On the Fundamental Particles and Reactions of Nature

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Abstract: There are unsolved problems related to inflation, gravity, dark matter, dark energy, missing antimatter, and the birth of the universe. Some of them can be better answered by assuming the existence of aether and hypoatoms. Both were created during the inflation in the very early universe. While aether forms vacuum, hypoatoms, composed of both matter and antimatter and believed to be neutrinos, form all observable matter. In vacuum, aether exists between the particle-antiparticle dark matter form and the dark energy form in a dynamic equilibrium: A + $\overline{A} \rightleftharpoons \gamma + \gamma$. The same reaction stabilizes hypoatoms and generates a 3-dimensional sink flow of aether that causes gravity. Based on the hypoatom structure, the singularity does not exist inside a black hole; the core of the black hole is a hypoatom star or neutrino star. By gaining enough mass, ca. $3 \times 10^{22} M_{\odot}$, to exceed neutrino degeneracy pressure, the black hole collapses or annihilates into the singularity, thus turning itself into a white hole or a Big Bang. The universe is anisotropic and nonhomogeneous. Its center, or where the Big Bang happened, is at about 0.671 times the radius of the observable universe at the Galactic coordinates $(l, b) \sim (286^\circ, -42^\circ)$. If we look from the Earth to the center of the universe, the universe is rotating clockwise.

Keywords: aether, hypoatom, neutrino, inflation, gravity, negative pressure, dark energy, dark matter, black hole, quantum mechanics, matter-antimatter asymmetry, baryogenesis-through-leptogenesis, fabric of space, center of the universe, fate of the universe, general theory of relativity

For the Schwarzschild metric:

v

$$ds^{2} = -\left(1 - \frac{2GM}{rc^{2}}\right)c^{2}dt^{2} + \left(1 - \frac{2GM}{rc^{2}}\right)^{-1}dr^{2} + r^{2}d\Omega^{2}$$
(1)

if we define speed

$$=\sqrt{2GM/r}\tag{2}$$

we have

(c) (i)

$$ds^{2} = -\left(1 - \frac{v^{2}}{c^{2}}\right)c^{2}dt^{2} + \left(1 - \frac{v^{2}}{c^{2}}\right)^{-1}dr^{2} + r^{2}d\Omega^{2}$$
(3)

on the right of which, the first term shows the time dilation effect, and the second term shows the length contraction effect. This unequivocally indicates that the stationary objects in a gravitational field are in motion. The length contraction effect in equation (3) even says that the direction of motion is radial and the speed v of motion is equal to the escape speed $v_{\rm esc} = \sqrt{2GM/r}$. Since motion is always relative to a frame of reference, we can make the stationary objects move by finding the reference frame that is moving in the

gravitational field. We therefore believe that there exist fundamental particles. Einstein once stated¹: "according to the general theory of relativity, space without aether is unthinkable." We then use the term aether to name the fundamental particles.

Creation of fundamental particles. To know what aether could be, we start with the idea of the inflation that was proposed to resolve the horizon, flatness, and magnetic monopole problems². Although the physical mechanism underlying inflation is still uncertain, it is often believed to be the result of a scalar field rolling down from the false vacuum to the true vacuum^{3,4}. We study the inflation by proposing the following reactions in the very early universe:

$$E \to A + \overline{A}$$
 (I)

$$iA + i\overline{A} \to E \ (i \in \mathbb{N}, \ i < n)$$
 (II)

$$nA + nA \rightarrow \gamma + \gamma$$
 (III)

$$\begin{array}{l} \gamma + \gamma \longrightarrow B + B \\ B + \overline{B} \longrightarrow \gamma + \gamma \end{array} \tag{IV}$$

$$B + B \rightarrow \gamma + \gamma \tag{V}$$

$$B + n\overline{A} \rightarrow \gamma + \gamma \tag{VI}$$

$$\mathbf{B} + n\mathbf{A} \to \gamma + \gamma \tag{V1}$$

 $\overline{\mathbf{B}} + n\mathbf{A} \to \gamma + \gamma \tag{VII}$

Reaction (I) was the first phase transition in the universe, converting the pure energy (E) of the singularity universe into the particles (A) and antiparticles (\overline{A}) that are aether (Fig. 1). This reaction fits in the current inflation theory well. As will be discussed below, the energy of the singularity can be regarded as photons whose wavelength is asymptote to zero. Therefore, the singularity universe was a false vacuum. As its energy was converted into aether particles, the universe became a true vacuum. According to Einstein's mass-energy equivalence principle, matter and antimatter pairs are the only possible products from energy. As Planck taught us that energy is quantized, what the supercooled universe could first create could only be the most fundamental quanta, even though it had sufficient energy to create any complicated particles. The fundamental aether particles A and \overline{A} settled at the lowest mass and in the smallest size with the highest stability possible for them to survive in the hot and dense primeval universe. As the reaction finished, the universe became a globe of aether particles A and \overline{A} ; the volume of the universe increased exponentially. As the energy of the universe was used up, the temperature of the universe dropped significantly, and the inflation ended naturally.

Right after the creation, aether particles A and \overline{A} were annihilated, raising the temperature of the universe back to what the adiabatic standard cosmology describes (Fig. 1). This is known as the reheating process. In this work, we postulate: *annihilation only happens if an equal amount of matter and antimatter particles are in contact with each other*. Therefore, numerous annihilations initiated simultaneously across the globe of the universe, competing for the remaining aether particles A and \overline{A} , and finished together when there were no more A and \overline{A} left in contact. While a pair or a small number (i < n) of pairs of A and \overline{A} particles were annihilated to energy (reaction II) due to the wavelengths of products being larger than the size of the universe at that moment, *n* pairs of aether particles were annihilated to produce photons with a wavelength the size of the universe (reaction III). It is reaction (III) that allowed the universe to deviate from energy and create more complicated particles (discussed below). Of course, the annihilations were impossible to be 100% complete. Some aether particles were left along and therefore survived.

The formed photons then collided to create particles B and antiparticles \overline{B} (Fig.1) by the Breit-Wheeler pair production process (reaction IV). This phase transition has been regarded as the second episode of inflation^{5,6}, though the universe would not experience a significant change of volume as it was already large. Immediately followed were three possible annihilations to reheat the universe: 1) B and \overline{B} (reaction V); 2) $n \overline{A}$'s with a B (reaction VI, the total amount of matter must be equal to that of antimatter: $n\varepsilon_{\overline{A}} = \varepsilon_{\overline{B}}$); and 3) n A's with a \overline{B} (reaction VII, $n\varepsilon_A = \varepsilon_{\overline{B}}$). Because the primeval universe was dense enough to allow multiple \overline{A} 's to contact with a B simultaneously and multiple A's to contact with a \overline{B} simultaneously for annihilation, both reactions (VI) and (VII) were possible, but their reaction rates did not have to be equal.

