

Not-So-Alternative Cosmology

Hints on CMB temperature anisotropies in 4-Sphere

Somewhere in the discussion there are questions and answers to ChatGPT, our Artificial Intelligence (see <https://openai.com/>), to know his thought and fill the gap in knowledge.

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ABSTRACT AND INTRODUCTION

This paper speaks of the measurement of the *CMB* [*] from the point of view of a non-standard model named "[4-Sphere](#)".

The *CMB* is the result of the expansion of the Radiation Era relic. The consequence of this is in its homogeneity and isotropy even among distant points of the Universe.

We can find small difference of its property, say *CMB* anisotropies [1], for various reasons. The most important concerns the discontinuities in the primordial plasma concentration, with production of gravity and pressure gradients of local character coming from the Inflationary Era. Physicists think these are the origin of galaxies and galaxy clusters.

Given the extreme complexity of the matter we will not adapt the Cosmological Perturbation of *ΛCDM* to 4-Sphere, but we will limit ourselves to a qualitative description of radiation interacting with the plasma, with pressure gradients proceeding in one isochoric scenario. We will show that all this is compatible with the "bottom-up" growth of the galactic structures we observe now.

A snapshot at Last Scattering of this situation is transmitted to us through the anisotropy of the *CMB*.

We will see how the *CMB* dipole, measured by an observer in peculiar motion, is coherent with the 4-Sphere geometry.

But the discussion is mainly about the temperature anisotropy due to cosmological perturbations. It follows that, with a directional antenna, what we measure is the interference of the overlapping radiation from two opposite directions: Maybe it could arise from the same cosmological perturbation. From that, a way to recognize the existence of the fourth dimension of space is proposed, as a verification of the 4-Sphere model.

[*] - [\[Astrophysical Journal v.339, p.632\] - Measurements of the Cosmic Microwave Background Radiation Temperature at 90 GHz](#)

CMB DIPOLES FROM A PECULIAR MOTION

Without necessarily referring to a particular cosmological model, we say that any model that respects the expansion described above, taking a snapshot of the Universe, expects an observer O_1 to see the *CMB* as coming from a homogeneous spherical radiation source of which the observer is in the center O . Incidentally, for many cosmological models the *CMB* is a disordered radiation and part of the above representation should apply in any case.

Now, we consider a celestial body with a peculiar motion (namely: that it is in motion with respect to the expanding frame of the *CMB*) as equivalent to another observer O_2 , this time in motion, in the instant in which he meets O_1 and crosses the center of the sphere.

The question that arises is: Does O_2 measure in O the same Radiation Intensity as O_1 or not? Or said in another way: Can a celestial body, for the sole fact that it has a peculiar motion, measure a temperature anisotropy of the *CMB* surrounding it?

We are not interested in knowing the distribution of energy on the surface of the sphere. For our purpose we can simply study the behavior of the radiation lying in a generic plane passing through O . Then with $\beta = v/c$, the frequency ν' due to the Oblique Doppler Effects is:

$$\nu' = \frac{\nu(1 - \beta^2)^{1/2}}{1 - \beta \cos \theta}$$

and for $\beta \neq 0$ we can get the indefinite integral, with the substitution $u = \tan(\theta/2)$, starting from:

$$\frac{(1 - \beta^2)^{1/2}}{\beta} \int \frac{1}{1/\beta - \cos \theta} d\theta$$

The definite integral, in the open interval $(-\pi, \pi)$ is $2\pi\beta(1 - \beta^2)^{-1/2}$ and we get $\nu' = \nu$ for mean values of frequency. In other words, Redshift and Blueshift compensate each other in the mean energy of the disordered radiation. (If this is true for a generic circumference then it is true for the whole surface of the sphere).

Then O_1 and O_2 measure the same mean temperature of *CMB* and this result also confirms what was said in [\[viXra:2209.0098\]](#) about the total absence of Radiation Friction by the *CMB* on a celestial body with any peculiar speed.

