to $t_2 = 380{,}000$ years. Hence, just out the expanding spherical layer with a width of 10^6 light years (the expanding "blue" spherical layer as shown in Fig1 and Fig 2),

$$\cdots\cdots\ a''''b'''' = a'''b''' = a'''b''' = a''b'' = a'b' = ab = 10^6 \text{ light years} \quad (6)$$

there is another spherical layer of a width of 380,000 light years, the "yellow" one spherical layer in Figure 3.

$$\cdots\cdots\ c''''a'''' \; c''''a'''' = c'''a''' = c''a'' = c'a' = 380{,}000 \text{ light years} \quad (7)$$

The two layers both ejected outward at light speed, one after the other, the yellow one progresses ahead and the blue one follows. After reaching their far-most positions in the closed universe, they will both return back, still one after the other.

Then they will keep shuttering in the closed universe, becoming more and more dispersive. After a long, long relaxation time, finally, both the "blue" and "yellow" light and thermal radiations should mingle into the stable immense 3K heat ocean.

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