Although the reaction parameters are difficult to know, these proposed reactions provide a possible mechanism of the inflation and reheating. More importantly, it is the products of these reactions that formed the observable universe.

Fabric of space. Aether particles, as the fundamental units, formed vacuum⁷, or the fabric of space (Fig. 2). Since they are undetectable dark matter, the nature of interparticle interaction is unknown. However, it is safe to assume that their pairs are bosons and the interaction between A and \overline{A} is attractive. As it has expanded for a long time after the Big Bang, the universe cooled down to a temperature of 2.7 K. Aether particles are much lighter than atoms, corresponding to a much higher transition temperature⁸, so the fabric of space has already become a Bose-Einstein condensate (BEC).

An atomic BEC could become unstable and make particles clump together⁸, if the interparticle interaction is attractive. The fabric of space is different. Once a pair of A and \overline{A} attract to clump or contact, the following annihilation happens:

$$+ \overline{A} \rightleftharpoons \gamma + \gamma \tag{VIII}$$

Since aether is the lightest particle in the universe, the generated photons are dark photons, having an ultralong wavelength, say, a light year. For reference, a reported mass⁹, 8.1×10^{-23} eV, as well as other ultralight dark matter, could be a candidate of aether. The photons can penetrate across the universe, or trigger the further annihilation of other aether particles to form photons with higher energy. All these reactions are in nature the same as reaction (II); the products here are photons under the Planck distribution, which appear as the vacuum energy or dark energy. This process can be reversed to create aether particles A and \overline{A} (represented as the reverse of reaction VIII).

Due to reaction (VIII), as well as the induced collective oscillations of aether particles, the velocity of a specific aether particle in the fabric of space, as Dirac has foreseen, can no longer be well defined¹⁰. Absolute vacuum, or the pure fabric of space, is a dynamic equilibrium system, with an equal rate of annihilation and creation of aether particles:

$$R_{\rm a} = R_{\rm c} \tag{4}$$

Note that the rate R_a of the annihilation is controlled by the local concentration of aether particles, while the rate R_c of the creation is determined by the energy density of the whole fabric of space, i.e. the dark energy density.

Hypoatoms. The \overline{B} particles that survived from the reactions in the early universe *recombined* with aether particles A to form a species $\overline{B}A_n$:

$$\overline{\mathbf{B}} + n\mathbf{A} \to \overline{\mathbf{B}}\mathbf{A}_n \tag{IX}$$

With the structure of an atom in mind, we believe that the \overline{B} is a nucleus and that n A's surround the \overline{B} (Fig. 2). We call $\overline{B}A_n$ a hypoatom. Note that this name does not mean that hypoatoms have the same structure as atoms. According to the particle-in-a-box model: $E_n = \frac{n^2 h^2}{8ml^2}$, $n \in N$, a hypoatom cannot exist as an atom, because it is impossible for the size l of a hypoatom to be much smaller than that of an atom, while the mass m and energy E_n of an aether particle are much smaller than those of an electron. Therefore, unlike the electron in an atom, the aether particle is not a standing wave in a hypoatom.

Instead, there exists a reaction on hypoatoms. An aether antiparticle \overline{A} oscillating with the dark energy in the fabric of space annihilates with one of the *n* aether particles A of a hypoatom $\overline{B}A_n$ (step 1, Fig. 2):

$$\overline{\overline{B}}A_n + \overline{A} \to [\overline{B}A_{n-1}] + \gamma + \gamma \tag{X}$$

The vacancy left in the hypoatom will then be filled by a particle A from the fabric of space (step 2, Fig. 2):

$$[\overline{B}A_{n-1}] + A \to \overline{B}A_n \tag{XI}$$

Therefore, hypoatoms $\overline{B}A_n$ constantly consume the aether particles in the fabric of space: $A + \overline{A} \rightarrow \gamma + \gamma$ (XII)

which is the forward of reaction (VIII), and, in nature, reaction (II). With that, the aether in a hypoatom can be regarded as a standing wave with an ultralong wavelength; hypoatoms are stabilized.

Similarly, the survived B particles recombined with aether particles \overline{A} to form an antihypoatom $\overline{BA_n}$:

$$\mathbf{B} + n\overline{\mathbf{A}} \to \mathbf{B}\overline{\mathbf{A}}_n \tag{XIII}$$

Like hypoatoms, antihypoatoms also exist stably in a dynamic equilibrium with the fabric of space. For simplicity, antihypoatoms \overline{BA}_n , the antimatter counterpart of hypoatoms \overline{BA}_n , will not be separately discussed in this work unless necessary.

Dark energy. Based on reaction (VIII), though the interaction between A and \overline{A} is attractive, the effective interaction⁸ is repulsive, and hence, the fabric of space is a stable system. Compared to the momenta of the oscillations under the dark energy, the mass of an A or \overline{A} is negligible: $m_A \ll q\hbar/c$, therefore the Bogoliubov dispersion relation is simplified¹¹:

$$= qc \tag{5}$$

where q, \hbar , c, ω are wave vector, reduced Planck constant, speed of light, and angular frequency, respectively. Based on the Planck distribution, almost all of the oscillations occupy the ground state:

ω

$$\epsilon_0 = \frac{1}{2}\hbar\omega \tag{6}$$

Since the density of states is: $g(\omega) = Vq^2/2\pi^2 c$, by summing up all frequencies from reactions (II) and (III), we have the dark energy density:

$$\varepsilon_{\rm vac} = \frac{1}{V} \int_0^{\omega_{\rm A,\,m}} g(\omega) \epsilon_0 d\omega = \frac{\hbar \omega_{\rm A,\,m}^4}{16\pi^2 c^3} \tag{7}$$

where $\omega_{A, m}$ is the maximum angular frequency. As aether particles are oscillating in equilibrium with hypoatoms:

$$\hbar^2 \omega_{\text{A, m}}^2 = m_{\overline{\text{B}}\text{A}_n}^2 c^4 + q_{\overline{\text{B}}\text{A}_n}^2 c^2 \hbar^2 \gtrsim m_{\overline{\text{B}}\text{A}_n}^2 c^4$$
(8)

the dark energy density is

$$\varepsilon_{\rm vac} \gtrsim \frac{m_{\rm BAn}^4 c^5}{16\pi^2 \hbar^3} \tag{9}$$

According to the Planck 2018 results¹², Hubble constant $H_0 = 67.66 \pm 0.42 \text{ km s}^{-1}\text{Mpc}^{-1}$, the density parameter for dark energy $\Omega_{\Lambda} = 0.6889 \pm 0.0056$, so the dark energy density is $5.92 \times 10^{-27} \text{ kg/m}^3$. Therefore, the upper limit of the mass of the hypoatom is ca. 8 meV. This mass is close to that of a neutrino.

