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Article

A New Frame Work of Thermodynamics Artificial Energy Cycle and the Big Energy Cycle in the Universe

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Abstract

This article comes up with a new frame work of thermodynamics, which consists of three parts. (**1**) **The traditional thermodynamics:** relating to all the ordinary thermodynamical processes we meet in 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. The final fate of the universe, as claimed by Clausisus, is heat death. (2) **The thermodynamics of thermal electrons in a magnetic field:** We have performed a new experiment of the thermal electrons emitted from two identical and parallel Ag-O-Cs emitters, A and B, within a vacuum tube. The tube is applied by a static magnetic field that bends the trajectories of the electrons, resulting in a weak asymmetry in the thermal motion of the electrons (to left or to right). Emitter A, losing some net electrons, was charged positively; emitter B, getting some net electrons, was charged negatively. An electric potential between A and B was formed, enabling the tube to output a weak and continuous but macroscope current and power to an exterior load, a resistor, or a storage battery. (It the direction of the magnetic field was opposite, the direction of the output current was reversed.) Due to the ceaseless output of electric energy, the internal energy of the tube should decrease slightly, and the tube followed to cool down slightly. The slightly cooled tube automatically absorbed waste heat from the ambient air to compensate its output electric energy. The experiment directly converted the waste heat in the air to electric energy, violating the Kelvin-Planck statement of the second law. A short experiment video (of 100 seconds) is included in this manuscript, showing intuitionally how the magnetic field here acts as a Maxwell's demon. (3) **Cosmic thermodynamics**: The authors approve of the idea that the universe is gravitationally closed, and there should be naturally an extremely immense ocean of thermal radiation in the central part of the closed universe. The 2.73K microwave background radiation discovered in 1965 should just be this immense heat ocean. Due to the big bang, all the galaxies are now flying outward fiercely. When they reach their individual far-most positions in the closed universe, they will turn back one after another towards the central region of the universe, and then keep shuttling with extremely great amplitudes in the closed universe, passing through the central region repeatedly. There are numerous stars and many black holes in every galaxy. Every black hole, once formed, ceaselessly takes in the 2.73K thermal radiation from the heat ocean. A black hole annexes any celestial body that it encounters. The directions of the shuttling of the galaxies are different in the 4p solid angle, so in a long, long duration, the more than 2×10^{12} galaxies should have numerous chances to meet each other in the central region. When a black hole, especially the immense core black holes of a galaxy, encounters a star or another black hole in the central region in the shuttling, annexation happens. All the matter scattered to the extremely vast space by the big bang will thus be collected step by step, until finally assemble to be a single extraordinary immense black hole, **the central black hole.** On the other hand, the big bang and all its subsequent processes are all huge irreversible processes. They produce and eject immense amount of light and thermal radiation into the vast cosmic space. The light and thermal radiation are also impossible to fly off the closed universe. They also keep shuttling ceaselessly in the closed

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universe with much, much greater amplitudes. After a long, long relaxation time, by interchange heat with the cosmic atoms, molecules, dusts and rocks (these matters are all at 2.73K) in the metagalaxy region, they will finally mingle into the 2.73 heat ocean. The central black hole, containing all the real matter of the universe, having an extraordinary immense event horizon, will continue to take in the thermal radiation from the 2.73K heat ocean with an extraordinarily power, leading eventually to a new big band. A big band followed by a big assemble forms a big cycle. All the matter and energy in the universe are involved in the big cycle. **Conclusion—the new theoretical system of thermodynamics**: The first law of thermodynamics is energy conservation. The amount of energy is conserved wherever and whenever. **The second law of thermodynamics is energy cycle. All the matter and energy are involved in a big cycle in the closed universe.**

Keywords: traditional thermodynamics; magnetic field is a demon for thermal electrons; a tiny energy cycle; a closed universe; an immense 2.73K heat ocean; black holes are natural demons; big band and big assemble constitute a big cycle

1. Traditional Thermodynamics (a Brief Description)

At present time, we spend electric energy (equivalent to work) every day. One joule **electric energy**, as we use it, converts to one joule **waste heat**. There are numerous similar processes that convert work to waste heat, such as various frictions between two objects, a stone falls down to the ground, wind or water whirling, air leakage of a car tire, even metal rusting, and so on, covering an extraordinarily immense scope.

One joule electric energy converts to one joule waste heat exactly. Energy is conserved in amount 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 can be used to do work once only.** 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.

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 useful energy in the universe changes to waste heat, and radiates to the infinitive vast cosmic space, leading to the Heat Death. [1–5]

2. Thermodynamics of the Thermal Electrons in a Magnetic Field

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 traditional second law of thermodynamics**. Among them, James Clerk Maxwell was the most genius and brave one.

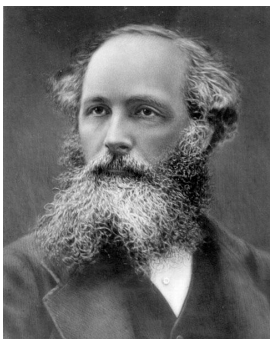

Figure 1. James Clerk Maxwell (1831-1879).

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From 1866 to 1871, Maxwell immersed himself in the search for a way of how to convert waste heat back to work again. Limited by the historic level of science and technology of his era, he did not successfully find such an experiment. Nevertheless, he wrote down his thoughts and experiences during 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.

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 2. 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**.

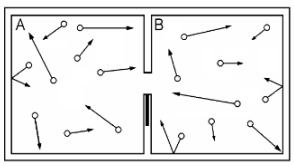

Figure 2. An air container of two parts, A and B. There is a small door at the middle of the separator, which is controlled by a small intellectual being.

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. In the first 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 3. Gradually, the temperature in A drops down and the one 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.

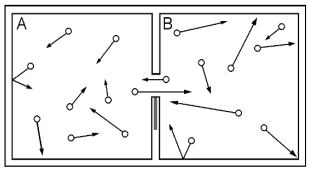

Figure 3. A temperature demon.

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 4. Gradually, the pressure in A drops down and the pressure in B rises up. A pressure difference between A and B emerges, also enabling a part of the internal energy of the air in the container to be used to do work.

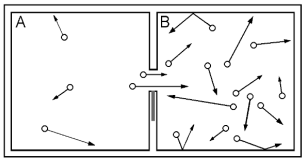

Figure 4. A pressure demon.

