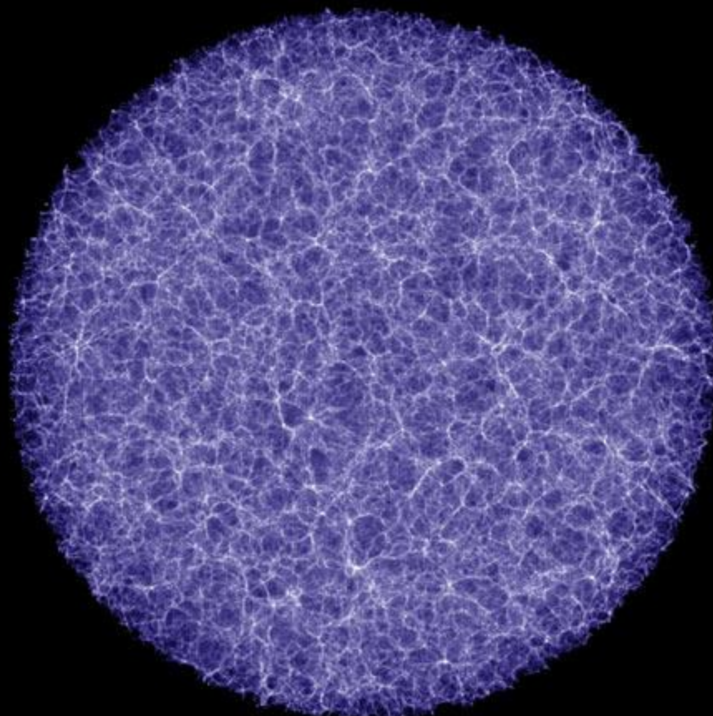

A Stationary Universe

THE RED SHIFT EFFECT IS CAUSED BY THE DECREASING SPEED OF LIGHT DUE TO THE CURVATURE OF SPACE - A PROPOSED EXPERIMENT

KRZYSZTOF SUDLITZ, PhD
NUCLEAR PHYSICIST | krzysztofsudlitz@gmail.com

Table of Contents

Abstract

In the following work, a hypothesis is proposed that the curvature of space modifies the basic equations of electrodynamics. This is based on the assumption that the universe is a three-dimensional sphere in four-dimensional space. The modification of the equations results in the slowing of the speed of light over very large distances. This results in the observed red-shift of distant galaxies. Finally, an experiment is proposed that would ultimately validate or refute the hypothesis. The experiment would require a direct comparison of the angles of incidence and reflection of light from very distant galaxies, and would need to be performed in outer space to avoid atmospheric blur.

Preface

I am a former researcher at the University of Warsaw. My activity can be described as a combination of atomic physics and plasma physics. In the distant past, I also worked on isotope production, and for a while at a nuclear reactor.

Theories concerning the construct of the universe have always existed. Theoretically, astrophysics and cosmology deal with these topics, but from my experience, an employee working in the "mainstream" focuses on very minor problems, whilst additionally burdened by plans, deadlines, and grants. Very few tackle these problems at large, and usually only do it part-time. In terms of the origins of the universe, there exists a group of individuals who are not entirely convinced by the Big Bang theory. Personally, I never liked the theory, or the explanation of the red-shift of distant galaxies using the Doppler Effect. First of all, what exactly exploded? Why 14 billion years ago and not 4? The cosmological principle is accepted in relation to space, but why not time? The microwave background radiation is assumed to be a remnant of the explosion, but it's easy to calculate (as outlined in the final chapter) that it is just as likely a result of summing the radiation of galaxies after taking their red-shift into account. These combined observations lead to the conclusion that the Big Bang theory is quite far-fetched.

In this work, I decided to put all my hypotheses and assumptions into readable form for those with a scientific background, as well as those with popular science interests. Therefore, I have decided not to include detailed mathematical derivations or references in my work; but for those interested, the details of certain derivations and assumptions can be found in common mathematics and physics textbooks.

The first chapter of this document is an introduction to the problem at hand and an overview of the concept of space with non-zero curvature. In the following chapters I assume that the basic equations of electrodynamics are affected by the curvature of space, and I present the reasoning behind my hypothesis. This assumption eventually leads to the conclusion that the speed of light decreases due to the curvature of space, and as such, light is affected by the path it travels. This leads to the widely observed phenomenon of the red-shift of distant galaxies. Finally, I propose an experiment that would ultimately validate or refute my hypothesis.