An earlier inflation. Although a wider range was proposed¹³, the inflation is generally assumed in the context of the Grand Unified Theory $(GUT)^{2-4, 14}$. However, based on the following factors: a) reaction (I) converted the pure energy of the singularity into aether particles A and \overline{A} ; b) aether particles A and \overline{A} are not included in the GUT; c) it is widely accepted that gravity begins to differentiate from the other three forces at the Planck time (discussed below), there should have been an inflation that started as early as the Planck time if not earlier (Table 1).

At the Planck time, 5.4×10^{-44} sec, the energy density of the false vacuum was 1.2×10^{19} GeV, equivalent to the mass density of $\rho_f = 5.2 \times 10^{96}$ kg/cm³. The inflation started at a patch size of the Planck length, $l_{\rm Pl} = 1.6 \times 10^{-35}$ m. From the first-order Friedman equation: $\left(\frac{a}{a}\right)^2 = \frac{8\pi G \rho_f}{3}$, we have the size of the universe exponentially increase

in the function of $a = \text{Constant} \cdot \exp(\chi t)$, where $\chi = \sqrt{\frac{8\pi G\rho_f}{3}} = \sqrt{\frac{8\pi c^5}{3\hbar G}} = 5.4 \times 10^{43} \text{ sec}^{-1}$. The universe after the first episode of the inflation and reheating (reactions I ~ III) would at least be as large as one half the wavelength of the B particle:

$$a \approx \lambda_{\rm B}/2 = \frac{hc}{E_{\rm BA_n}} \gtrsim \frac{hc}{8 \,{\rm meV}} = 0.16 \,{\rm mm}$$
 (10)

Thus the size of the present universe:

$$a_0 \gtrsim \frac{1.2 \times 10^{18} \text{ GeV}}{k_{\text{B}} \times 2.7 \text{ K}} \times 0.16 \text{ mm} = 9.0 \times 10^{10} \text{ light years}$$
(11)

which is in agreement with the inflationary theory¹⁴.

Neutrinos. The next to be created, after aether particles, in the second episode of inflation and reheating were \overline{B} particles (for simplicity, B particles will not be discussed). On the other hand, based on the inflationary theory^{2-6, 13, 14}, at ca. $10^{-34} \sim 10^{-32}$ sec or $10^{15} \sim 10^{14}$ GeV there was supposed to be a phase transition for the formation of a GUT particle (Table 1). To resonantly produce intermediate Z-bosons^{15, 16}:

$$+ \bar{\nu} \rightarrow Z$$
 (XIV)
a a hypotomy $m_{-} = m_{-} \leq 0 \text{ maV}$ then the required

if a neutrino mass eigenstate is a hypoatom: $m_{\nu} = m_{\overline{B}A_n} \leq 8 \text{ meV}$, then the required energy is:

$$E_{\nu} = \frac{M_Z^2}{2m_{\nu}} \gtrsim 5 \times 10^{14} \text{ GeV}$$
(12)

These neutrinos at the GUT energy scale are called ultrahigh-energy (UHE) neutrinos. Therefore, UHE neutrinos and \overline{B} particles were created at the same time. In addition, they both have a unique characteristic property. The neutrino cross section increases with energy^{17, 18}. If we recognize each created \overline{B} particle, with A particles nearby, as an ultralarge hypoatom $\overline{B}A_n$, then when the universe was cooled down, the hypoatom energy decreased with cross section.

This can further be confirmed by the phase transitions that happened in the early universe (Table 1). Up-quarks, down-quarks and electrons were created at ca $10^{-12} \sim 10^{-6}$ sec, nuclei at ca $1 \sim 10^2$ sec, and then nuclei and electrons recombined to form atoms at ca 10^{13} sec. Aether particles were created at ca $10^{-44} \sim 10^{-42}$ sec, and \overline{B} particles at ca $10^{-34} \sim 10^{-32}$ sec. All these time slots are about $10^{10} \sim 10^{11}$ times apart, so if there were a phase transition similar to the recombination of atoms, it would be at the next time slot near 10^{-22} sec or 10^8 GeV (Table 1). However, no stable particles were created in the period of $10^{-32} \sim 10^{-12}$ sec or $10^{14} \sim 10^2$ GeV, which is called the *gauge desert*¹³. This matches our assumption: no recombination process was required to form hypoatoms; hypoatoms are neutrinos. Note that if the Z bosons decayed into photons, reaction (XIV) is equivalent to reaction (V), another agreement of our model with particle physics.

Of course the gauge desert was not truly quiet; various intermediates were formed in this period from the lepton asymmetry to the baryon asymmetry. Although the mechanism has not been fully understood, it is well accepted that flavor matters in this process. First, the third generation Yukawa couplings presented at ca 10^{12} GeV, then decayed into the second generation (ca 10^9 GeV) and finally into the first generation (ca 10^5 GeV)^{19, 20}. This is understandable, because while the cross section reduced with temperature, the stability of hypoatoms that are composed of both matter and antimatter could be challenged. $10^{-32} \sim 10^{-12}$ sec can therefore be considered as the period that nature explored the stable states. Stabilized particles, which are up-quarks, down-quarks and electrons, then formed atoms. Thus our model fits in the baryogenesis-throughleptogenesis theory^{19, 20}.

Stability of hypoatoms. One might wonder how a particle composed of matter and antimatter could be stable. We will therefore discuss the lifetime of hypoatoms before any further discussion.

Known particles closest to hypoatoms $\overline{B}A_n$ are the pseudoscalar mesons that have the same amount of matter and antimatter. Based on Sargent's rule, the lifetime of a type of particle, including mesons, is directly proportional to the reciprocal of the mass to the fifth-power²¹: $\tau \propto 1/m^5$. Fig. 3 plots the lifetimes of the pseudoscalar mesons $q\bar{q}$ composed of symmetric quark q and antiquark \bar{q} versus their masses²². If we extrapolate the line: $\log(\tau/\text{sec}) = -5.2123 - 5.0000 \log(m/\text{GeV})$ to the upper limit of the mass of a hypoatom, then the lifetime of a meson-like particle with the mass of 8 meV will be ca 2×10^{35} sec. Based on our postulate, annihilation only happens if all of the *n*+1 bodies that form a hypoatom contact simultaneously. Even if some of the *n* particles A settle on the particle \overline{B} , annihilation will not happen. Therefore, the lifetime of a hypoatom should be much longer than 2×10^{35} sec, which is projected for a 2-body meson-like particle. For comparison, the theoretical lifetime of an electron²³ is 2.1×10^{36} sec, and that of a proton²⁴ is in the range of $10^{35} \sim 10^{43}$ sec.