In the past about 150 years, many physicists and inventors, have made numerous efforts to design and execute various experiments, hoping to find such a demon.

However, they all failed.

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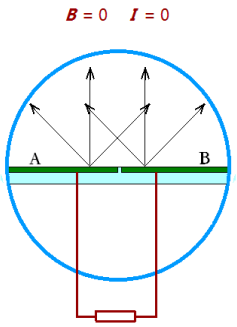
The two authors of this paper, in the past several decades (X. Y. Fu since 1960, 65 years already; Z. T. Fu since 2000, 25 years already), following Maxwell's steps, insisted on searching for such an entropy reducing experiment. They finally replaced Maxwell's gas molecules in the container by the thermal electrons in a vacuum tube, which contains two identical and paralelll Ag-O-Cs thermal electron emitters. Figure 5 (1) and (2) show such 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" 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 anticipated output current and power are very weak.

(1) a photo of electron tube FX8-24

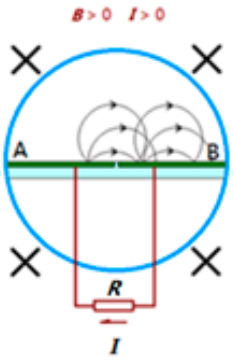


(2) the cross section and the circuit

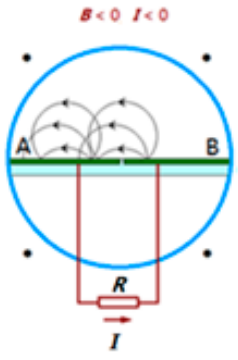
Figure 5. The electron tube FX8-24.

When no magnetic field is applied to the tube, there is no output current, as shown in Figure 5 (2).

Then a static and uniform magnetic field (that is provided by one or a pair of stationary permanent magnets) is applied to the tube, bending the trajectories of the thermal electrons in the tube. For the first time, the direction of the magnetic field points into the paper, and it bends the trajectories of the thermal electrons as shown briefly in Figure 6 (1). A slight asymmetry (to left or to right) in the electrons' thermal motion emerges. The number of electrons emitted from A and fall into B in each second is slightly greater than the one of the electrons emitted from B and fall into A. Emiter A losing some net electrons continuously, charges positively; and emitter B, receiving some net electrons continuously, charges 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, a resistor *R*, or a storage battery.



(1)



(2)

Figure 6. An electric potential demon. (1) When the direction of the magnetic field enters into the paper, the output current is positive. (2) When the direction of the magnetic field leaves out the epaper, the output current is ngative.

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For the second time, the direction of the static magnetic field is opposite, pointing out from the paper. The direction of the output current is also opposite, see Figure 6 (2).

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

As the electron tube ceaselessly outputs electric energy to do work on the exterior resistor with a power $P = I^2R$, as shown in Figure 6, according to the first law of thermodynamics, 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.

As the tube has cooled down slightly, it can spontaneously absorb the waste heat from the ambient air (that keeps at the constant room temperature) 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 other effects**, violating the Kelvin-Planck statement of the second law of thermodynamics.

The following is an experiment video of the vacuum tube FX8-24:

20100802 FX8-24 100s.mp4

In this experiment, the whole closed circuit is desired to be kept at a same room temperature, say, $t = 20^oC$. 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 about $5^oC \sim 10^oC$ changes in temperature every day (24 hours). So, the temperature of the room is actually always changing, very slowly. And there is usually temperature difference distributed along the closed circuit, of the magnitude of several 0.1^oC. The temperatures changes at the different parts of the circuit mostly do not keep the same step. And, 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, very small, and fluctuates ceaselessly. That results in a weak background fluctuating current in the circuit.

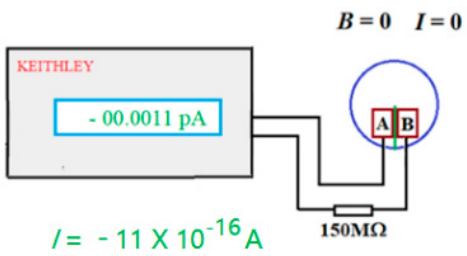
The whole video lasts for 100 seconds.

(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.

$$I_o \approx (-8 \sim -14)\ x10^{-16}\ A = (-0.8 \sim -1.4)\ fA,$$

(as shown in the simple drawing below)



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

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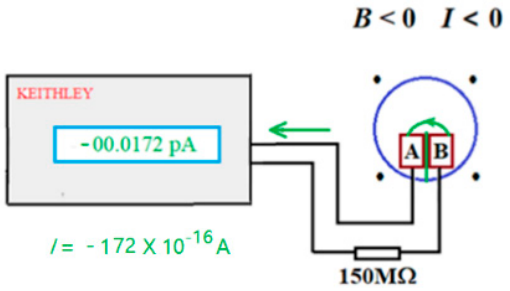
Move in a permanent magnet of 2 kg at t = 10 seconds, as shown in the video. There appears quickly a fundamental negative output current in the circuit, fluctuating slightly.

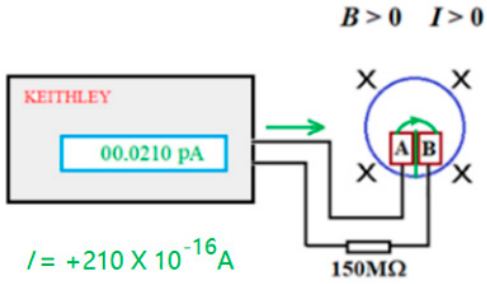
$$I \approx (-140 \sim -190)\text{x}10^{-16}\ \text{A} = (-14.0 \sim -19.0)\ \text{fA},$$



(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 is also reversed. The output current becomes positive, fluctuating slightly.

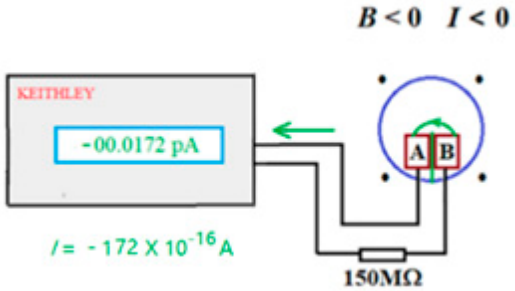
$$I \approx (+210 \sim +240)\text{x}10^{-16}\ \text{A} = (+21.0 \sim +24.0)\ \text{fA}$$



(4) From t = 70 to t = 100 seconds

Restore the direction of the magnetic field to be negative again at t = 70 seconds, as shown in the video. The direction of the output current is also restored. The output current becomes negative again, fluctuating slightly.

$$I \approx (-140 \sim -190)\text{x}10^{-16}\ \text{A} = (-14.0 \sim -19.0)\ \text{fA},$$



Two clear photoes of the set up of the experiment

(1) The general set up of the experiment

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

(There is a compass on the top of the copper box, showing the direction of the magnetic field.)