For those interested, I may be contacted at the following address: krzysztofsudlitz@gmail.com

Acknowledgements

My heartfelt thanks to my nephew, Ksawery Rettinger, MEng Biomedical Engineer, for compiling my random notes into a readable article. It is thanks to his efforts in pointing out the errors and ambiguities in my crazy (and often confusing) formulations, that I may now present my work in readable form.

Introduction

At the end of the twentieth century there was a dispute regarding the geometry of the universe. In the end, it was assumed that the most likely geometry is Euclidean - also referred to as 'flat'. Of course, this concerned areas of cosmic dimensions, because in the "everyday" world, Euclid's geometry works with great accuracy. It also works well for inter-galactic distances - the problem concerns vastly larger distances.

For now, the so-called "Big Bang" theory is widely accepted, but the question remains - what exploded? There are still several phenomena that are difficult to explain, including the absurd brightness of the so-called quasar, or the synchronous emission of radiation from structures whose size would exclude the possibility of such synchronicity.

The main evidence supporting the theory of an expanding universe is the red-shift of distant galaxies (the increased wavelength of electromagnetic radiation from these galaxies), which is attributed to the Doppler effect. This model predicts that the universe expands by reducing its density. Assuming an expanding universe, the fulfillment of the cosmological principle (the lack of a specific center of the "world" - that is, each place is the same) requires the adoption of an infinite universe. An infinite universe can hardly expand, since it is difficult to be ever more infinite. Therefore, the model of a three-dimensional spherical universe - in four-dimensional space - must remain. This assumption automatically imposes a curvature of space - the surface of a sphere has non-zero curvature. This is contrary to the commonly assumed Euclidean geometry, and requires a different view on the mechanisms of light propagation - since the Laplace operator of the wave equation takes a different form. The laws of electrodynamics in non-Euclidean space would also act differently.

The following work attempts to explain the observed phenomenon of the red-shift of distant galaxies by adopting the following hypothesis: <u>the speed of electromagnetic waves decreases with distance travelled, due to the curvature of space</u>.

It is commonly assumed that in every possible frame of reference, the speed of light is constant - *c*. However, in the presented hypothesis, it is assumed that the speed of light in non-Euclidean space is dependent on the path travelled. Therefore, the path of light must be considered relative to the point of emission, reflection, or the point at which the light enters a particular medium. Failure to comply with this rule often leads to absurd conclusions (e.g. the interpretation of the Michelson's - Morley experiment).

Based on the aforementioned hypothesis, an attempt is made to create a model of a stationary universe with a non-Euclidean geometry and a <u>constant positive curvature</u>. Because it is difficult (impossible) to predict how "physics" will behave in curved space, conclusions are drawn based on heuristic considerations.

The wave equation for positively curved space includes trigonometric functions which, even after significant simplifications (adopting a spherical symmetry and the $sin(r/R)$ function as a slow-changing one), seem to be analytically unsolvable - one can only try to solve them numerically.

The following work also proposes an experiment that would determine whether the model presented here is reasonable. The experiment would require a direct comparison of the angles of incidence and reflection of light emitted at very large distances - cosmic distances. The difference in the speed of incident and reflected waves would also potentially explain the problems observed with telescopes outside of Earth's atmosphere - including Hubble's Mirror Flaw.

Electrodynamics in Non-Euclidean Space

In Euclidean space (also referred to as flat; “everyday”) - the distance dS between any two points in a reference system is described by:

$$dS^2 = dr^2 + r^2 d\theta^2 + r^2 sin^2\theta d\varphi^2 \quad (1)$$

where,

r – radius (distance from origin),
$d\theta$ – vertical angle difference,
$d\varphi$ – azimuth angle difference.