It is interesting to note that based on the above calculation, a Majorana neutrino would stably exist in a structure as $[(\overline{B}A_n)(B\overline{A}_n)]$, with an estimated lifetime of ca. 6×10^{33} sec.

Creation strategy: The matching lifetimes are not an accident. While using a type of matter particle and antimatter particle, such as A and \overline{A} , no stable systems would be created, using two types of matter particles and antimatter particles with significantly different

masses, such as A and \overline{B} or \overline{A} and B, stable hypoatoms $\overline{B}A_n$ and antihypoatoms $\overline{B}\overline{A}_n$ would be created. Nature uses this strategy of the asymmetric structure of hypoatoms and antihypoatoms to create this world.

Now we have a sketch of the universe: a) the fabric of space, or vacuum, is formed by aether particles A and \overline{A} and their energy form; b) all observable particles or matter is composed of hypoatoms $\overline{B}A_n$ (neutrinos) and antihypoatoms $\overline{B}\overline{A}_n$ (antineutrinos), the enigma of missing antimatter does not exist!

It is of interest to note from its composition that a hypoatom $\overline{B}A_n$ does *own* the energy that Einstein taught us: $E = m_{\overline{B}A_n}c^2$, and it can be released once annihilated. A typical example is the nuclear energy that is released when some hypoatoms or neutrinos are annihilated in nuclear reactions.

General theory of relativity. In the general theory of relativity, the pure fabric of space is regarded as flat spacetime (equation 4 is valid):

$$ds^{2} = -c^{2}dt^{2} + dr^{2} + r^{2}d\Omega^{2}$$
(13)

Based on our proposed model, the annihilation and creation of aether are in equilibrium (reaction VIII). Therefore, there is no net flow of aether particles (equation 4), and hence, aether has no observable mass in the pure fabric of space.

Now if a massive object is introduced, the rate R_a of annihilation rises dramatically. This annihilation generates a 3-dimensional *sink flow* of aether particles towards the center of the massive object. It is this sink flow that warps the spacetime in the vicinity of the massive object! Because of this flow, the time term of equation (13) needs to be rewritten with the time-dilation expression: $\sqrt{1 - v^2/c^2}dt$ and its radial term with the length-contraction expression: $\frac{dr}{\sqrt{1 - v^2/c^2}}$, while the last term on the right stays correct²⁵. Considering equation (2), we have the Schwarzschild metric (equation 1). To the best of our knowledge, this is the first *derivation* of the general theory of relativity, the greatest law of nature. If the speed of the sink flow is small, the relativistic effect is negligible; we then have Gauss's law or Poisson's equation for gravity: $\nabla^2 \phi = 4\pi G\rho$, equivalent to Newton's law of universal gravitation.

In the above analysis, the creation of aether particles (the reverse of reaction VIII), which reduces the sink flow a bit, has not been considered, because compared to that of the annihilation, the rate of the creation is negligible:

$$R_{\rm a} - R_{\rm c} \approx R_{\rm a} \tag{14}$$

If it is considered, then Einstein's field equation should be written with the addition of the Λ term, and Newton's law is: $\nabla^2 \phi = 4\pi G \rho - \Lambda c^2$.

With the existence of the sink flow, aether particles in the fabric of space are in fact oscillating in *quasi*-equilibrium with hypoatoms (equation 8). It is time to note that this quasi-equilibrium is natural: if the dark energy density were higher, then more aether particles would be annihilated at hypoatoms, equivalent to a higher flowrate of the sink flow, thus resulting in a larger hypoatom mass and vice versa.

Based on the Landau criterion, within the limit of the speed of light (equation 5), the fabric of space is a superfluid⁷. Therefore, the sink flow only generates the curvature of spacetime, but does not pull or push objects directly.

Interestingly, our model does show that the fabric of space has the character of negative pressure that is vital to Einstein's field equation. Think about an adiabatic

cylinder-piston system. When A and \overline{A} are created (the reverse of reaction VIII), the change of internal energy is: $\Delta U = mc^2$, where *m* is the mass of aether particles A and \overline{A} created. The creation of aether particles increases the volume of the system, so the system does work: $W = p\Delta V$. According to the first law of thermodynamics, we have $mc^2 = -p\Delta V$ or $p = -\rho c^2$. When A and \overline{A} are annihilated (the forward of reaction VIII), the character is identical. The negative pressure can also be understood in a different way. Each time when an \overline{A} from the fabric of space annihilates with an aether particle A of a hypoatom (reaction X), the hypoatom temporarily loses, not gains, the momentum of the annihilated aether particle A. Therefore, the hypoatom experiences negative pressure.

Einstein taught us that the curvature of spacetime causes gravity, but did not mention why. Using the character of negative pressure, it is not difficult to understand gravity. For an object m under the curvature of spacetime generated by an object M, the annihilation rate on the side near M is higher than that on the far side. In other words, the force on the near side (pointing towards M) is larger than that on the far side (pointing away from M). Therefore, m experiences an attractive force, which is gravity.

Newton taught us that gravity is universal. Indeed it is, because all matter is made of hypoatoms. For the same reason, gravity cannot be shielded by any objects. The objects in the gravitational field do nothing but result in reaction (XII), further warping spacetime. This is also true for energy, which enhances the annihilation of aether particles and generates gravity, in agreement with the general theory of relativity.

The difficulty of unifying four fundamental forces is well known. Based on our model, gravity, in fact, is a collective property of aether particles in the fabric of space, while the other three forces are just interactions of the interested particles or objects.

Dark matter. For a uniform sphere *M* of radius r_M and density ρ_M , the rate R_a of annihilation can be calculated by the flowrate of the sink flow across the sphere of radius *r*:

$$R_a = 4\pi r^2 v_{\rm esc} \rho_{\rm A} \tag{15}$$

where ρ_A is the density of the aether particles. The rate of annihilation is also proportional to mass:

$$R_a = k(M+A) \tag{16}$$

where A is the mass of the aether particles within the sphere of radius r, and k the proportional constant, then we have

$$dA = \rho_{\rm A} \cdot 4\pi r^2 dr = \left(\frac{k^2}{2G}\right)^{\frac{1}{2}} (M+A)^{\frac{1}{2}} r^{\frac{1}{2}} dr \tag{17}$$

By integration, the mass of aether is

$$A = \left(\frac{2k^2M}{9G}\right)^{\frac{1}{2}} r^{\frac{3}{2}} + \frac{k^2}{18G} r^3$$
(18)

and the density of aether is

$$\rho_{\rm A} = \left(\frac{k^2 M}{32\pi^2 G}\right)^{\frac{1}{2}} r^{-\frac{3}{2}} + \frac{k^2}{24\pi G} \tag{19}$$

The last term on the right is the density at infinite distance $(r \to \infty)$: $\rho_{A,\infty} \equiv \frac{k^2}{24\pi G}$, which is also the density in the pure fabric of space. By subtracting it, the density ρ_D of dark matter is

$$\rho_{\rm D} = \rho_{\rm A} - \rho_{\rm A,\infty} = \left(\rho_{\rm M}\rho_{\rm A,\infty}\right)^{\frac{1}{2}} \left(\frac{r_{\rm M}}{r}\right)^{\frac{3}{2}}$$
(20)

The mass D of dark matter in the vicinity of M is

$$D = 2\left(\frac{4}{3}\pi r^3 \rho_{A,\infty} M\right)^{\frac{1}{2}}$$
(21)

which is divergent. This indicates that all the halos in the universe are overlapping, which is correct as gravity is infinite.