(2) The arrangement within the copper shielding box

An electron vacuum tube, a resistor R = 150 MW (red, at the top), a long metal tube containing a thermometer probe（at right-below）, and some connection lines, etc.

3. Cosmos Thermodynamics

Most astrophysicists today, including the authors of this manuscript, believe that the present universe was produced by a big bang. [21–24]

The authors approve of the idea that the universe is gravitationally closed. All the matter and radiation are impossible to fly off the closed universe. A big bang followed by a big assemble forms a big cycle. All the matter and energy in the universe are involved in such a big cycle.

It is a thermodynamical exploration.

3.1. Re-Assemble of All the Matter That Scattered into the Cosmic Space by the Big Bang

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

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However, there is a major deficiency in the present theories of cosmology: Where did **the primitive atom** (Lemaitre's terminology) of the big bang, come from?

Most people just avoid this problem.

The authors assert that **this problem is a crucial one in the big bang theory of cosmology. It should not be avoided, absolutely.**

The authors approve of the idea that the universe is gravitationally closed. All the matter, all the electromagnetic radiations and so on，are impossible to fly off the closed universe. They are involved in an extremely immense cycle in the closed universe: a big band followed by a big assemble forms a big cycle.

The big bang is only a special turning point in the big cycle.

However, 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,

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

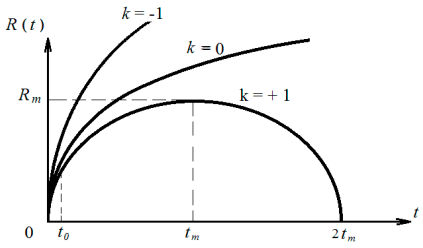

Figure 7. Different space curve sign k result in different $R = R(t)$.

Einstein's field equation and the equation of state, 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.

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

(1) ***k* = + 1，the cosmic space is closed**. All the matter, radiation and so on 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, passing through the central region, shuttling in the closed universe ceaselessly, and so on.

(2) ***k* = 0，the cosmic space is flat.** In this situation, all the matter, radiation and so on that scattered into the cosmic space by the big bang can fly outward to the infinitely remote space, however, with a lower and lower kinetic energy, gradually approaching zero. They would never return back.

(3) *k* = -1，the cosmic space is open. In this situation, all the matter, radiation and so on that scattered into the cosmic space by the big bang just fly rather fast outward to the infinitely remote space. They will never return back.

The above descriptions of equation (1) and Figure 1 are correct, strict and profound, well recognized by most astrophysicists today. However, the theory is really abstract, and it is not easy to perceive clearly and to use it. 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 radiation, neutrinos, and so on. There should be still some kinds of matter that are still totally unknown to

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mankind today. According to the present knowledge, the dark matter is 5 times of the visible matter, seems very important.

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

The two factors contend against each other, that determines the essential evolution of the universe.

If the first factor prevails over the second one, the universe is closed.

If the two factors are just "equivalent" each other, the universe is flat.

If the second factor prevails over the first 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 part of the extraordinary and closed immense universe, naturally, there should be an extremely immense ocean of equilibrium thermal radiation at some essentially stable temperature. The microwave background radiation at 2.73K discovered in 1965 should just be this extremely immense heat ocean. It is intrinsic in the closed universe. It is not produced by the big bang. [25–28]

More than 2×10^{12} galaxies produced in 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 of the closed universe again. It is of course impossible for them to return back to the start point of the big bang at a same time. 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, also because of the gravitational attraction, they will slow down, and finally return back once again to the central region. In such a way, they will keep shuttling through the central region of the universe repeatedly, with different great amplitudes.

In every galaxy, there are numerous stars and many black holes. Every black hole, once formed, takes in all the matter and electromagnetic radiation that approach it, and gets larger. A black hole even annexes any celestial body that encounters with it, including annex another black hole.

The directions of the shuttling of the 2×10^{12} galaxies are various in the 4p 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 (may be, more than 2×10^{23} stars and other celestial bodies) will also have numerous chances to approach even meet each other.

Annexation happens whenever a black hole meets another celestial body in the shuttling. Especially, the black holes of all the galaxy cores (e.g., the core of the Milky Way) are extremely greater than the black holes with a mass of several or even more stars. 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 become shorter and shorter. These two factors will greatly increase the chances of the survived black holes to encounter with the other shuttling celestial bodies. The general annexation processes in the whole universe will thus become faster and faster.

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，which is a rudiment of a new primitive atom for the next big bang.**

In this matter assembling process, most of the original kinetic and potential energy of all the celestial bodies in the 2×10^{12} galaxies are eventually concentrated into the central black hole, preserving directly a great amount of precious energy for the next big bang, without undergoing the process of entropy increase.

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Black holes have an extremely important "collection mechanism" and "assembling mechanism". Without their "collection mechanism" and "assembling mechanism", the reassemble of all the matter is impossible to realize.

At that time, the picture of the universe will become very simple: In the infinitively vast universe, in its immense gravitationally closed central part, there is an extremely great 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, which has an even more massive core containing all the real matter of the universe. The 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 reassemble of all the real matter.

The next problem is, how to overcome **the deadly obstruction of the second law of thermodynamics** to recollect and assemble again the tremendously great amount of energy that has scattered into the vast cosmic space by the big bang and all its subsequent irreversible processes in the form of light and thermal radiation, and, finally mingle into the vast 2.73K heat ocean.

The black holes can accomplish this extremely difficult task. They, especially the final central blackhole, can eliminate the entropy that was produced during the big bang and all its subsequent processes. How much energy in the form of light and thermal radiation a big bang and all its subsequent processes have scattered into the extremely vast 2.73K heat ocean, how much energy in the form of 2.73K thermal radiation, will all the black holes, especially the extremely immense central black hole, recollect back from the heat ocean and assemble them again, leading to a new big bang. [26–32]

3.2. The 2.73K Background Radiation Was Not Produced by the Big Bang

3.2.1. The 2.73K Heat Ocean is an Intrinsic Existence in the Closed Universe

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 directions. The microwave background radiation shows three fundamental characteristics: (1) uniform and stable, (2) excellent isotropic, (3) its spectrum coincides with Planck's formula for the black body radiation at a temperature of about 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. [25]

The authors believe that it is just the intrinsic extremely immense heat ocean in the central part of the closed universe. It is not produced by the big bang.