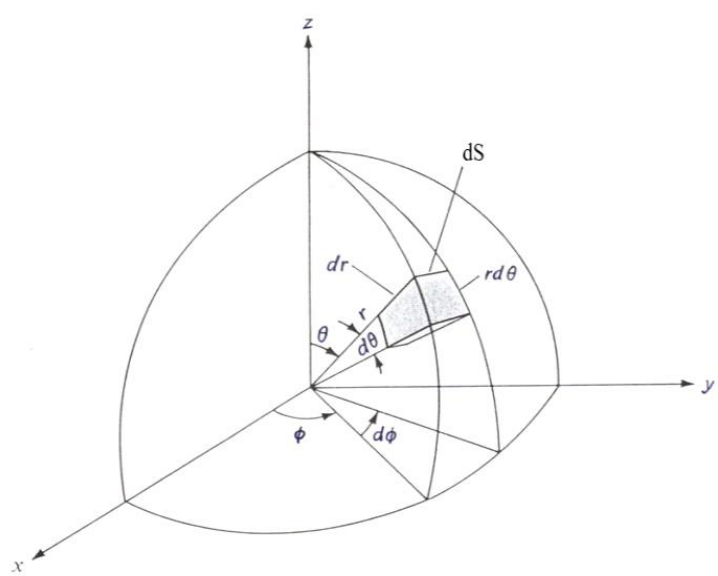

Fig. 1: The figure shows a convenient way of determining the distance between two points on a sphere, e.g between stars in the proposed non-Euclidean space.

For positively curved space, the formula becomes more complex:

$$dS^2 = dr^2 + R^2 sin^2\left(\frac{r}{R}\right)d\theta^2 + R^2 sin^2\left(\frac{r}{R}\right)sin^2\theta d\varphi^2 \qquad (2)$$

where R is the *radius of curvature* - a measure of the deviation from Euclidean space (i.e. the magnitude of space curvature).

In each geometry, the shortest line between any two points is referred to as the *geodesic line*. In Euclidean space, geodesic lines are straight. In space with non-zero curvature, light also travels along geodesic lines, but the lines are no longer straight.

In reference to equation (2), it can be seen that when: $\frac{r}{R} = \frac{\pi}{2}$, $sin^2\left(\frac{r}{R}\right) = 1$, i.e. dS reaches a maximum and $r = \frac{\pi}{2}R$ becomes the so-called horizon.

For small distances, $r \ll R$, $sin\left(\frac{r}{R}\right) = \frac{r}{R}$, and equation (2) simplifies into equation (1), i.e. for small distances, space is flat (almost).

It can be seen that initially, as r increases, dS grows just as quickly in both geometries, but for values of $r \sim R$, the geodesic lines diverge slower for geometries with positive curvature; and for $r = R\frac{\pi}{2}$, they become parallel (Fig. 2).

So in the case of curved space, light moves as if it enters an increasingly dense medium - light rays converge towards each other and, according to the wave description, light slows down.

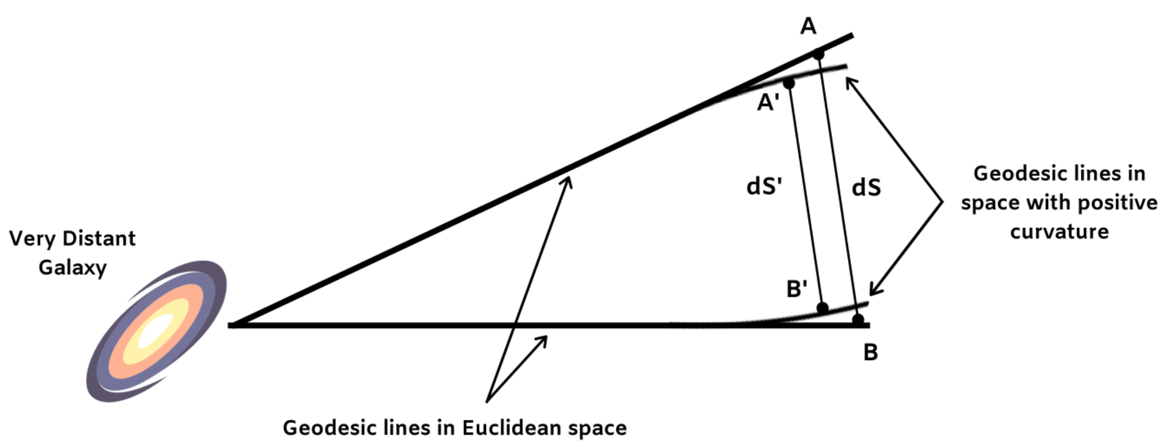

Fig. 2: Light runs along geodesic lines. In the case of curved space, these lines additionally converge towards each other; as if the light is entering an increasingly dense medium.