But the above sphere is generic. What happens if we identify it with the observable Universe [*], and use a directional antenna to measure the *CMB* in one *RA* and *Dec* direction of the sky and its opposite one?

As a first consideration we should be able to measure the motion of the observatory with respect to the frame of the *CMB* (approximately the center of mass of the orbiting Local Group) and from this, knowing the motions of stars and galaxies near us, we could calculate their peculiar velocities.

Having a space probe at your disposal, it is not a question of setting a certain course but only of memorizing time, the probe position, course and speed, together with the *CMB* measurements.

Testing these considerations would be easy with the proper tools. To confirm the *CMB* origin, the antenna should be oriented in a direction orthogonal to the plane containing the probe's course and the line connecting the probe to the interesting point (in our case the center of mass of the orbiting Local Group): a non-zero dipole will falsify the assumption. [**]

But this is not the only interesting aspect.

[*] – The Radius of the Observable Universe depends on the cosmological model. For Λ CDM we consider the Hubble Radius. Here instead, we consider the 4_Sphere's one, that is, the border with the Relativistic Elsewhere zone. This quantity is important because it is linked to the Principle of Locality which in turn regulates the relationship between cause and effect.

[**] – For this check it is not necessary to assume any particular model. Space is so close to us that we can choose the classic Cartesian system and small differences in distances do not affect angles involved.

CMB ANISOTROPY AS DIPOLES WHICH DIFFER SIGNIFICANTLY FROM EACH OTHER ACCORDING TO THE DIRECTION

We point out that, while there are some alternative theories of the *CMB*, here we follow that of the Standard Model.

Fluctuations in the primordial plasma gave rise to the formation of galaxies and their distribution in space can be associated with local gravity and pressure gradients created in the primordial plasma and started to collapse soon after the Recombination Era. For the discussion, the representation of the Universe from the chosen cosmological model is decisive.

For example, in Λ CDM, the Last Scattering surface belongs to the measurable Universe, while in the 4-Sphere the Elsewhere zone of Special Relativity begins beyond the distance corresponding to 1 radian and our observations stop there; the ray of light, which travels the most recent circle and reaches us after a rotation of 2π radians, had an age of 25 million years from Big Bang when started.

The Cosmic Background Radiation is born with the Last Scattering and makes more than one turn of the Universe before reaching us, entering the observable Universe about 8.8 billion years ago. When it is born, the first halo of molecular hydrogen has not yet formed.

But then, what do we measure when we point our directional antenna to observe the *CMB*?


The disordered relic of the Radiation Era was released in all directions, so also a density disturbance of the plasma was dispersed, even if unevenly as a temperature anisotropy, likewise.


When we affirm that a *CMB* dipole is due to a peculiar motion we are also saying that, if we were at rest with respect to the Galactic Recession frame, we would always measure the same anisotropy for all pairs of opposite sky (celestial sphere) directions.

Therefore, there are two opposite directions from which two perturbed rays come from, and what we receive is not the intensity of the perturbations, but the radiation interference, managing to isolate it with a suitable antenna.

In our geometric context, every expanding Great Circle traveled by the *CMB* does not originate in the center of the hypersphere but continues its trajectory by detaching itself from a point of the surface at the time of Last Scattering. We must therefore try to explain the presence of these anisotropies which vary significantly according to the direction. The question is: Are we able to trace back, to the same Early Universe's position, the anisotropies observed in two opposite directions of the sky?

Our answer must be consistent with the assumption that Last Scattering occurred when the Universe was not expanding, and the electromagnetic wave traveled in both directions an arc of 4-Sphere Great Circle. Being deflected by plasma islands before dying down due to the Thompson scattering, original radiation dispersed in all directions and then detached itself from the surface.

 I: Can we say that the *CMB* crossing a gravity well or hill can be deflected but conserve its energy and temperature?

