An alternative to the expanding universe theory

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Abstract: The article points out several errors in the expanding space theory that is currently believed to explain the cosmological redshift. The article proposes a tired light theory that gives the correct reduction factor. This tired light theory includes a mechanism that slows down transitions of electrons in the atomic level. The mechanism is not explained: it is only proposed that the fine structure constant changes over long time periods. The article suggests that Cosmic Microwave Background radiation did not come from the Big Bang and that it comes from lost energy of photons traveling through the space as in tired light theories.

Keywords: Gravitational redshift, Cosmic Background Radiation, expanding universe theory, tired light theory.

1. Introduction

Hubble noticed that light from distant galaxies was redshifted, and he formulated Hubble's law. The relevant equations of Hubble's findings in this article are the following:

$$z = \frac{\lambda_0}{\lambda_e} - 1 \tag{1}$$

where z is named as redshift, λ_0 is the observed wavelength and λ_e is the emitted wavelength. Redshift z can be expressed by the expansion factor $R(t)$ of the space as

$$z = \frac{R(t_0)}{R(t_e)} - 1 \tag{2}$$

where t_0 is the observer's time and t_e is the emitter's time. The distance between comoving points changes proportionally to the expansion factor

$$\frac{D(t)}{D(t_e)} = \frac{R(t)}{R(t_e)} \tag{3}$$

so

$$D(t_o) = (1+z)D(t_e). \tag{4}$$

Hubble's constant is

$$H_0(t_e) = \lim_{t_o->t_e} \frac{R(t_0)-R(t_e)}{t_o - t_e}\frac{1}{R(t_e)} = \lim_{t_o->t_e} \frac{z(t_o)}{t_0 - t_e} \tag{5}$$

therefore for small z the following formula is a good approximation

$$z \approx (t_o - t_e)H_0(t_e) \approx (t_o - t_e)H_0(t_0) \tag{6}$$

but $H(t)$ changes with time and the formula many not be accurate enough for large z. If the distance D to a galaxy is not too large, Hubble's law is a reasonable approximation for estimating the distance D of a galaxy from the redshift z of its light:

$$z \approx \frac{D}{c} H_0 \quad \rightarrow \text{ Hubble's law } \quad D = \frac{cz}{H_0}. \tag{7}$$

The expanding universe theory is a way to explain the cosmological redshift z as being caused by an expansion of the space of the universe. The theory claims to be compatible with the General Relativity Theory (GRT). Tired light theories are alternative explanations for the cosmological redshift by photons from a distant galaxy losing energy through interactions with matter and fields. Currently the main stream theory is the expanding universe. The presented article demonstrates the following claims:

1. The derivation of Tolman's surface brightness test that gives the $(1+z)^{-4}$ dependency of surface brightness on the redshift is incorrect in several steps. In an expanding universe, assuming that GRT is correct, the wavelength of an emitted photon increases, not decreases, causing $(1+z)$ increase. The rate of emitted photons does not decrease, the second $(1+z)^{-1}$ reduction is missing. In an expanding universe without GRT the wavelength of an emitted photon does not change and the rate of emission of photons does not change. The argument in the derivation of Tolman's surface brightness test that gives the remaining $(1+z)^{-2}$ reduction makes no sense in my opinion. The factor $(1+z)^{-4}$ of reduction agrees with measurements, but the derivation of this formula in the expanding universe theory is incorrect, see Section 2 for the derivation of this term from the expanding universe theory and lates sections for explanation of the errors in it.

2. Section 3 explains why an expansion of a geometry in itself does not cause any redshift or decrease of the rate of photons. In order to get redshift in the expanding universe theory one needs to add the GRT interpretation that the geometry is the gravitational field. In this interpretation a single photon loses energy when it moves from a higher gravitational (more expanded space-time) to an area of lower gravity (less expanded space-time). That is, GRT would cause a blueshift of photons in the expanding universe theory. In the GRT interpretation the rate of photons would not change. The expanding universe theory cannot be explained by GRT, therefore it is not a verification of the Relativity Theory. Section 3 also explains why the cosmological redshift and decrease of the rate of photons requires a change of electromagnetic forces in an atom, causing a decrease of the the frequency of emitted photons and more. The section proposes that the reason could be that the fine structure constant is not constant over long times, but the section does not look deeper at this issue as it is beyond the scope of the article and not a well researched topic.

3. Tired light theories do not need to give $(1+z)^{-4}$ dependency of surface brightness on the redshift as is currently claimed by the main stream. Section 4 presents a version of a tired light theory that gives the $(1+z)^{-4}$ dependency of surface brightness on the redshift. The section also explains why scattering

does not cause blurring and briefly addresses other arguments against tired light theories.