The meaning of **isotropic** here is: at any point in the 2.73K heat ocean (and also at any point in the cavity within a solid at the same temperature), in any direction in the 4p solid angle, the intensity and spectrum of the thermal radiation are identical.

The 2.73K heat ocean is also a proof that the universe is closed. If the universe were not closed, the microwave radiation would have flied outward to the infinitively vast cosmic space, and would have not kept so excellently stable for so long a duration.

Many researchers had different opinion from ours. They believed that the microwave background radiation at 2.73K was produced by the big bang.

The authors, also accepted the current theory that after the big bang, the primitive fireball expanded very quickly. The interior of the expanding fire ball was at extremely high temperature, filled up with plasma and thermal radiation. The thermal radiation exchanged heat with the electrons and protons of the plasma ceaselessly, and hence kept in the same temperature with the plasma all the time. As the fireball expanded ceaselessly, its temperature decreased step by step quickly. In this duration, the plasma was actually opaque for the thermal radiation. The thermal radiation was constrained in the expanding fireball. They could not fly off the expanding fireball.

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About 3.8×10^5 years after the big bang, when the interior temperature of the expanding primitive fire ball dropped down to about 3000K, the electrons and protons in the plasma combined to become 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 photons of the decoupled thermal radiation within the fire ball got free, and started immediately to fly off the fire ball at light speed in all the directions to the exterior extremely vast space. **That is obviously a free ejection**.

The decoupled 3000K thermal radiation ejected freely into the vast space at light speed, getting farther and farther. However, because the universe is closed, the 3000K decoupled thermal radiation could not fly to the infinitively far space. Like the galaxies' shuttling（that we have discussed above）, after reaching their far most positions in the closed universe, the outward flying decoupled thermal radiation should turn back to the central part of the universe again, and then kept shuttling in the closed universe with extraordinarily greater amplitudes, meanwhile, becoming more and more dispersive. Then, after an extremely long, long relaxation time, through exchanging heat with the cosmic atoms, molecules, dusts and rocks (they are all 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 vast 2.73K heat ocean is the final destination of the emitted decoupled thermal radiation.

(For more details about the free ejection of the degenerated thermal radiation, read the appendix A of this article, please.)

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 expanded finally to the 2.73K microwave background equilibrium thermal radiation of today. They believe, the 2.73K heat ocean is still expanding outward adiabatically at present.

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

The initial state of the "adiabatic expansion" was an equilibrium thermal radiation at 3000K in the decoupled fire ball, and the final state (i.e., the present state) of it is an equilibrium thermal radiation at 2.73K, occupying an extraordinarily immense cosmic space. Then, how about the numerous intermediate states? Were they all at thermal equilibrium states? That is a difficult problem for these researchers to answer.

If all the intermediate states were all equilibrium states, the expanding process should have been a quasistatic process, which is extremely slow. That is obviously not true. All the 3000K decoupled photons are travelling outward freely at light speed. There is no anything like the cylinder piston system or something else to control or limit the outward ejection at light speed of the decoupled photons. The "expansion" in was just a free isotropic ejection at light speed of the 3000K decoupled photons to the infinitively vast space, not an "expansion" of the thermal radiation within any container.

If all the intermediate states were not equilibrium states, how could the scattering decouple thermal radiation that flied outward freely at light speed finally changed suddenly to a 2.73K equilibrium state?

Hence the authors claim here again，the 2.73K microwave background radiation is not the afterglow of the decoupled fire ball. 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.** It was certainly not produced by the big bang.

3.2.2. 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 a black body surface at a given temperature) at $T = 2.73$K is (Steven-Boltzmann's law)

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$$J = \sigma T^4 = 3.15\times10^{-6}\, js^{-1}m^{-2} \quad . (2)$$

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, at T = 2.73K, the energy density of the immense heat ocean is

$$u = \frac{4}{c}J = 4.26\times10^{-14}\, Jm^{-3} \quad (4)$$

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

$$\rho = \frac{u}{c^2} = 4.73\times10^{-31}\, kg/m^3 \quad (5)$$

Now, let us imagine to have a look at the picture of the 2.73K 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 should be located at the central part 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 briefly shown by the blue part in Figure 2. Astronomic observations show that our earth, our Milky way, our metagalaxy are all immersed in an immense heat ocean at a temperature of 2.73K.

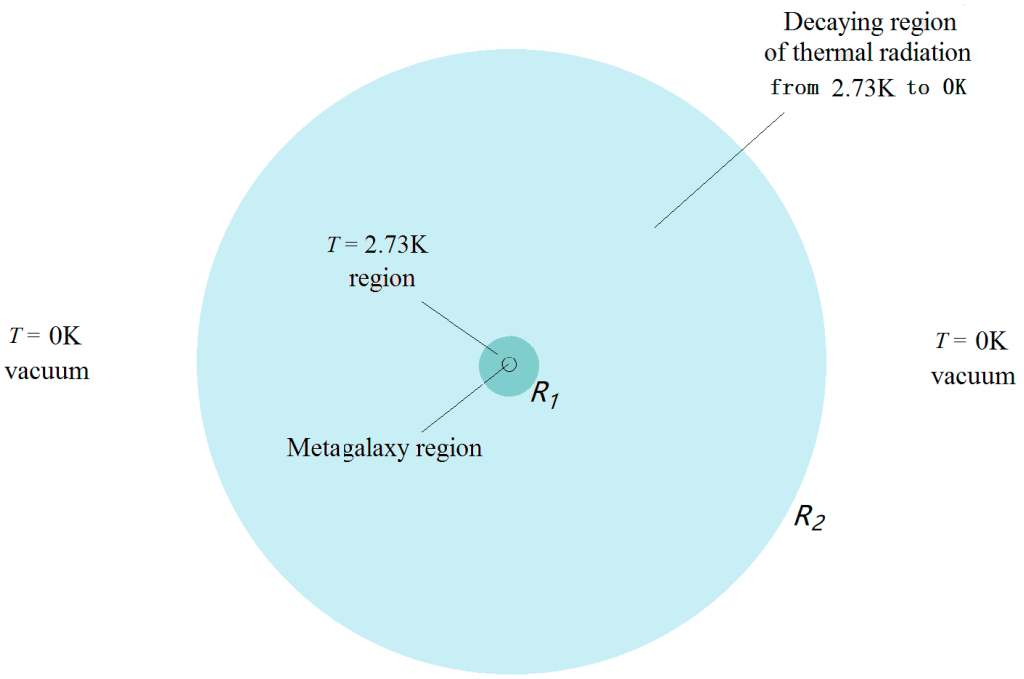

Figure 2. A heat ocean model. The central small circle is the metagalaxy region. The bigger blue circle with a radius R_1 is the 2.73 K region. Then, from R_1 to R_2, is the thermal radiation decaying region, with the temperature drops down gradually from 3K to 0K, as shown by a light blue color. Out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