 AI: When the cosmic microwave background (*CMB*) radiation passes through a gravity well or hill, it can be deflected by the gravitational potential of the object. This deflection can cause the *CMB* radiation to change direction and potentially be distorted. However, the conservation of energy and temperature still holds.


The *CMB* radiation has a fixed energy and temperature that are determined by the early universe conditions, and these properties remain constant as the radiation travels through space. When the radiation encounters a gravity well or hill, its energy is not changed, but the path that it takes may be altered. The temperature of the *CMB* radiation is related to its frequency, and if the frequency of the radiation is not changed, its temperature will also remain constant.

Therefore, we can say that the *CMB* radiation crossing a gravity well or hill can be deflected, but its energy and temperature will remain conserved. The deflection can cause the *CMB* radiation to be observed from a slightly different direction, which can provide important information about the gravitational properties of the object causing the deflection.

Then, we cannot easily reconstruct the map of the plasma islands at the time of the Last Scattering because the energy of the outgoing radiation in Thompson scattering depends on the energy of the incident radiation as well as that of the electron, and the scattering angle and polarization can also affect the properties of the scattered radiation.

A TEST TO RECOGNIZE THE FOURTH DIMENSION OF SPACE

Let's see if, with the help of ChatGPT, we can determine a way forward.

 I: why does Thompson scattering produce the black body spectrum in the *CMB*?



AI: Thomson scattering by free electrons is one of the mechanisms that led to the formation of the Cosmic Microwave Background (CMB) radiation. The blackbody spectrum of the CMB is a result of the thermalization of the radiation with the matter in the early universe.

During the early stages of the universe, the universe was filled with a hot and dense plasma of free electrons, protons, and photons. The photons were tightly coupled to the matter through Thomson scattering, which is the scattering of photons by free electrons. The photons scattered many times off of the free electrons in the plasma, and this process led to the thermalization of the radiation with the matter.

As the universe expanded and cooled, the temperature of the radiation decreased, and the photons became decoupled from the matter. The photons then traveled freely through the universe, but they retained the blackbody spectrum they had acquired during the period of thermalization.

The blackbody spectrum of the CMB is a result of this thermalization process, where the radiation was brought into thermal equilibrium with the matter through repeated Thomson scattering interactions. The spectrum of the CMB is extremely close to that of a perfect blackbody, with a temperature of about 2.7 Kelvin. This means that the CMB radiation has a nearly uniform intensity at all frequencies, and this is a key prediction of the Big Bang model of the universe.

In summary, the blackbody spectrum of the CMB is a result of the thermalization of the radiation with the matter in the early universe through repeated Thomson scattering interactions. The blackbody spectrum was then preserved as the radiation became decoupled from the matter and traveled freely through the universe.



I: Could a fluctuation of the primordial plasma cause an alteration of the black body spectrum of the CMB?



AI: Yes, fluctuations in the primordial plasma can cause alterations in the blackbody spectrum of the Cosmic Microwave Background (CMB) radiation. The CMB is a snapshot of the universe about 380,000 years after the Big Bang, when the universe was filled with a hot and dense plasma of electrons, protons, and photons. Tiny density fluctuations in this plasma were imprinted onto the CMB as it decoupled from the matter, and these fluctuations are responsible for the temperature anisotropies observed in the CMB today.

The density fluctuations in the primordial plasma caused variations in the temperature and density of the CMB radiation in different parts of the sky. These fluctuations can cause the CMB spectrum to deviate from a perfect blackbody spectrum. The degree of deviation depends on the amplitude of the density fluctuations and their spatial distribution.

There are different physical processes that can cause fluctuations in the plasma, such as acoustic waves, gravitational waves, and the diffusion of photons in the plasma. These processes can cause different types of temperature and polarization anisotropies in the CMB, which can be observed and used to infer the properties of the primordial plasma and the early universe.