To estimate the amount of dark matter, we need to choose a cutoff radius. From $-\frac{GM}{r} + \frac{1}{6}\Lambda c^2 r^2 = 0$, where $\Lambda = 8\pi G \rho_{\rm vac}/c^2$, and $\rho_{\rm vac}$ is the density of dark energy, we have

$$r_{\text{cut-off}}^3 = \frac{6GM}{\Lambda c^2} = \frac{M}{\frac{4}{3}\pi\rho_{\text{vac}}}$$
(22)

The mass of dark matter in the vicinity of M, at least, is

$$D_{\min} = 2 \left(\frac{\rho_{A,\infty}}{\rho_{\text{vac}}}\right)^{\frac{1}{2}} M \tag{23}$$

The most important piece of information here is that every massive object in the universe has a dark matter halo whose mass is proportional to its own mass. Because the ratio $\rho_{\text{vac}}/\rho_{A,\infty}$ or the equilibrium constant of reaction (VIII) is unknown, we cannot compare D_{\min}/M with the ratio of dark matter to ordinary matter from cosmological observation. Given the fact that most popular stellar systems are galaxies composed of stars, this proportional relation allows us to estimate the mass of the dark matter halo for a galaxy by simply summing up all the masses in the galaxy. Because stars are distributed in the galaxy, the density will reduce along the radial direction a little slower than that of an isolated object ($r^{-1.5}$, equation 20). For comparison, a profile²⁶ of dark matter obtained from cosmological *N*-body simulations has an asymptotic slope of $r^{-1.4}$. Therefore, aether is a major contributor to dark matter.

It is of interest to note that as the universe expands, the mass ratio of dark matter to ordinary matter almost stays the same (equations 21 and 23), while the mass ratio of dark energy to matter increases with the expansion because the density of dark energy is a constant. This is in agreement with the results of cosmological observation.

Quantum mechanics. Based on our model, quantum mechanics can be understood relatively easily. Here are a couple of examples. Because all particles are in the fabric of space and the fabric of space is a constantly oscillating dynamic system, the wave-particle duality is natural. The zero-point vibration of aether particles (equation 6) is equivalent to Heisenberg's uncertainty principle. In theory, particles heavier than aether could be created by multiple ultralong-wavelength photons. Of course, the heavier the particles, the lower the chance of creation, corresponding to a shorter lifetime in the quantum field theory. The wave function of a particle from the Schrodinger equation is the superposition of wave vectors from the local interactions and the creation and annihilation of aether particles in the fabric of space, not a property of only the interested particle itself. This is why Lorentz invariance is violated for Schrodinger's wave functions. For the double-slit interference experiment, the interference pattern of electrons (or photons) is obtained because the oscillation of the local fabric of space is interfered by the slits. When they are *observed*, the light of observation overwrites the interference pattern no longer exists.

Another unsolved problem is the conflict between the general theory of relativity and quantum mechanics. For a massive object, as the size goes down, for example, to the Schwarzschild radius, quantum effects from the dynamic fabric of space become negligible. Therefore, the general theory of relativity and quantum mechanics are compatible.

Black hole. The most condensed star observed is a neutron star. If its mass further increases, it will collapse into a black hole. Within a black hole, it is generally believed to form a singularity. However, based on the proposed hypoatom structure, hypoatom degeneracy pressure can provide new support to prevent the collapse. In other words, the core of a black hole within the event horizon is indeed a hypoatom star or a neutrino star.

Outside its event horizon, a rotating black hole usually has an accretion disk perpendicular to the axis of rotation. As we have known, the accretion plane is the primary direction that matter falls into the black hole. Although we do not exactly know the physical law inside the event horizon, it is reasonable to assume that matter from the accretion disk continues to fall into the *naked* core of the black hole in a spiral flow V_{spiral} , as Penrose²⁷ depicted. Fig. 4 illustrates the structure of a black hole. As the falling fabric of space passes through the event horizon, the photons from the annihilation of aether can no longer escape. The dark energy density inside the event horizon is thus increased; there naturally exists a fireball. This annihilation process would easily become a nonlinear system, leading to pulsations or the so-called quasi-periodic oscillation²⁸.

The raised dark energy density breaks the equilibrium with hypoatoms (equation 8). Therefore, it initiates reaction (IV), creating B particles or, in consequence, hypoatoms. Together with the falling matter, if it exists, this process makes the mass of the hypoatom star increase or the black hole grow. The creation of hypoatoms or neutrinos would be the primary ability of black holes in the evolution of nature. This mechanism to create hypoatoms within black holes is identical to the particle creation mechanism in the early universe, i.e. reactions (III) ~ (VII).

At the Big Bang, the universe was only able to convert part of its energy into matter by zigzagging inflation and reheating processes (reactions I ~ VII, IX and XIII). Therefore, it is reasonable to assume that in a much milder process on the course of the growth of black holes, not all aether falling into black holes is immediately converted into hypoatoms and immobilized at the core. The energy that is not immobilized temporarily escapes from the core as an emission beam V_{beam} along the magnetic axis of the core (Fig. 4). This scene of a neutrino star inside a black hole is very similar to that of a pulsar. Of course nothing would be able to escape beyond the event horizon; everything falls back to the core for further conversion and immobilization.

Birth of the universe. Analogous to the Tolman-Oppenheimer-Volkoff limit for neutron stars, we can estimate a mass limit for a neutrino star or a black hole:

$$M \approx \left(\frac{m_{\rm n}}{m_{\rm v}}\right)^2 M_{\rm n} \gtrsim \left(\frac{939.6 \,\mathrm{MeV}}{8 \,\mathrm{meV}}\right)^2 \times 2.2 M_{\odot} = 3 \times 10^{22} M_{\odot} \tag{24}$$

where m_n is the mass of a neutron, m_v the mass of a neutrino, M_n the mass limit of a neutron star, and M_{\odot} the mass of the sun. Without considering a potential addition due to the rotation of the black hole, this mass limit is very close to the accepted mass of the observable universe, ca. $10^{23}M_{\odot}$. If the mass of a black hole exceeds this limit, the structure of the hypoatoms cannot withhold and thus the black hole or neutrino star

collapses. In result, all particles annihilate to become the pure energy that is named as a singularity, in which the wavelength of photons is asymptote to zero. Thus the black hole turns into a white hole, producing the Big Bang (Fig. 5).