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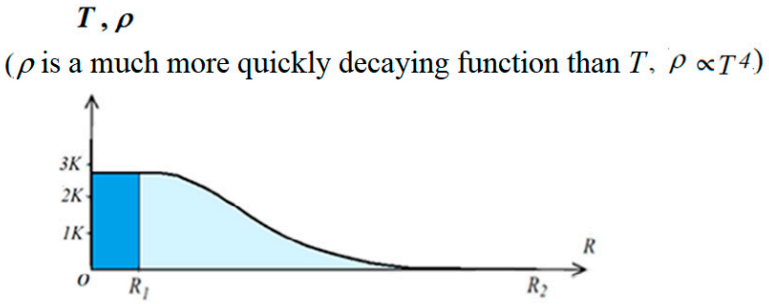

Figure 3. We suppose the central part of the heat ocean is a spherical region of radius R_1, filled up with 2.73K thermal radiation. Stretched outward from R_1 to R_2, the temperature of the thermal radiation decreases gradually from 2.73K to 0K, while the density of the thermal radiation decreases much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

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

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

which corresponding to a roughly similar but much more fast decaying mass density,

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

for r is essentially proportional to T^4, as shown by (2) - (5).

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

In the 2.73K region, and, also in the thermal radiation decaying region, all the outward flying photons undergo red shift. When they reached their individual possible far most sites in the closed universe, they will turn back and fly towards the central region 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 $4p$ solid angle, all with extraordinarily great amplitudes, and the whole closed heat ocean keeps fundamentally stable and equilibrium.

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

3.2.3. The Big Bang and All Its Subsequent Processes Are All Extraordinarily Great Irreversible Processes, Resulting in Immense Increase of Entropy in the Universe

(1）The big band is a tremendously great explosion. Like a supernova, it directly scattered extraordinarily tremendous amount of light and thermal radiation into the space. These light and thermal radiation cannot fly off the closed universe. They will keep shuttling in the closed universe ceaselessly with extremely great amplitudes. After an extremely long relaxation time, they finally mingle into the 2.73K heat ocean, too, increasing the entropy of the universe.

(2）As have discussed above, about 3.8×10^5 years after the big bang, the interior temperature of the expanding primitive fire ball dropped down to about 3000K. The diameter of the decoupled fire ball was about 10^6 light years, having an immense volume similar to the volume of the Milky Way. It was at a very high temperature of 3000K, having an extraordinary immense total amount of energy in the form of light and thermal radiation. At that time the whole fire ball became transparent suddenly. All these light and thermal radiation got free, started immediately to fly off the decoupled fire ball at the speed of light in all the directions, and travelled into the farther extremely vast space. Then, because the universe is closed, they should also keep shuttling in the closed universe with extraordinarily great amplitudes, after a long relaxation time, also mingle into the 2.73K heat ocean, increasing the energy of the heat ocean, increasing the entropy of the universe.

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(3) In the further expansion of the fireball, all the real matter (mainly hydrogen and helium) of an immense amount within it changed into numerous nebulae, next changed into even more galaxies, and then into numerous and numerous stars and other celestial bodies. All these processes were also irreversible, sending immense amounts of light and thermal radiation into the heat ocean, producing immense entropy, too.

(4) 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 (actually longer or shorter), ejecting ceaselessly light and thermal radiation into the vast space due to the energy produced in their interior nuclear fusions of hydrogen and helium. All these light and thermal radiation also scatter into the closed universe, and finally mingle into the 3K heat ocean.

And so on.

All the processes described in the above paragraphs deliver immense amount of light and thermal radiation into the vast 2.73K heat ocean, increasing the entropy in the closed universe tremendously.

According to Clausisus' famous prediction, all these processes leading the universe eventually to a miserable state of Heat Death.

3.3. The Re-Collection and Assemble of Energy from the 2.73K 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 vast 2.73K heat ocean, so it takes in the 2.73K thermal radiation at the speed of light from all the directions since its birth and throughout its long, long lifetime. Meanwhile, a 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 has 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 universe.

(Let us see a metaphor: A common bomb contains a great amount of chemical energy, that can do a great amount of 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 see 3 typical examples of black holes of different grades.

3.3.1. A Black Hole with a Mass 10 Times of the Sun

As shown in Figure 4 (a)，the mass of this black hole is

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

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 collapsed down into the new formed black hole. The great amount of the gravitational potential energy of the matter of the original star first converts to kinetic energy and heat step by step, move inward, 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. The newly formed black hole can also be regarded to be equivalent at some extremely high latent temperature, see Figure 4 (a).

The volume and surface area of the event horizon of the black hole of the $M_1 = 10\,M_\odot$ are

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

$$S_1 = 4pR_1^2 = 1.13\times10^{10}\text{m}^2 \quad (11)$$

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respectively, as shown in Figure 4 (a).