4. Cosmic Background Radiation is briefly discussed in Section 5. The proposed explanation for it is that it is radiation coming from temperature of matter in space that received the energy that photons lost in interaction with matter.

2. Derivation of Tolman's $(1+z)^{-4}$ factor

The $(1+z)^{-4}$ dependency of surface brightness on the redshift is calculated in the following way. Surface brightness is defined as luminosity per area

$$SB = \frac{F}{\Omega} \tag{8}$$

where Ω is a solid angle and F is the flux. The luminosity distance d_L can be defined as

$$d_L = \sqrt{\frac{L}{4\pi F}} \tag{9}$$

where L is luminosity. It is possible to measure d_L from the apparent magnitude m and absolute magnitude M (which is known in some few cases, like for type Ia supernovas) with the formula

$$d_L = 10^{(m-M)/5-1}. \tag{10}$$

A comoving distance d_M is defined to be d_L from the above formula assuming that the universe is static and non-expanding. For close-by galaxies the formula gives a good approximation of the distance to the galaxy.

A galaxy is a relatively wide object on the sky, so dim that it cannot be seen with a naked eye. Surface brightness SB of a galaxy is a useful concept because for galaxies sufficiently close to us, SB does not depend on the distance. This is so because if the distance D is doubled, the apparent luminosity of each star in the galaxy goes to one fourth, but at the same time the fixed area (the area in a chosen angle) that the telescope looks at is four times larger and therefore (in average) includes four times as many stars, each with one fourth of its luminosity. As a result the surface brightness of the object remains constant.

Yet, this is only true if the galaxy is sufficiently close to us. If the galaxy is far away (and consequently z is large), the surface brightness of a galaxy decreases and measurements show that this decrease is about

$$SB = SB_M(1+z)^{-n} \quad n = 4 \tag{11}$$

where SB_M is the surface brightness without the reduction caused by z. This is not an exact formula: measurements by Lubin and Sandage in 2001 found the exponent n to be between 2.28 and 3.6 instead of 4. They explained it by evolution of the galaxy in time.

The way this term $(1+z)^{-4}$ is derived is as follows: For larger z values holds the equation $d_L = (1+z)d_M$. This is explained by the expansion of space or by the Doppler effect. The formula implies that the flux $F \sim d_L^{-2}$ must be multiplied by $(1+z)^{-2}$.

In the derivation of Tolman's test, this term $(1+z)^{-2}$ is divided to the effects of a redshift of a photon causing $(1+z)^{-1}$ and slowing down of the rate of emission of photons also causing $(1+z)^{-2}$. Dividing the term in this way illustrates the difference between a Doppler effect of the expansive universe theory and the loss of energy because of interactions with matter in tired light theories. The time dilation in the expansive universe theory is in some explanations claimed to come from a Doppler effect. A Doppler effect does slow down both the emission rate of photons and the oscillation rate (frequency) of each photon. In tired light theories the emission rate of photons is not slowed down assuming that the only mechanism is that a photon loses energy in interactions. This is why the main stream claims that in tired light theories there is only the one reduction factor $(1+z)^{-1}$ from photons losing energy and that in tired light theories $SB = SB_M(1+z)^{-1}$.

So far we have the reduction factor $(1+z)^{-2}$ for the expanding universe theory and still need to find another $(1+z)^{-2}$ to get the exponent $n = 4$. In Tolman's test derivation this second factor is obtained in the following way: it is explained that when the photons left the galaxy it was close to us that it is when the light is received, the the visibility angular size that was measured is larger than what the galaxy now has. This means that the angle is too large and the inferred distance d_A is too small. Therefore it is conclude that d_A must be made smaller

$$d_A = \frac{d_M}{(1+z)}. \tag{12}$$

Decreasing the radius d_A increases the angle Ω is calculated in one post in the web as (what the symbols are is irrelevant as this explanation has no sense)

$$\Omega = \frac{d_A^2}{dl^2} = dl^{-2}\frac{(1+z)^2}{d_M^2} \tag{13}$$

and then the surface brightness is

$$SB = \frac{F}{\Omega} = \frac{L}{d_L^2}\frac{1}{\Omega} = \frac{L}{(1+z)^2 d_M^2}\frac{d_M^2}{(1+z)^2} = \frac{L}{dl^2}\frac{1}{(1+z)^4}. \tag{14}$$

I cannot follow this explanation and do not give the reference to the post as I disagree with the calculation, maybe it is not the main stream calculation. But whatever the calculation should be, there is no justification in changing the size of the visible d_A to anything. It is the size that is seen and it corresponds to the size the galaxy had when it emitted the light. Section 4 gives two mechanisms from a tired light theory that can give this missing $(1+z)^{-2}$ factor: one $(1+z)^{-1}$ factor comes from the decrease of the energy of a photon when it interacts with matter and the second $(1+z)^{-1}$ factor comes from the reduction of the intensity of light because not all emitted light arrives to the observed, light can be obstructed or scattered too much.