The lowest cross section of neutrinos experimentally measured²⁹ is about 10^{-56} cm². the density of If we use it to estimate the hypoatoms: $\rho_{\nu} =$ $5 \text{ meV}/(10^{-30} \text{ m})^3 \sim 10^{52} \text{ kg}/m^3$, then the minimum size of the cores of black holes right before the collapse can be estimated: $a \sim \sqrt[3]{M/\rho_{\nu}} \gtrsim \sqrt[3]{3 \times 10^{22} M_{\odot}/10^{52}} = 2 \text{ m}.$ This collapse before the Big Bang can almost be regarded as the reverse process of the inflation after the Big Bang (Fig. 5).

Interestingly, the first episode of the inflation (reaction I) was a process to create, not consume, aether particles A and \overline{A} . Therefore, the gravity during the inflation appeared as a repulsive force! Although producing an attractive gravity later on, A and \overline{A} in the inflation were a repulsive-gravity material. Based on earlier discussion, this process did produce negative pressure. This mechanism is in agreement with the inflationary theory¹⁴. On the other hand, gravity indeed is the first force separated with the GUT force or from the universal forces, because once reaction (I) occurred, gravity existed. While they formed the matter of the universe, created B particles reduced the gravity of the universe, such that the universe would not collapse back to a black hole.

Where we are. Based on our model, right before the Big Bang, the precursor black hole of our universe, a hypoatom star or neutrino star, collapsed into a singularity that can be regarded as photons whose wavelength is asymptote to zero. The singularity then turned into a white hole, emitting matter and energy at the speed of light or higher, which is the Big Bang. We have known that before the collapse, besides the falling fabric of space, there existed two major flows around the core of the precursor black hole: one was the falling spiral flow V_{spiral} , the other was the outgoing emission beam V_{beam} (Fig. 4). Both flows are essential for the precursor neutrino star to grow and reach the mass limit for the Big Bang at ca. $10^{-34} \sim 10^{-32}$ sec before the Big Bang (Fig. 5). Although their generations would be interrupted during the emitting moments, both flows still existed after the Big Bang, due to the momenta they had. The flows would certainly interact with the powerful expansion waves V_{BB} of the Big Bang (Fig. 6).

Because V_{spiral} was perpendicular to V_{BB} , the two flows collided, resulting in a hot disk in the infant universe, even though the momentum of the spiral flow P_{spiral} was small compared to that of the Big Bang flow P_{BB} . The hot disk intersected with the surface of last scattering generating a hot ring in the cosmic microwave background (CMB). This hot ring is also very noticeable in the CMB (Figs. 6a and 6b), which is sometimes known as the *Axis of Evil*. The hot ring is very thick, with an open angle as large as ca. 30° in the CMB, but is not always continuous, which is reasonable as it was from the spiral flow V_{spiral} . We chose its strongest points in the middle of the ring, labelled as 1 to 9, for the following studies. If we change the Galactic coordinates into the x-y-z coordinates, then the bestfitting hot disk plane is:

 $z = -0.5793x + 0.0277y - 0.3594r_{\text{CMB}}$ (25)

where r_{CMB} is the radius of the CMB or the radius of the surface of last scattering.

Because V_{beam} had the same direction as V_{BB} , compared to regions with the falling fabric of space, less collisions happened, leading to a lower temperature where V_{beam} passed through. Therefore, two cold spots are observed in the CMB: SC, at the Galactic

coordinates $(l, b) \sim (208^\circ, -56^\circ)$, on the southern side³⁰ of the hot disk, and NC, at $(l, b) \sim (317^\circ, -6^\circ)$, on the northern side (Figs. 6a and 6b).

We therefore have the following important results:

First, the V_{spiral} plane of the hot ring and the beam V_{beam} intersect at the Galactic coordinates $(l, b) \sim (286^\circ, -42^\circ)$, at a distance ca. $0.671r_{\text{CMB}}$ away from the Earth, or at a redshift of z = 2.27. This intersection is the point where the Big Bang happened or the center of the universe (Fig. 6b). As r_{CMB} is nearly equal to the radius of the observable universe, ca. 46.5 billion light years, we are ca. 31.2 billion light years away from the center of the universe. The specialty near the direction of the universe center has long been noticed by many researchers³¹⁻³⁶. However, without our model, people have not found the center of the universe.

Second, only half of the hot ring is observed, while the other half is hardly visible (Fig. 6b). This is due to the Doppler effect and the Doppler beaming: if we look from the Earth, V_{spiral} was spiraling clockwise into the precursor core of our universe. Due to the frame-dragging effect, the neutrino star core also rotated clockwise. We therefore know that: a) if we look from the Earth to the center of the universe, the universe is rotating clockwise; b) the plane of the hot ring is the plane of the equator of the universe (equation 25); c) the angle between the equator plane of the universe and the Galactic plane is ca. 30°; d) the North half-ball, or more accurately, the North half-ellipsoid, of the observable universe is bigger than the South half; e) the Earth is inside the North half-ball; f) the axis of the rotation of the universe, perpendicular to the equator plane, is: $\frac{x-0.1388r_{\text{CMB}}}{0.5793} = \frac{y+0.4749r_{\text{CMB}}}{1} = \frac{z+0.4529r_{\text{CMB}}}{1}$; g) the rotation axis intersects with the surface of last scattering at $(l, b) \sim (324^\circ, 31^\circ)$ on the North end and $(l, b) \sim (257^\circ, -62^\circ)$ on the South end.

This clockwise rotation is also confirmed by the cold spots in the CMB. The observed angle between the V_{spiral} plane and the beam V_{beam} is ca. 58°. With this angle, the rotating precursor core dragged the beam V_{beam} to sweep the inner space within the event horizon, just like a pulsar sweeps through space. Therefore, a low-temperature tail spreading in a wide range is observed following the NC in the CMB (from NC to k, j, i, and h, Fig. 6c). A similar tail should also exist following the SC. However, the regions of the surface of last scattering that the beams were sweeping are very different. As the Northern beam swept from h to i, j, k, and NC, the distance to the universe center reduced (Fig. 6c). This is very suitable for the tail to be observed, because the sweeping beam arrived at the surface of last scattering at almost the same time. On the contrary, as the Southern beam swept, the distance to the universe center increased quickly (Fig. 6c). Any potential tail would thus fly beyond the surface of last scattering. In addition, the potential tail, even if it existed, would be very much overshadowed by the high temperature near the universe center and the equator.