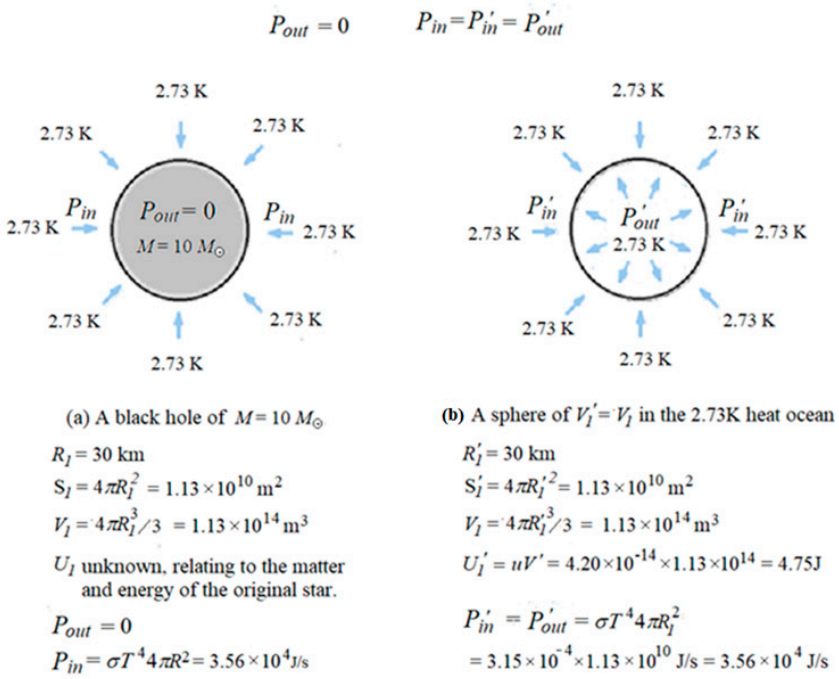

Figure 4. (a) A black hole of M = 10$M_\odot$, R_1 = 30km, V_1 = 1.13×10^{14}m^3, its internal energy is considerably great; (b) In the heat ocean, in a same volume V_1'= V_1, the energy of the 2.73K thermal radiation is only U_1'= 4.75J.

For comparison（mainly to compare their temperature）, imagine a sphere in the 2.73K heat ocean of a same volume V_1 and a same surface area S_1 as shown in Figure 4 (b),

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

$$S_1' = S_1 = 4pR_1'^2 = 1.13\times10^{10}\text{m}^2, \quad (13)$$

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 just 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

$$P_{in}' = sT^4 4pR_1'^2 = 3.15\times10^{-6}\times1.13\times10^{10} = 3.56\times10^4\text{J/s}. \quad (15)$$

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

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

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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 also **a typical process of spontaneous heat transfer from an extremely low temperature region (at 2.73K) to an extremely high latent temperature region (the black hole)**. Such a unidirectional process is apparently in contradiction to the Clausius statement of the second law of thermodynamics.

Black holes are natural demons in the universe.

Numerous and numerous such black holes in all the millions over millions of galaxies ceaselessly absorb a very great general amount of thermal radiation from the vast 2.73K heat ocean throughout their individual extremely long, long lifetimes. That is a great process of energy collection, also a great entropy reducing process.

3.3.2. The Central Black Hole of a Galaxy

Such a black hole usually has approximately a mass of about 10^{10} times of the mass of M_1 (actually may be much greater or much smaller), 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 of event horizon 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,

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

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 energy absorbed by M_2 in each second is

$$N_2 = P_{2\text{in}} / U_1' = 3.56\times10^{24}\,\text{J} / 4.75\text{J} = 7.50\times10^{23} \quad (23)$$

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

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

As all these above mentioned two kinds of black holes unite step by step (together with all the other celestial bodies in all 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 2.73K heat ocean in their individual long, long lifetimes to enter the central black hole.

3.3.3. The Central Black Hole of the Universe

The central black hole contains all the real matter of the whole universe, having an extraordinarily immense amount of mass. Its radius of event horizon is proportional to its mass. The area of its Schwarzschild sphere is proportional to the square of its radius. Hence, it has an extraordinarily immense spherical area. It will absorb the 2.73K thermal radiation from the extremely vast 2.73K 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 great. **The internal energy of the central black hole will rise extraordinarily fast, 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 to 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, extremely quickly and monotonically. **The interior matter should undergo a series of endothermic changes.** By the end of all these endothermic changes, the energy possessed

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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**, **very 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 followed by a big assemble forms a big cycle. [26–32]

4. Conclusion: A New Theoretical System 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, challenging the traditional second law of thermodynamics sharply and profoundly.

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

Hence, the old theoretical system of thermodynamics needs to be reformed. We put forward **a new theoretical system for thermodynamics** as follows, with the first law keeps unchanged, and the second law changes considerably.

(1) The first law of thermodynamics is energy conservation.

Energy is conserved in amount, 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. The black holes are natural demons in the universe. Entropy can either increase or decrease. In a big cycle, the increase and decrease of entropy match each other.

The new theoretical system of thermodynamics is obviously different from the old one, especially about the second law.

Nevertheless, the traditional second law of thermodynamics should not thus be discarded totally. 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 when the speed of an object is very high, approaching the speed of light. 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, covering an extremely wide scope. Almost all the practical thermodynamical processes are irreversible, and entropy can only increase, never decrease.

About Entropy

Like energy, entropy is also a real equivalent quantity in physics. It has many different forms, for examples, heat temperature quotient entropy, volume expanding entropy, phase change entropy, chemical entropy, and so on. They are equivalent each other.

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Entropy is conserved in all reversible processes. This may be regarded as a thermodynamical theorem. The theorem provides a way to find the credible and accurate equivalent relations between the different forms of entropy. A certain amount of entropy in one form can convert through a reversible process to any other form of entropy, obviously, the two quantities of entropies are equivalent each other.

However, unlike energy that keeps its amount unchanged where ever and whenever, entropy tends to increase spontaneously in numerous and numerous ordinary processes that we meet in our life, work and ordinary researches. The behaviors of energy and entropy are very differen.

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 process, the experiment of thermal electrons in a magnetic field, results in some very tiny decrease of entropy, forming a very tiny cycle of energy in the macroscopic world. Although it is a very tiny process, its output current is already a macroscopic direct current. Such a peculiar and interesting experiment challenges sharply and profoundly the traditional second law of thermodynamics in the macroscopic world.

Some adding words

(1) The universe is extraordinary immense and mysterious. There are so many, many things in the universe still keep totally unknown and mysterious to mankind. This article just provides a tentative thermodynamical exploration of the big 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 does not release any energy to its exterior. It 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.

Some people might argue that, according to Bekenstein, the "area entropy" of the event horizon of a black hole should increase when it takes in the 2.73K thermal radiation from the 2.73K heat ocean, 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 a wrong idea. Actually, there are several other serious 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 pdf file of this article cannot demonstrate our experiment video of the tube FX8-24. The readers who are interested in the experiment video can find it through the Reference [15] of this article, or directly to preprints 109425.