So if light slows down after traveling a long distance ($r \sim R$ after a very long flight time), the measured wavelength of light from distant objects will be larger, relative to the point at the which the light was emitted - i.e. the light will become more red. A key principle should be adopted here, namely:

> Light (generally an electromagnetic wave) should be considered in a frame of reference centered on the point of emission, whereby the point of emission is either the point of reflection of the wave, or the point of entry/exit of the wave into a dielectric.

It is worth noting that in the case of positively curved space - and for an identical telescope aperture - the observed solid angle of a distant galaxy would be much larger than that observed in Euclidean space (Fig. 3). This could explain the observed absurd brightness of certain distant objects (e.g. certain quasars).

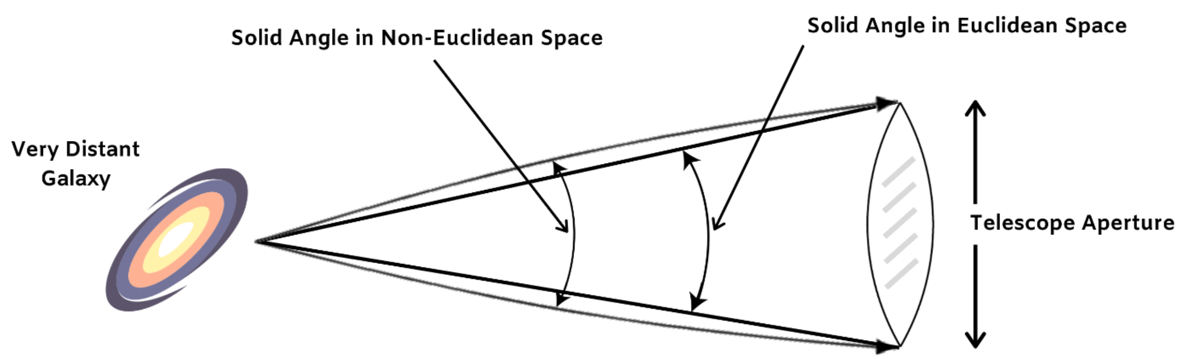

Fig. 3: In the case of positively curved space - and for an identical telescope aperture - the observed solid angle of a distant galaxy would be much larger than that observed in Euclidean space. This difference can be quite significant for very distant objects. This could explain the absurd brightness of certain distant objects (e.g. certain quasars).

Magnetic Fields of Electric Current in Non-Euclidean Space

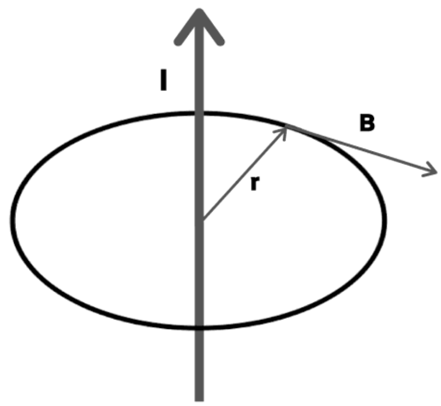

Fig. 4: Electromagnetic induction. $I =$ current, $B =$ magnetic induction intensity, $r =$ radius of circle surrounding the electric flow line.

The laws of electrodynamics require that the product of the length of the circle surrounding an electric current flow line and the magnetic field induction intensity remain constant regardless of the radius of the circle, 3). More generally, the linear integral of the magnetic induction intensity, B, on the contour surrounding the conductor must be equal to the current multiplied by the constant μ_0 (Fig. 4):

$$2\pi r B = \mu_0 I \tag{3}$$

$$2\pi r H = I \tag{4}$$

where,

r – radius of circle surrounding the electric flow line,
B– magnetic induction intensity,
H – magnetic field intensity,
μ_0 – permeability of free space,
I – electric current.