3. Does geometry cause time dilation and if not, what does?

A metric of GRT in Cartesian coordinates has the form

$$ds^2 = g_{00}c^2dt^2 - g_{11}dx_1^2 - g_{22}dx_2^2 - g_{33}dx_3^2. \tag{15}$$

Infinitesimal time units in places x and x' are $\sqrt{g_{00}(x)}dt$ and $\sqrt{g_{00}(x')}dt$ and typically they differ. Let us not yet understand geometry as a gravitational field. We will show that geometric change of infinitesimal time and space units does not itself cause a redshift or time dilation. Let us look at the cosmological redshift and only think of the geometry, not identifying geometry with gravitation.

We assume that the value of g_{00} at the emitter time and place x differs from in the receiver time and location x'. Let light travel from the emitter to the receiver. We divide the world path of this light beam into small segments that differ in time by one microsecond. Let there be n such segments. We continue the endpoints of these segments as timelike worldpaths to the observer time in the future direction and to the emitter time in the past direction. Let a spacelike worldpath connect x and x' on the time t_o and on the time t_e.

The spacelike worldpath at the time t_e is divided into segments by the timeline worldpaths. Select the fist segment and let light travel from one endpoint in it to the other. The time for this travel is necessarily one microsecond when measured in local time (the time from g_{00} at that segment). The length of the trip is necessarily c times a microsecond, i.e., when measured in local meters it is $c\mu s \approx 300m$. The same is true for the spacelike worldpath at the time t_o. A similar observation is true at every time moment between t_e and t_o at every segment. The trip of light from the starting point of one segment to the ending point always takes one microsecond and has the length c times one microsecond if measured with local time and space units. The whole trip from the emitter to the observer is always n segments whether this trip is spacelike or timelike or lightlike, or travelled with a speed slower than c or with a speed faster than c, provided that the time and length are at every point on the trip measured with the local time and space units.

Assume that the light the emitter used has the wavelength 300 nm in the local time and space units. This light makes 300 m/300 nm $=10^9$ oscillations when traveling one segment. When it comes to the last segment, reaching the observer, this light has oscillated the same number of oscillations in each segment. In the last segment it has made 300 m/300 nm $=10^9$ oscillations and it has the wavelength 300 nm in the observer's meters. This means that the wavelength in local time and space units is the same, so is the frequency. Geometry does not cause a change of wavelength of the type that Hubble observed. No matter what the local value of g_{00} was at the emitter's site, the light that the receiver gets has the same wavelength when measured in the observer's meters than what it had at the emitter's side when measured in the emitter's meter.

In the expanding universe theory the distance of the emitter and the observer grows because space expands at every point, i.e., the geometry expands. Notice that this is not a Doppler effect. It does not cause any redshift to the light that the observer receives. In local time and space units the wavelength and frequency are not changed.

Hubble noticed that the wavelength was increased. Therefore a geometry alone is not an explanation. Let us add GRT. In GRT geometry is the gravitational field. Then a photon, or any electromagnetic wave, or any mass, when moving from higher gravitation to lower gravitation necessarily loses energy because there is a potential energy difference. Higher gravitation means a larger g_{00} and lower gravitation means a smaller g_{00}. In the expanding universe model g_{00} is growing when moving from the emitter to the observer. This means that the gravitational field is getting stronger (without any given reason, it violates conservation of energy as a field has energy). A photon in the expanding universe theory should have a blueshift, not a redshift, if the theory is compatible with GRT. However, timing of events is not changed because of the interpretation that geometry is gravity. The rate of emitted photons should not decrease or increase.

Einstein did confuse the issue by explaining that the time slows down in higher gravity. He thought that this slowing down is explained by geometry, that the value of g_{00} gives the local time unit. It does give the local time unit, but geometry does not cause any redshift or decrease of any rate, as was explained above. By geometry alone, a single photon, when emitted, is a wave and the wavelength and frequency of this wave remains constant when measured in local time and space units. Only by adding the requirement that overcoming a potential energy difference requires work we get the result that a photon loses energy when moving from higher gravity to lower gravity. This is still not time dilation as the apparent time dilation in the Doppler effect: the rate of emitting photons is not changed because the gravitational potential difference must be overcome.