Appendix A

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 extraordinary immense stable 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 of the decoupled fire ball, 3.8×10^5 years after the big bang. From the decoupled thermal radiation to the present 2.73K background radiation, there was an "adiabatic expansion" of an extremely long duration. They believe further that the 2.73K microwave background radiation is now still expanding "adiabatically".

We have explained above that their idea of the "adiabatic expansion" is not correct, the actual process should be a free ejection. When the decouple happened, the fire ball became transparent. All the thermal radiation (i.e., all the photons) in the fireball got free, immediately started to fly off in all

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the directions at the speed of light to the exterior extremely vast cosmic space, and traveled straight forward farther and farther. Obviously, it was just a free ejection, not an "adiabatic expansion".

Now, let us show 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, 3.8×10^5 years after the big bang. Its radius is approximately oa ≈ 10^{22} m = 5×10^5 light years, with a volume approximately equal to the Milky way, filled up with plasma at a high temperature of 3000K. Hence, the general thermal energy of the decoupled fireball is extraordinary great!

Let us see how the thermal radiation flied freely to the infinitively vast space.

5×10^6 years later, all the thermal radiation from point o arrived at the spherical surface of the radius of oo' = 5×10^6 light years (we take oo' = 10 oa), as shown in Figure 1. And **in the direction of oo'.** 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 radiation in the direction of oo' from all the points of the decoupled fire ball aob (i.e., ab) now reached the corresponding points of an equal ball a'o'b', which lay in the spherical layer a'b'. Obviously a'b' = 10^6 light years.

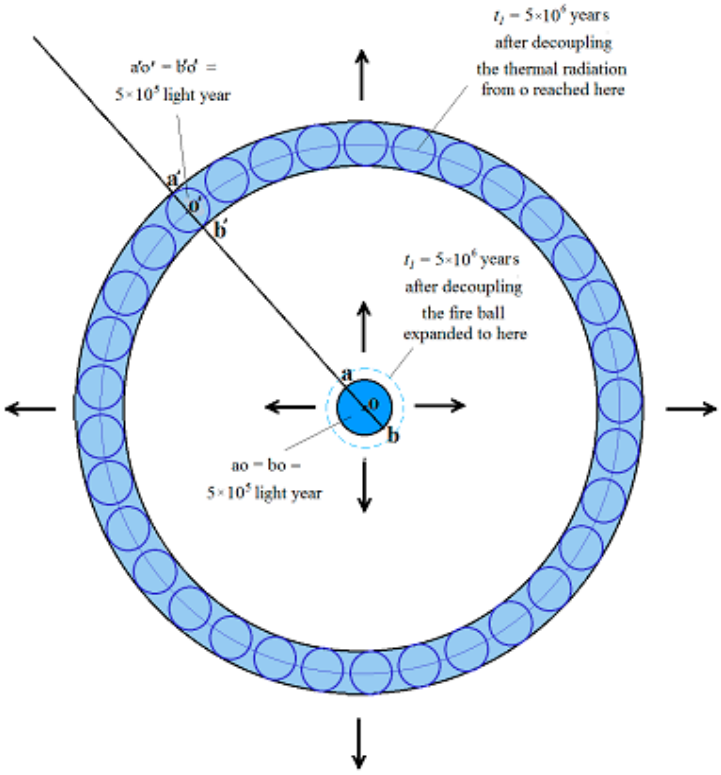

Figure 1. The radius of the decoupled fire ball was about ao ≈ 5×10^5 light years, 380,000 years after the big bang. The diameter is ab ≈ 10^6 light years. Once decoupled, all the thermal radiation within the whole decoupled fire ball aob began to fly off at the speed of light to leave it in all the directions. 5×10^6 years later, the radiation 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' ≈ 10^6 light years'. And all the thermal radiation from the decoupled fire ball in all the directions in the 4p solid angle all reached the spherical layer a'b' with a width of a'b' = 10^6 light years, the big blue spherical layer in this figure.

And all the thermal radiation ejected from the decoupled fireball ab **in all the different directions** in the 4p solid angle now all reached points within the whole spherical layer a'b', as shown

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in Figure 1. The thickness of the spherical layer a′b′ equals the diameter of the original small ball ab, and all the thermal radiation from the decoupled fire ball reached the spherical layer a′b′

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

Then, 5 ×10^7 years after the decouple, all the thermal radiation from point o arrived at the spherical surface of the radius of oo'' = 5 ×10^7 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 radiation from point o reached point o'', the thermal radiation from point b reached point b''. All the thermal radiation 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''.

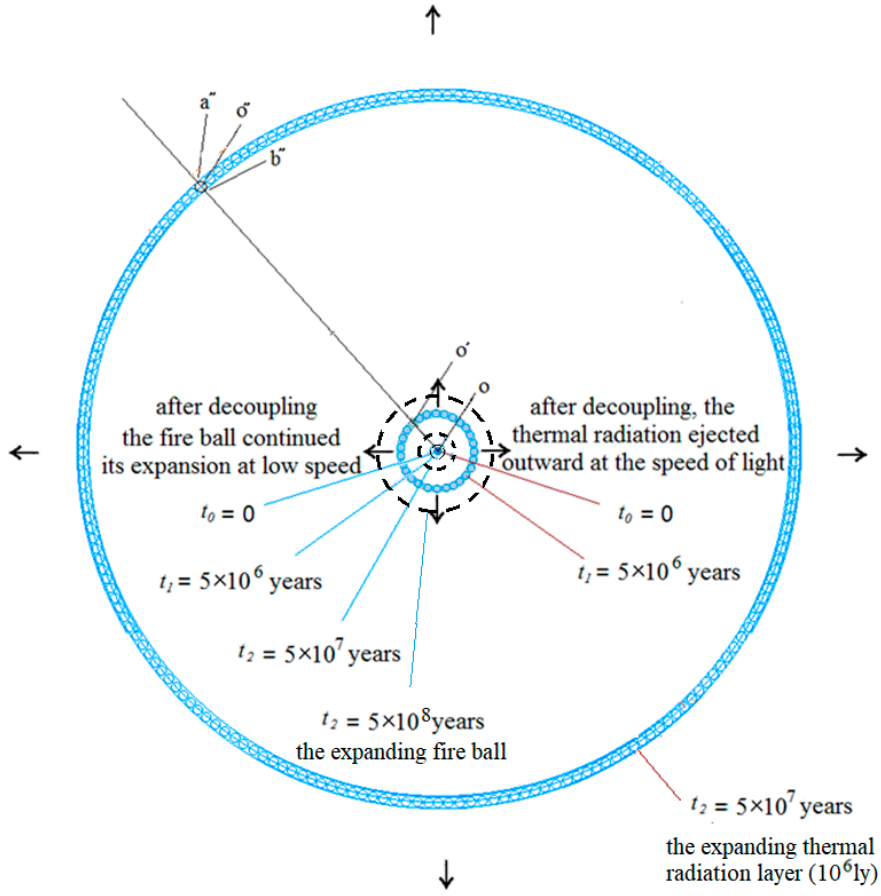

Figure 2. 5 ×10^7 years after the decoupling, in the direction of oo'', the radiation from o reached point o'',and the radiation from a reached a'', the radiation from b reached b''. The radiation from all the points of the decoupling ball aob reached the corresponding points of ball a''o''b'', laying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