In summary, fluctuations in the primordial plasma of the early universe can cause alterations in the blackbody spectrum of the CMB radiation through temperature and polarization anisotropies. The study of these anisotropies can provide important clues about the physics of the early universe and the origin of cosmic structure.



I: Can we say that the head end of the CMB spectrum consists mostly of photons that have interacted with electrons only at the highest temperature?



AI: The head end of the cosmic microwave background (CMB) spectrum, also known as the Wien tail, corresponds to the highest energy (shortest wavelength) photons in the CMB. These photons are thought to have originated from the hot, dense plasma of the early universe, when the universe was only a few hundred thousand years old.

During this time, the universe was filled with a sea of ionized gas (plasma), including free electrons, protons, and helium nuclei. Photons in the CMB interacted with these free electrons through a process called Thomson scattering, in which the photons scattered off the free electrons like billiard balls.

As the universe expanded and cooled, the free electrons and ions recombined to form neutral atoms, and the universe became transparent to radiation. The photons in the CMB then began to travel freely through space without interacting with matter.

The highest energy (shortest wavelength) photons in the CMB, which correspond to the head end of the spectrum, are thought to have last scattered off electrons at the highest temperature in the early universe, when the plasma was still hot and dense. These photons would have been scattered multiple times by free electrons before finally escaping the plasma and propagating freely through space.

Therefore, we can say that the head end of the CMB spectrum consists mostly of photons that have interacted with electrons at the highest temperature in the early universe, before the universe became transparent to radiation.

If we then consider the head end of the CMB spectrum, we could hypothesize that most of the photon-electron interactions occurred at the highest temperature, in a narrow area of plasma, and that the concentration of electrons was in any case sufficient to scatter the radiation in all directions. Thus, in an unobstructed path the temperature anisotropy of the same primordial plasma fluctuation would come at us from two opposite directions.


The precedent conclusion comes from the 4-Sphere geometry and its conjecture. Moreover, the wavelengths we measure for the CMB are very short and it would be interesting to have a directional antenna capable of detecting the standing wave once the effect of movement has been eliminated. The experiment is conditioned by the possibility of shielding radiation generated by the Sun and by the disk of the Milky Way. This can be done more easily if the antenna is highly directional.

With the space probe mentioned above and the latter antenna installed on it, the CMB measurement obtained in the direction orthogonal to the plane containing the probe's course and the line connecting the probe to the center of mass of the orbiting Local Group, should results free from the dipole due to motion.

Once multiple routes are combined, find standing waves between some of these directions would be confirmation that we are receiving the same cosmological perturbation from two opposite directions, hence it would be a sign of the existence of the hypersphere and its surface on which the Universe lies.

But regardless of the technology used, shielding the signal (not just from the Sun) so as to receive a standing wave might be practically impossible. It is therefore preferable to have two antennas oriented in opposite directions and process the two synchronized signals, purifying them, through a computer to verify if their sum corresponds to a stationary wave.

Heard ChatGPT, here's his take:

 I: As an alternative to an antenna capable of measuring a standing electromagnetic wave, could I use two attached antennas that simultaneously receive the wave from two opposite directions and analyze their sum with a computer?



AI: Yes, it is possible to use two antennas to measure a standing electromagnetic wave by analyzing their sum with a computer. This technique is called interferometry and is commonly used in radio astronomy.

In this method, two antennas are placed at a known distance apart and are used to receive the electromagnetic wave from two opposite directions. The signals received by the antennas are then combined and analyzed using a computer to extract information about the wave.

The interference pattern created by the combination of the two signals can reveal information about the standing wave, including its amplitude, phase, and polarization. By analyzing the interference pattern, it is possible to extract information about the properties of the wave and the environment in which it is propagating.

Interferometry is a powerful tool for studying electromagnetic waves and has many applications in fields such as radio astronomy, telecommunications, and radar. However, it is important to carefully calibrate the system to ensure accurate measurements and to minimize noise and other sources of interference.