It is not worth to look for a solution to Hubble's redshift by sticking to GRT because GRT has two major errors. The first can be explained in a short way. Look at the metric in (15). Lightlike worldpaths have $ds = 0$, therefore light that goes to the direction of x_i has the square of the speed given by

$$0 = g_{00}c^2dt^2 - g_{ii}dx_i^2 \quad \rightarrow \quad c^2 = \frac{g_{ii}}{g_{00}} \tag{16}$$

as the differentials dt and dx_i are Euclidean and $(dx_i/dt)^2 = 1$. It follows from the above equation that $g_{11} = g_{22} = g_{33} = c^2 g_{00}$ and we can name g_{00} as $\Phi(x)^2$ where $x = (ct, x_1, x_2, x_3)$. The function $\Phi(x)$ is a scalar gravitational potential and the metric is a scalar metric. Thus, if the speed of light is locally constant, then necessarily the metric is induced by a scalar gravitational field. Then notice that the only time independent solution of the Einstein equations in the situation of a point mass in otherwise empty space is the Schwarzschild metric. That means, the Schwarzschild metric is the only possible model for the gravitational field of the Earth or the Sun of GRT is correct. Next notice that the speed of light is not locally constant in the Schwarzschild metric. This contradicts measurements that show that the speed of light is locally constant on the Earth. Einstein knew that the speed of light is not locally constant in the Schwarzschild solution by accepted it, but this is not the only problem with the Schwarzschild solution. The more serious problem in this solution is that the spatial part of a metric should be a Riemannian metric. If it is not, then one cannot use Riemannian metric tensor and cannot derive Einstein's equations. The spatial part of the Schwarzschild metric is not a Riemannian metric: there is no inner product in the tangent space that gives this metric, see [1]. See also in [1] why this problem is not generally known: journal editors refuse to review papers showing errors in the Relativity Theory. See also [2] for reasons why the gravity is a a field, not geometry.

Therefore we forget GRT and try to find some other way that can explain Hubble's observation that there is cosmological redshift.

Let us start with a concrete example. We demand that light that was send by the emitter with the wavelength 300 nm arrives to the observer with the wavelength 600 nm.

The frequency of the light at the observer is

$$\nu_o = \frac{c}{\lambda_o} = \frac{3*10^8}{600*10^{-9}}\frac{1}{s} = \frac{1}{2}10^{15}Hz. \tag{17}$$

The frequency of the light at the emitter is

$$\nu_e = \frac{c}{\lambda_e} = \frac{3*10^8}{300*10^{-9}}\frac{1}{s} = 10^{15}Hz. \tag{18}$$

The meters of the observer and the emitter relate as

$$600*10^{-9}m_o = 300*10^{-9}m_e \quad \rightarrow \quad m_o = \frac{1}{2}m_e. \tag{19}$$

The seconds of the observer and the emitter relate as

$$\frac{1}{2}*10^{15}\frac{1}{s_o} = 10^{15}\frac{1}{s_e} \quad \rightarrow \quad s_o = \frac{1}{2}s_e. \tag{20}$$

This means, it is possible to get the redshift that Hubble observed, but it means that the emitter really did send light with a longer wavelength, it was longer in the emitter's own meters. In the case of a galaxy this light came from some star and from some atom. If the atom emitted a photon having a lower frequency that a photon coming from the particular atomic transition has in the Earth, then it means that something changed emissions in an atom.

If it would be the case of gravitational redshift and gravitational time dilation, then the answer in [3] may suffice: electron orbits are not changed by an external gravitational field, time is not actually dilated, what happens is that a photon that is emitted does not have all of the energy that the transition in the electron belt gives: some of that energy is used to overcome a gravitational potential difference.

But here we cannot assume that there was present any strong gravitational field to cause the redshift. There are not many options to explain how an atom could emit photons with lower energy. If an atom emits a photon with a smaller energy than it normally would, then (at least) one of the paramters that determine the energy levels of electrons should be different than normally. These parameters are: electron charge, electron mass, $\hbar$, c and ε_0. Most of these are believed to be constants, see [4] for Sommerfeld's solution of the electron orbits in a hydrogen atom. The only one that might not be a constant is ε_0.

Instead of ε_0, the actual constant that may not be a constant is the fine structure constant α, ε_0 is a constant derived from α. The fine structure constant is the more fundamental one, it gives the strength of the Coulomb force.

Thus, I come to the conclusion that the explanation for the cosmological redshift is that α had a different value in the past. I cannot in this article explain if this is possible or give any analysis of this hypothesis, only that Hubble's redshift must have an explanation and the expanding universe is not an explanation (it has errors) and a tired light theory without a mechanism that slows down emission of photons (and their emission rate) is also not an explanation (it gives a wrong factor $(1+z)^{-1}$ or $(1+z)^{-2}$).