In the case of Euclidean space, the length of the contour surrounding the conductor is also the circumference of the $2\pi r$ circle. However, in the case of the space with curvature R, the length of the contour L, is given by the following equation:

$$L = 2\pi r sin\left(\frac{r}{R}\right) \tag{5}$$

For large distances, the perimeter of the circle of the same radius in curved space is smaller than that in Euclidean space. Therefore, in order for the product of H and L to remain constant (since the current I does not change), the magnetic field intensity in curved space must be larger than that in Euclidean space:

$$2\pi rH = 2\pi R\sin\left(\frac{r}{R}\right)\kappa H \tag{6}$$

$$2\pi rH\mu_0 = 2\pi R\sin\left(\frac{r}{R}\right)\kappa H\mu_0 \tag{7}$$

where κ is a coefficient of the magnetic field intensity in curved space. Therefore (for large distances):

$$B = \mu_0 \frac{r}{R\sin\left(\frac{r}{R}\right)} H \tag{8}$$

$$\mu_k = \mu_0 \kappa \tag{9}$$

where μ_k is the permeability of free space in positively curved space, and κ is given by:

$$\kappa = \frac{r}{R\sin\left(\frac{r}{R}\right)} \tag{10}$$

Consequently, the coefficient μ must increase with radius r in curved space. Since the speed *c* of an electromagnetic wave is inversely proportional to the square root of μ, <u>at large distances the speed of an electromagnetic wave in curved space must decrease.</u>

Of course μ_0 does not actually change, however travelling light <u>behaves as if</u> μ_0 does indeed increase according to this rule.

Electric Fields In Non-Euclidean Space

The electric field produced by a point charge propagates radially. The law of electrostatics states that the flow of this field through the surface surrounding the charge is constant and independent of the spatial distribution of the charge. The concept of the displacement vector D is introduced. The displacement vector is perpendicular to the surface surrounding the charge and its magnitude is equal to the value of the charge divided by the area of the surrounding surface. For a sphere, the following applies:

$$4\pi r^2 D = q \tag{1}$$

where q is a point charge surrounded by a sphere of radius r.

Vector D is also related to the electric field strength, E, on the surface of the sphere by the following relation:

$$D = \varepsilon_0 E \tag{2}$$

where ε_0 is the dielectric constant in a vacuum.

In positively curved space, the surface area of a sphere is given by:

$$S = 4\pi R^2 sin^2\left(\frac{r}{R}\right) \tag{3}$$

where r is the radius of the sphere, and R is the radius of the curvature of space.

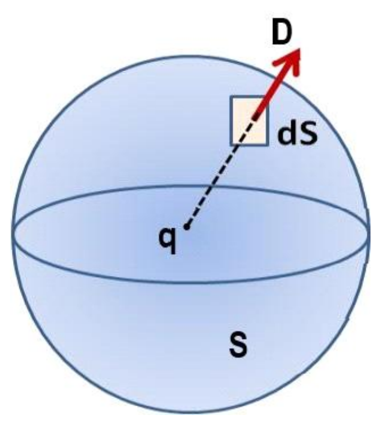

Fig. 5: The displacement vector D is related to the electric field strength, E, on the surface of the sphere via the expression $D = \varepsilon_0 E$. The surface area of two spheres with the same radius will differ in Euclidean space and positively curved space – it will be smaller in the latter.

Since the surface of the sphere is smaller in positively curved space (relative to Euclidean space), the displacement vector D must be larger (since the electric charge remains constant):

$$4\pi R^2 sin^2\left(\frac{r}{R}\right) D_k = q \tag{4}$$

where D_k is the displacement vector in positively curved space.

Taking into account (1) - (4):

$$4\pi r^2 \varepsilon_0 E = 4\pi R^2 sin^2\left(\frac{r}{R}\right) D_k \tag{5}$$

Therefore, D_k is given by the following relation:

$$D_k = \varepsilon_0 \frac{r^2 E}{R^2 sin^2\left(\frac{r}{R}\right)} \tag{6}$$

Therefore, in cases where $r \sim R$ (very large distances), the following expression should be used to express a new dielectric constant, ε_k:

$$\varepsilon_k = \varepsilon_0 \frac{r^2}{R^2 sin^2\left(\frac{r}{R}\right)} \tag{7}$$