Given the possible complications due to the frequency of the wave, we could even settle, at first, for obtaining two waves with the same mean amplitude (once isolated the wavelength) in a very short measuring interval.

With the following stored data available: synchronized date and time, probe position, course and speed, together with the *CMB* measurements, once verified that the dipole is of Doppler origin, we can eliminate the calculate redshift, adapting the wavelength of the measurements, and obtain the correct radiation interference in all directions.

Even if the two waves, moving in opposite directions, do not come from the same perturbation, the dipole we would measure would still be due to the Doppler effect on their interference. Then, in the absence of a complete shielding, once the Doppler effect has been calculated and removed, if we measure, purified from the estimate of unwanted radiation, the same power in the two antennas we can deduce that we have two electromagnetic waves traveling in opposite directions with the same amplitude and frequency.


Doing so, the two antennas can also be mounted on a high-altitude aerostatic balloon (as in the "BOOMERanG" project).


THE 4-SPHERE ISOCHORIC SCENARIO

4-Sphere as a speculation [\[viXra:2209.0098\]](#) is limited to calculating the Galactic Recession, some parts of the model being the result of a logical construction which is not falsifiable [*]. The latter include the mechanism that regulates the expansion of the Universe and the period in which the expansion ceases and then resumes. In fact, to respect the observed value of the standard deviation in its radiation temperature and the accuracy of its Blackbody spectrum, we need a *CMB* whose redshift is only gravitational, in the absence of any Doppler effect, due to the recession of its point of origin [**].

However, the fact that a thought construction cannot be falsified does not exempt us from its discussion because through this we can arrive at contradictions or even just to verify if, and how much, we are moving away from our perception of reality.

Here is the thought of ChatGPT:

 I: When a scientific speculation is partly supported also by a hypothesis that cannot be falsified, is it still appropriate to question the latter as a thought construction?

 AI: Yes, it is still appropriate to question a hypothesis that cannot be falsified. The hallmark of science is empirical testing, and a hypothesis that cannot be falsified is outside the realm of empirical testing. While it is possible that such a hypothesis may turn out to be correct, it is also possible that it is simply a thought construction or an untestable speculation.

It's important to note that a hypothesis that cannot be falsified is not necessarily invalid or meaningless. In some cases, such hypotheses can be useful as a way of generating new ideas or as a starting point for further research. However, they should be treated with caution and skepticism, and not accepted as established facts without empirical evidence to support them.


In summary, while it is appropriate to consider all available evidence, including hypotheses that cannot be falsified, when evaluating a scientific speculation, it is important to maintain a critical and evidence-based approach.


The considerations of this paragraph should be read in this spirit.

Standard cosmology foresees that cosmological perturbations (due to quantum fluctuations) do come from the period preceding the Inflationary Hot Big Bang Era.

"... the rather simple idea that the observed structure in our universe has resulted from the gravitational amplification of weak primordial fluctuations seems to work remarkably well. These small perturbations grew slowly over time until they were strong enough to separate from the background expansion, turn around, and collapse into gravitationally bound systems like galaxies and galaxy clusters."

(Christos G. Tsagas)

 I: Is it correct to say that in BAOs we could use Euler's equations to study compression waves in a fluid in which matter is not yet separated from radiation?

 AI: The study of Baryon Acoustic Oscillations (BAOs) does involve the application of fluid mechanics concepts, but it is not entirely correct to say that Euler's equations are used to study compression waves in a fluid in which matter is not yet separated from radiation.

In the early Universe, the baryonic matter and the photon-baryon plasma were tightly coupled and behaved as a single fluid. This fluid was subject to various physical processes, including pressure gradients, gravity, and radiation pressure, which drove acoustic oscillations in the fluid. These oscillations created overdensities and underdensities in the density field of the Universe, which later led to the formation of galaxies and other cosmic structures.