One might wonder why we did not observe the rotation of the Earth to the rotation axis of the universe in the CMB. In fact we did; it is hidden in the dipole anisotropy that causes the temperature difference of 6.706 mK^{37} . Interestingly, the angle between the rotation axis of the universe and the Galactic plane is ca. 60° , while the angle between the ecliptic plane and the Galactic plane is also ca. 60° .

Third, the universe is anisotropic and nonhomogeneous. It is important to note that the universe was born to be isotropic and homogeneous (except for its edge, of course), as it was a uniform globe of aether particles (reaction I) or hypoatoms (reactions IX and XIII). For the infant universe at ca. 380,000 years after the Big Bang, the deviation from the isotropy was insignificant. This is why the CMB looks nearly isotropic and homogeneous. As it expands, the universe has been becoming more anisotropic and nonhomogeneous, mainly due to two factors: a) the edge effect; b) the rotation of the universe.

As shown in Fig. 5, the growth of a precursor black hole until ca. $10^{-34} \sim 10^{-32}$ sec before the Big Bang required falling matter and energy outside the precursor black hole. This mechanism also works after the Big Bang. We may understand it in one of these ways: either that the universe has expanded into the outside vacuum, or that the expansion of the universe has been accelerated or decelerated by the dark matter and dark energy outside the universe. This mechanism made the universe expand faster at the edge than at the inner. If we use the well-known raisin bread model to explain, then on top of the primary raising up of the whole bread, aether and its energy counterpart can be considered as additional bread added from the outside. Even though the aether bread would migrate from the edge to the inner during the expansion (as discussed above, the fabric of space is a superfluid), a gradient of the concentration of bread must exist, resulting in an edge effect.

If we measured it at the center of the universe, then the Hubble constant H(R) would increase with the distance R. Since the Earth, whose coordinates are $(R_0, \theta_0, \varphi_0)$, is not at the center of the universe, the Hubble constant that we observed is a function of distance r and directions (l, b): $H(r, l, b) = H(R) - H(R_0, \theta_0, \varphi_0)$. As it is normally presented in the values at the present time, the noticeable is the space anisotropy $H_0(l, b)$. The center of the universe is at $(l, b) \sim (286^\circ, -42^\circ)$, therefore H_0 has the minimum in that direction, and the maximum in the opposite direction, at $(l, b) \sim (106^\circ, 42^\circ)$. If we place an ellipsoid with its major axis along $(l, b) \sim (286^\circ, -42^\circ)$ to $(l, b) \sim (106^\circ, 42^\circ)$, while the two minor axes have the same length, then the Hubble constant will be inversely proportional to the distance from the Northern focus to the ellipsoidal surface. The anisotropy of the universe due to the edge effect can be defined by an eccentricity:

$$e = \frac{H_{0, \max} - H_{0, \min}}{H_{0, \max} + H_{0, \min}}$$
(26)

Another key factor to produce the anisotropy of the universe is due to its rotation, which has made the universe a *rotation twisted body*. Our model does not provide any real structures at the center of the universe; the center of the universe is basically the same as any other space. Therefore, the centripetal force required to maintain the rotation is fully contributed by inter-galaxy or inter-structure gravity. Like the mechanism to produce the Coriolis force, the anisotropy is generated by the gradient of the velocity of rotation: $\nabla V(R,\theta) = \frac{\partial V}{\partial R} \mathbf{e}_R + \frac{1}{R} \frac{\partial V}{\partial \theta} \mathbf{e}_{\theta}$, where *R* is the distance to the center of the universe, and θ the angle to the equator plane. Since the Earth is not far away from the center (ca. $0.671r_{CMB}$) and the equator plane (ca. $0.359r_{CMB}$), the rotation velocity gradient would twist the direction of anisotropy, away from the center of the universe. As it is a function of the distance of observation, the observed direction of anisotropy could be scattered³¹⁻³⁶.

Note that this space anisotropy could also appear as the time dependence or the socalled Hubble tension³⁸. It seems that both the time dependence, and the space anisotropy³⁶ calculated using equation (26) are all about 9%. Other observations such as the sigma-8 tension³⁹ would be due to the same reason. The position of the center of the universe would also drift a bit, due to many factors: a) the drift of the equator plane by the edge effect, which would be larger than expected as the center of the universe is extrapolated from the thick half hot ring; b) the drift of the cold spots due to the same reason; c) the precise synchronization of the cold spots, etc. Detailed analysis on them is beyond the scope of this work.

Besides the most noticeable hot half ring and cold spots, almost all of the other characters in the CMB can also be explained.

The regions immediately surrounding both the Northern and Southern beams V_{beam} show higher temperatures (the Northern: 27-26- 25-17-18-19-20-29-28, Figs. 6c and 6d; the Southern: 35(11)-12(23)-32-31-30, Fig.6e), probably due to the back falling flows near them. For comparison, we generally believe that the hotter spots in the CMB correspond to the less dense portions of space⁴⁰. If so, then the vast regions inside the loops connected by these high-temperature spots would also be less dense. This is not supported by cosmological observations.

Other regions that show higher temperatures are often located on the edge of the Northern hemisphere (33-34-13-14-16, Fig. 6d). On the contrary, the vast region below 20-19-18-17-16-14-13-34 is very uniform. This phenomena would be due to a geometric effect of the back falling flows: the collisions on the edge look longer and brighter; while the collisions on the top look shorter and dimmer.

Since it is closer to the center of the universe and the hot equator plane, the Southern hemisphere is supposed to be hotter than the Northern hemisphere. However, the regions immediately close to the hot ring from the South side often have lower temperatures (a-b-c and r-s-u-v-t, Fig. 6e). This is because right after the decoupling, the hot disk had a temperature that was still higher than the decoupling temperature, and hence was not as transparent as other regions, while the Earth is in the North half-ball.

Some other cold spots, such as g, m, and n, would also be due to the Doppler effect, because they are very close to the equator plane.

All these observations in the CMB, as well as the space anisotropy and the Hubble tension, provide strong evidence of our hypoatom model.

Fate of the universe. Based on our model, the universe is a flat, open system; the fate of the universe will end up with many new Big Bangs. This naturally explains the accelerating expansion of the current universe. Black holes, or their mergers, are the seeds of the universes of the next generation, and hence require space or energy to grow, though not all growth is guaranteed. Our universe is still at her young age!