It should be noted that the speed of light, c, is inversely proportional to the dielectric constant, ε_0, and the permeability of free space, μ_0:

$$c = \frac{1}{\sqrt{\varepsilon_0 \mu_0}} \tag{8}$$

It follows that for very distant objects (where $r \sim R$, $\varepsilon_k > \varepsilon_0$, and $\mu_k > \mu_0$), <u>the speed of light would be lower than c, and a red-shift would be observed</u>:

$$v = \frac{1}{\sqrt{\varepsilon_k \mu_k}} < c \tag{9}$$

It is worth noting that both ε_0 and μ_0 are constant at any point in space, however <u>the curvature of space acts as if it increases the density of the "medium" of space - for both magnetic and electric fields alike</u>.

Proposed Experiment

The following section outlines a proposed experiment, which would ultimately validate or refute the theory of a large-scale non-Euclidean geometry of the universe.

As aforementioned, light (generally an electromagnetic wave) should be considered in a frame of reference centered on the point of emission, whereby the point of emission is either the point of reflection of the wave, or the point of entry/exit of the wave into a dielectric. In the proposed experiment (Fig. 6), a space telescope would be set up in such a way, as to record images of distant galaxies indirectly – via light reflected from a flat mirror. In addition, the incident light would either be passed through a transparent plate, or directly onto the mirror. As a result, depending on whether the light has passed through the plate, two potential outcomes would be observed.

If the light is passed directly onto the mirror, the angles of incident and reflected light would differ. This is because light changes its properties as it is reflected – the incident light reaches the surface and is re-emitted by the mirror itself, at an increased speed – c. Therefore, assuming a positive curvature of space, the speed of incident and reflected light would differ (since light from a distant galaxy would slow down); and consequently the angles of incident and reflected light would also differ. If on the other hand, the incident light would be passed through a dielectric surface before reaching the mirror, its speed would now match that of the reflected light (since it would be re-emitted by the dielectric). Consequently, the angles of incident and reflected light would also match.

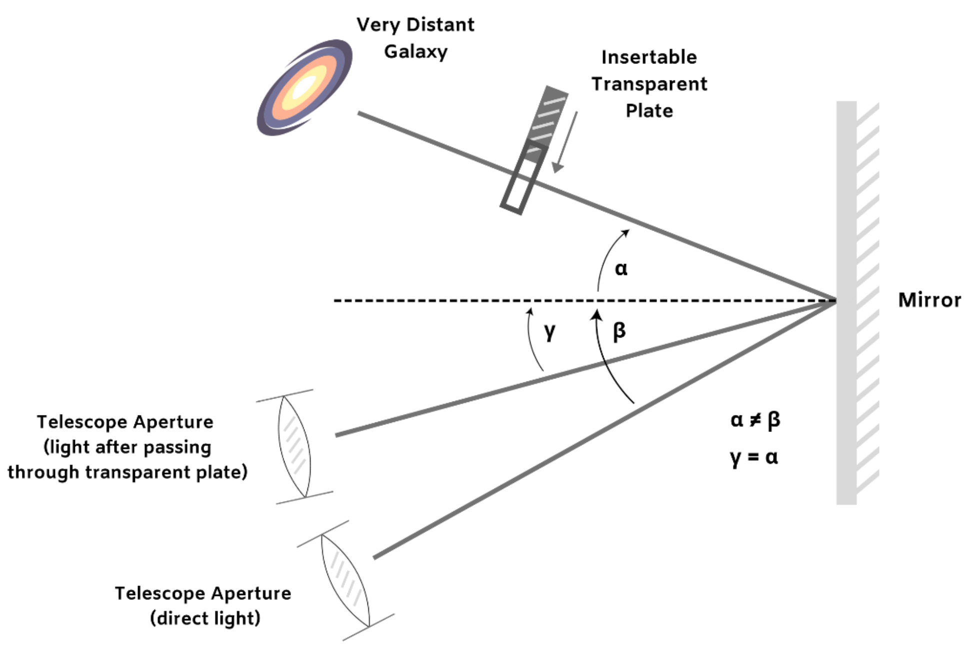

Fig. 6: Proposed experiment**:** a space telescope is set up to record images of distant galaxies indirectly – via light reflected from a flat mirror. The incident light is passed either through a transparent plate, or directly onto the mirror.