The study of BAOs involves modeling the evolution of these overdensities and underdensities using the tools of cosmological perturbation theory. This theory involves the linearization of the equations that describe the evolution of the Universe and the perturbations in the fluid. The linearized equations can be solved using techniques from fluid mechanics, such as the continuity equation and the Navier-Stokes equations.

However, it is important to note that the behavior of the photon-baryon plasma in the early Universe is not exactly like that of a normal fluid. In particular, the presence of radiation pressure and the coupling between the baryons and photons make the fluid more complex than a simple compressible fluid. Therefore, the modeling of BAOs requires the use of specialized techniques that take into account these additional physical effects.

Overall, while the study of BAOs does involve the application of fluid mechanics concepts, it is not accurate to say that Euler's equations are used to study compression waves in a fluid in which matter is not yet separated from radiation.

Because of its extreme complexity, here we do not intend to develop the existing theory of Cosmological Perturbation introduced in [***], not even in its simplified form through Euler's equations. We simply intend to rely on the geometry of the hypersphere.

The consequence is giving up a quantitative analysis of the phenomenon.

As for the Standard model, 4-Sphere foresees the Inflation. But here, the primitive idea would be to think that this expansion lasted longer. Having reached its peak, it suddenly ceased, throwing the plasma onto the surface of the 4-Sphere, thus causing the reheating: as if all this obeyed the same metric of the interior of a black hole. The Timeline of this event may not be related with eras of the Big Bang, and this occurs at a hypothesized $r_{4-sphere} = 720,000 \text{ ly}$.



I: Did BAOs Develop During Inflation?



AI: Baryon Acoustic Oscillations (BAOs) did not develop during the inflationary epoch of the Universe. Inflation is a period of rapid expansion that is believed to have occurred in the very early Universe, shortly after the Big Bang. During inflation, quantum fluctuations in the inflaton field were stretched to cosmic scales, leading to the formation of the large-scale structure of the Universe.

BAOs, on the other hand, developed after inflation, during the period known as the radiation-dominated era. During this period, the Universe was filled with a hot plasma of photons and baryons that were tightly coupled together. The plasma was subject to acoustic oscillations, driven by the pressure of the radiation and the gravitational attraction of the matter. These oscillations created a pattern of overdensities and underdensities in the plasma, which imprinted a characteristic scale on the matter distribution in the Universe.

The scale of BAOs is set by the sound horizon at the time of decoupling, which is the distance that a sound wave can travel in the plasma before it becomes free-streaming. This scale was imprinted during the radiation-dominated era, long after inflation had ended.

However, inflation did play an important role in setting up the initial conditions for the evolution of BAOs. The quantum fluctuations generated during inflation provided the seeds for the density perturbations that eventually grew into the large-scale structure of the Universe, including the pattern of BAOs. Therefore, while BAOs did not develop during inflation itself, the imprint of inflation can still be seen in their properties.

We have not yet defined which other events of the Big Bang are contained in this phase. To continue with the speculation by dealing all these aspects, this conjecture and its chronology need to be reworked. Currently we only need a period of isochoric transformations where Thompson scattering occurs, spreading in all direction the radiation coming from plasma discontinuities due to primordial fluctuations.

Thus, that local gradients of pressure, due to the interference of multiple photons, somehow survived during Nucleosynthesis and further, beyond Recombination and till now.

At the end of nucleosynthesis, the electrons constitute the hottest part of the plasma, and the heat is exchanged with the radiation via Thompson scattering, continuing the cooling in the absence of expansion.

Assuming a today baryon density equal to $3 * 10^{-28} \text{ Kg m}^{-3}$, with a radius at that time of 720,000 ly and a hypothetical temperature of 52,000 K [****], we compute a baryonic density of $2 * 10^{-15} \text{ Kg m}^{-3}$ vs. a radiation density of $6 * 10^{-14} \text{ Kg m}^{-3}$. Still at the same temperature, the characteristic plasma Debye length for electrons could be $\lambda_{De} = 1.65 \text{ cm}$.