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Time	Energy	Events	Particles created
< 10 ⁻⁴³ s	$> 10^{19} {\rm GeV}$	Symmetry breaking (gravity	A & Ā
		separated from other three forces)	
$10^{-34} \sim 10^{-32}$ s	10^{15} ~ 10^{14}	Electrostrong symmetry breaking	B & \overline{B} , or UHE
	GeV		neutrinos
(10^{-22} s)	(10^8GeV)	Gauge desert	Intermediates
$10^{-12} \sim 10^{-6}$ s	100 ~ 0.1	Electroweak symmetry breaking	u, d & e
	GeV		
1 ~ 10 s	1 ~ 0.1 MeV		Nuclei
$\sim 10^{13}$ s	~ 0.4 eV		Atoms

Table 1.	List of]	particles	created	in the	early	universe
m.		-		-		



Fig. 1. Creation of the fundamental particles of nature. a) First episode of inflation: the pure energy (E) of the singularity turned into a globe of A and \overline{A} (reaction I). The lowest temperature is taken from ref. 4. b) First reheating: numerous annihilations of A and \overline{A} raised the temperature back to what the adiabatic standard cosmology describes. While one or a small number of aether pairs annihilated into energy (reaction II), *n* pairs of aether, by competition, produced photons (reaction III). Some aether particles were left along and therefore survived. c) Second episode of inflation: the photons collided to create particles B and antiparticles \overline{B} (reaction IV). The temperature drop in this episode is much smaller than that in the first episode. d) Second reheating: the annihilations of particles B and \overline{B} , without and with aether particles, raised the temperature again.



Fig. 2. A schematic diagram of a hypoatom, the fabric of space, and the generation of the sink flow of aether. Hypoatom $\overline{B}A_n$: a particle \overline{B} (blue, open) is the nucleus; *n* particles A (slashed red area) surround the particle \overline{B} . Fabric of space: composed of aether particles A (red, filled) and \overline{A} (blue, open). Sink flow: an \overline{A} (blue, open) in the fabric of space oscillates and contacts with an A (red, filled) at the hypoatom and gets annihilated (step 1). The vacancy is then filled by another A (red, filled) in the fabric of space (step 2). The hypoatom $\overline{B}A_n$ constantly annihilates the aether particles, converting them into ultralong-wavelength photons, and thus produces a 3-dimensional sink flow of aether, warping spacetime and generating gravity.



Fig. 3. A plot of the lifetimes of the pseudoscalar mesons $q\bar{q}$ composed of symmetric quark q and antiquark \bar{q} versus their masses. By extrapolating the line: $\log(\tau/\text{sec}) = -5.2123 - 5.0000 \log(m/\text{GeV})$ to 8 meV, the upper limit of the mass of a hypoatom, then the lifetime would be ca 2×10^{35} sec. Based on our postulate, annihilation only happens if all of the *n*+1 bodies that form an asymmetric hypoatom contact simultaneously. Therefore, the lifetime of a hypoatom would be much longer than 2×10^{35} sec, a value projected for a 2-body meson-like particle.



Fig. 4. A schematic diagram of a black hole. The orange circle is the event horizon. The core (red) is a hypoatom star or neutrino star. The black line is the axis of rotation. The horizontal zone (blue) is a falling spiral flow, going in on the left and coming out on the right. The yellow solid lines represent the magnetic field of the neutrino star core. The dark red lines and dashes represent the emission beams, emitting along the magnetic axis from the core, and then falling. A fire (yellow) is lit within the event horizon due to the annihilation of the fabric of space.



Fig. 5. The size of a universe before and after a Big Bang. Before the Big Bang (blue): it is a growing black hole. At ca. $10^{-34} \sim 10^{-32}$ sec before the Big Bang when its mass exceeds ca. $3 \times 10^{22} M_{\odot}$, the core of the black hole collapses from ca. 2 m into a singularity. After the Big Bang (red): the universe expanded with zigzagging inflation and reheating processes, creating the fundamental particles of nature. After the first episode of inflation and reheating at ca. 10^{-41} sec, the size of the universe is ca. 0.25 mm. After the second episode of inflation and reheating at ca. $10^{-34} \sim 10^{-32}$ sec, the universe returns to its size before the collapse.



Fig. 6. The center of the universe. The lines in this figure are for guidance only. **a**, Hot (red, number) and cold (black, letter) spots are labelled in the cosmic microwave background. The zone between the white dash curves is a hot ring. Cold spots: SC, at $(l, b) \sim (208^\circ, -56^\circ)$, and NC, at $(l, b) \sim (317^\circ, -6^\circ)$. **b**, 3D globe of the surface of last scattering (green), on which half of the hot ring (red), 1-2-3&4-5-6-7-8-9, is visible. The plane of the hot ring and the line between the SC and NC (blue) intersect at $(l, b) \sim (286^\circ, -42^\circ)$, at a distance 0.671 times the radius of the surface of last scattering from the Earth. This intersection is the center of the universe (red) where the Big Bang happened. Based on the Doppler effect and the Doppler beaming, if we look from the Earth (green) to the center of the universe (red), the universe is rotating clockwise. Thus the plane of the hot ring is the equator plane of the universe, and the Earth is inside the North half-ball of the universe. **c**, The axis of rotation (black) is the line between $(l, b) \sim (324^\circ, 31^\circ)$ and $(l, b) \sim (257^\circ, -62^\circ)$.

this angle, the rotating precursor black hole, a hypoatom star or neutrino star, dragged the beams (blue) to sweep the inner space within the event horizon. On the Northern hemisphere, a low-temperature tail, NC-k-j-i-h, is following the cold spot NC. This tail can be seen because as the beam swept from h to i, j, k, and NC, the distance to the universe center reduced. The tail on the Southern hemisphere is not seen, because as the Southern beam swept, the distance to the universe center increased quickly. Any potential tail would thus fly beyond the surface of last scattering. The regions immediately surrounding the Northern beam, 27-26-25-17-18-19-20-29-28, show higher temperatures, probably due to the back falling flows near the beam. **d**, If we look from the North pole (N) down to the observable universe, higher temperatures are often located on the edge of the Northern hemisphere, 33-34-13-14(15)-16, together with those surrounding the Northern beam, 27-26-25-17-18-19-20-29-28. The rest space of the Northern hemisphere is very empty; there are only some scattered weak hot or cold spots, such as 24 (hot), and o, p, and d (cold), etc. e, The South half-ball is smaller than the North half-ball. The regions immediately surrounding the Southern beam, 35(11)-12(23)-32-31-30, show higher temperatures. The regions immediately close to the hot equator, such as a-b-c and r-s-u-v-t, often have lower temperatures, because right after the decoupling, the hot equator had a temperature that was still higher than the decoupling temperature, and hence was not as transparent as other regions. The thin blue line from the SC shows the position of a tail if it exists.