To further validate the results of the proposed experiment, the Hubble constant could be derived from the observations, and could also be used to determine the magnitude of the curvature of space, R. In order to determine the connection between the Hubble constant and the curvature of space, an additional distance measurement would be required (for example, brightness). Consequently, this experiment would need to be carried out in space to avoid atmospheric blur.

Relict Radiation

The additional piece of evidence that supports the Big Bang theory is the so-called Cosmic Microwave Background Radiation (CMBR); also referred to as Relic Radiation. The CMBR spectrum corresponds to the radiation of a black body with a temperature of about $2.7°K$, and is considered a remnant from an early stage of the universe. However, a simple calculation reveals another potential source of the CMBR: summing up the radiation of galaxies with regard to their red shift results in radiation with an energy corresponding to a black body; with a temperature of about $2.4°K$.

The energy of radiation at any point in space is the sum of the energy radiated from all spherical shells of thickness dr surrounding the point - where r is the radius of the sphere. If the red shift of galaxies would be omitted, the energy coming from a given sphere would be independent of R (since the sky would be equally bright at each point – Olbers' paradox). Since this is not the case, the red shift must be considered in any calculations. Taking this factor into account, the average energy of a galaxy ($10^{38}W$), and the average density of galaxies in the universe (0.03 galaxies per Mpc^3), the average energy density in the universe can be derived as $5 * 10^{-32}\, W/m^3$. By integrating all spherical shells of thickness dr surrounding a point, from $r \sim 0$ to at least $r = 10^{26}m$ (the maximum distance at which light can remain unobstructed by other light sources), a value of $3 * 10^{-6}\, W/m^2$ can be derived. Accepting that the Universe is a black body (an obvious observation), and multiplying the obtained value by the Boltzmann constant, the average temperature of radiation can be derived as $2.4°K$ – an astonishing result, considering that approximate values of the brightness and density of galaxies were used in these calculations.

Conclusions

The principle underlying the hypothesis presented here is that <u>light (generally an electromagnetic wave) should be considered in a frame of reference centered on the point of emission, whereby the point of emission is either the point of reflection of the wave (e.g. from a mirror), or the point of entry/exit of the wave into a dielectric</u>. This principle results from the fact that reflected light is a wave generated by the mirror, due to currents induced by the incident light. Therefore, the reflected wave has a specific velocity for the medium (in a vacuum $= c$) relative to the mirror (not relative to a particular reference system). Failure to comply with the above principle led to absurd interpretations of the famous Michelson-Morley experiment. Those interested should consider the microwave version of the experiment (which involves microwaves travelling inside waveguides) – in that experiment, the frame of reference for the speed of the wave is clear.

In the classically accepted model of the world, a "balloon shell" (i.e. positive curvature) shape of the universe is assumed, regardless of whether it is expanding or not. Therefore, in intergalactic space, it is necessary to consider the entire path of travelling light – from the point of emission to the point of entry into the atmosphere or the lens of the telescope. If the geometry of space imposes a geodesic curvature, this must be taken into account in the equations of electrodynamics and their modifications.

The result of these considerations is the adoption of a hypothesis that light slow down after travelling sufficiently large distances in outer space. The ideal mathematical method to authenticate this hypothesis would be to solve the wave equation for positively curved space. Unfortunately, the Laplace operator in curved space is very complex, and its analytical solution seems impossible (it can be attempted numerically).

One corroborating piece of evidence for the existence of the Big Bang is the Cosmic Microwave Background Radiation (CMBR) – assumed to be a remnant of the early universe. However, a simple summation of the radiation of all galaxies (taking the red-shift effect into account) gives a radiation intensity of $10^{-6}\ W/m^2$, which corresponds to a temperature of about $2.4°K$ – a value that closely corresponds to the observations. Therefore, the Big Bang theory becomes redundant, as it is no longer needed to support the existence of the CMBR.

Finally, an experiment that would ultimately validate of refute the presented hypothesis is proposed. The experiment would involve a direct comparison of the angles of incidence and reflection of light from very distant galaxies, and would need to be carried out in space to avoid atmospheric blur.