With the 4-Sphere model, the equilibrium between matter and radiation will not be reached before the Recombination.



I: Can hydrogen in the form of plasma survive at 50000 K?



AI: Hydrogen in the form of plasma can certainly survive at 50,000 K. In fact, at that temperature, hydrogen would be fully ionized and exist as a plasma. This is because at high temperatures, the thermal energy of the particles is sufficient to overcome the electrostatic attraction between the positively charged protons and negatively charged electrons that make up the hydrogen atom. As a result, the electrons are stripped away from the nucleus, creating a plasma of positively charged protons and negatively charged electrons.

Plasma is a state of matter in which atoms are ionized and the resulting free charged particles can conduct electricity. At 50,000 K, hydrogen is in a highly ionized state, meaning that the electrons have been stripped away from most of the hydrogen atoms. This makes the plasma a good conductor of electricity, which is why plasmas are used in a variety of industrial and scientific applications.

In summary, hydrogen in the form of plasma can survive at 50,000 K and higher temperatures, due to the ionization of the atoms at these high temperatures.

Inside the overlying thermal random motion, density and pressure gradients are accompanied by small electrical positive charge gradients because electrons continue to be scattered away.



I: Can it be said that in very hot plasma the electrons tend to separate from the positive ions?



AI: Yes, in very hot plasma, the electrons can become highly energetic and can separate from the positive ions, resulting in a situation where the plasma is composed of a mixture of free electrons and positive ions.

This phenomenon is due to the high temperature of the plasma, which causes the electrons to gain enough energy to overcome the attractive forces between the electrons and ions. As a result, the electrons can move freely through the plasma, while the positively charged ions remain relatively stationary.

This separation of charges in a plasma is what gives rise to its unique electrical and magnetic properties, which can be harnessed for a wide range of applications in fields such as materials science, astrophysics, and energy production.



I: And can we also say that the separation of electrons from positive ions prevents islands of ions from collapsing under gravity?



AI: It's true that the separation of electrons from positive ions can play a role in preventing the collapse of plasma islands under gravity.

In a plasma, the positive ions are attracted to each other by the force of gravity, and without some mechanism to counteract this force, they can clump together and form dense regions known as "islands". However, in a hot plasma where the electrons are separated from the positive ions, the repulsive electrical force between the free electrons and the positive ions can balance out the attractive force of gravity. This can help to stabilize the plasma and prevent the islands of ions from collapsing under their own weight.

It's worth noting, however, that the stabilization of plasma islands is a complex phenomenon that can be influenced by a variety of factors, including the magnetic field configuration, the temperature and density of the plasma, and the presence of additional particles such as neutrals or impurities.

Then, the collapse of ions is resisted even in the absence of expansion. Not only do local islands of discontinuities not collapse but, due to their collective effect of positive charge, they also do not stick each other, all of this being compatible with the "bottom-up" growth of the galactic structures we observe now (also because, otherwise we wouldn't have galaxies orbiting each other).

This happened, at some temperature greater than at 52,000 *K*, while some of the radiation leaves the plasma until the onset of adiabatic expansion occurs. Only then, after the Recombination, will the discontinuities in matter begin to approach and collapse.

At that time the radiation made one revolution every 4.5 million years. Thompson scattering being able to occur everywhere, 4-Sphere has not a *Horizon* Problem.

[*] – See "NOTHING BUT AN IDEA BEHIND THE DRAGGING OF MATTER" in the description of the 4-Sphere model.

[**] – See "COSMIC BACKGROUND RADIATION" in the description of the 4-Sphere model.

[***] – [\[arXiv:astro-ph/0201405\]](https://arxiv.org/abs/astro-ph/0201405) – [Cosmological Perturbations](#)

[****] – See "THE REACTIONS AT THE LAST SCATTERING AS AN EXPLANATION FOR POINT 2" in the description of the 4-Sphere model.

References from Wikipedia:

[1] - [Cosmic microwave background](#)