And, all the thermal radiation from all the points of the decoupled fire ball (the small ball aob) **in all the different directions** in the 4p solid angle now all reached the points within the whole spherical layer a'' b''. We have,

$$a'' b'' = a'b' = ab = 10^6 \text{ light years} \quad (2)$$

Similarly, 5 ×10^8 years later，all the radiation from the whole decoupled fire ball at $t = 3.8\times10^5$ years and **in all the different directions** in the 4p solid angle, all reached the correspondent points within the whole spherical layer a'''b''', obviously,

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

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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,

… = a''''b'''' = a'''b''' = a''b'' = a'b' = ab = 10^6 light years （4）

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'''', 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. And, 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, long relaxation time, by interactions (exchange heat) with the cosmic atoms, molecules, dusts or rocks (these matters are all at 2.73K) and so on in the metagalaxy region, all the thermal radiation from the decoupled fire ball will eventually mingle into the 2.73K heat ocean. The 2.73K heat ocean 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. In other words, it was not produced by the big bang. It itself is just an extremely immense intrinsic 3K vast heat ocean in the closed universe. It is rather stable. **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 $t_2 = 3.8\times10^5$ years. Now we make it up as follows.

Please have a look at Figure 3.

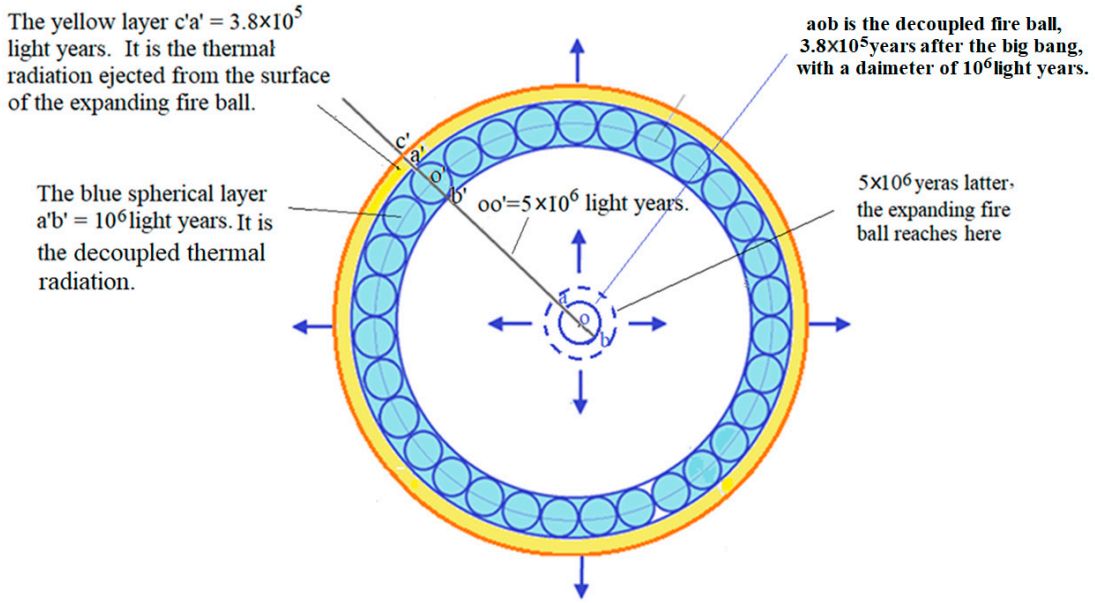

Figure 3. Another spherical layer with a width of c'a' = 380,000 light years (shown as a "yellow" one in the figure) just out the spherical layer of 10^6 light years (the "blue" ones a'b', a''b'', a'''b''', ……).

After the big bang, the expanding fireball was initially at an extremely high temperature.

The temperature descended very rapidly as it expanded very fast. In this process, the whole interior of the fireball was still 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 out the fireball. Nevertheless, in this duration, the surface of the expanding fire ball was plasma at a

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lower but still very high temperature. As the surface is exposed to the outer space, it should emit thermal radiation ceaselessly, until the time of $t_2 = 3.8\times10^5$ years.

Let us make a compare: as is well known, the temperature at the central part of the sun is about 15,000K, and the temperature at the surface of the sun is about 6,000K. So, the interior thermal radiation of the sun cannot fly off the sun, because the interior plasma is totally opaque for the interior thermal radiation. Only the surface of the sun, which is exposed to the exterior space, would eject light and heat ceaselessly. And the temperature of the emitted light and heat of the sun 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 extremely high. The surface kept being plasma in this duration until the decouple happened, and it was exposed to the vast exterior space in the duration. Like the surface of the sun, the surface of the expanding primitive fire ball, exposed to the exterior space, should eject thermal radiation continuously from $t_1 = 0$ to $t_2 = 3.8\times10^5$ years. Hence, just out the expanding spherical layer with a width of ab = 10^6 light years (the expanding "blue" spherical layer as shown in Figure 1 and Figure 2), i.e.,

…… a''''b'''' = a'''b''' = a'''b''' = a''b'' = a'b' = ab = 10^6 light years, （5）

there is another spherical layer of a width of 3.8×10^5 light years, the "yellow" one spherical layer in Figure 3.

…… c''''a'''' c'''a''' = c'''a''' = c''a'' = c′a′= 3.8×10^5 light years （6）

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, the yellow one progressed ahead. The blue one follows.

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" thermal radiation should mingle into the stable immense 2.73K heat ocean, that is their final destination.

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