There is some indication that α may not be a constant. According to the Standard Model (with the Higgs mechanism of the Unified Field Theory), the fine structure constant α did change in the far past: according to this theory all four interactions were initially of comparable strength and a phase transition triggered by lowering temperature caused the splitting of the original unified force into four interactions. There is also some research work on whether α does change, thus there is certain suspicion that it might change.

The only alternative to α having changed is that the cosmological redshift is caused by acceleration. This alternative is not the expanding universe theory. Though in some explanations of the expanding universe theory the cause of time dilation is said to be the Doppler effect, this theory does not include a Doppler effect. The space is expanding, the galaxies are not moving. An expanding space is expanding geometry where both the space and time units expand at each point. Space expansion does not cause a Doppler effect. There is no acceleration time dilation in the expanding universe theory: as the galaxies do not move, they also do not accelerate. While in the Special Relativity Theory (SRT) interpretation the galaxies do have a relative velocity, the expanding universe theory does not include SRT time dilation by velocity because the galaxies do not move. A theory that is based on the Doppler effect could give a frequency change, but it cannot produce all characteristics that are needed to fit measurements. This is why the expanding universe theory does not have moving galaxies and instead has an expanding space. I do not see any other way to look for the explanation to Hubble's redshift than to check if all constants that influence electron orbits in an atom are really constants.

A pure tired light theory also does not explain all observations. This is because type Ia supernova events last longer when they happen at a galaxy with larger z. This means that something is slowed down in the emitter. Some explanations of the expanding universe theory claim that a Doppler effect causes an apparent slowing of time, in which case there is no need for anything to slow down in the emitter side, but the expanding universe theory is not based on the Doppler mechanism, and the theory does not work. Therefore something must slow down in the emitter side.

There are only two differences between the observer and the emitter: the place and the time. Let us look at the space difference. The emitter is far from us for a large z. We could image that we are somewhere close to the center of the universe and these large z galaxies are close to the edge of the universe. We could imagine e.g. a Cosmic Egg theory where the whole universe is inside an egg, which might have physical boundary or a boundary by a singularity as in the event horizon of the Schwarzschild metric. Such a border of a type might create a huge gravitational field, so it could be possible to explain the slowing of time in far away galaxies with the gravitational time dilation. But this alternative seems highly speculative. It is easier to think that the essential difference is time, not space. The emittions happened a long time ago. This means that something that influences photon emissions has changed over the time. If so, what else could it be than that α changes over long times?

I do not know if a change in the fine structure constant could explain why a type Ia supernova lasts a different time for different z, but the electromagnetic force strength is relevant for a supernova of this type. In type Ia supernova two neutron stars merge and pass a critical mass that causes a collapse of electomagnetic forces in atoms that have so far kept the stars from collapsing by gravitation. I have not looked at what happens in this collapse, but in a neutron star the electron belts have already been destroyed and electrons have merged with protons into neutrons, but there still is the Coulomb force resisting the gravitational force. We see here the role of the Coulomb force and why the value α could be relevant.

4. A tired light theory

A pure tired light theory cannot give the $(1+z)^{-4}$ dependency. Let us assume that a changed value of α (or something else) causes both the reduction of frequency of a photon by $(1+z)^{-1}$ and the reduction of the emission rate of photons by $(1+z)^{-1}$. Together these give a $(1+z)^{-2}$ factors. It is the same factor that the expanding universe theory explains with the Doppler effect (which is not a Doppler effect and actually does not give the factor). Next we need the second $(1+z)^{-2}$ factor. I cannot understand the argument that the expanding universe theory has for this second $(1+z)^{-2}$ factor. I think this factor is unexplained in the expanding universe theory. It can be explained in a tired light theory as soon will be seen.

The reduction of surface brightness by photos interacting with matter on their way over the space gives a further reduction of $(1+z)^{-1}$. This is easily seen: from

$$z = \frac{\lambda_o}{\lambda_e} - 1 \qquad 1+z = \frac{\lambda_o}{\lambda_e} = \frac{h\nu_e}{h\nu_o} = \frac{E_e}{E_o}. \tag{21}$$

Thus $E_o = E_e(1+z)^{-1}$. Brightness is proportional to power and these photons coming to the observer move energy in time, i.e., they are power.

Some photons are scattered away or obscured by matter in the space and they do not come to the observer. Let us assume that these incidences are randomly distributed and the number of incidences is proportional to the emitter intensity I_e and to the time t, and that there is some (so far unknown) constant β that gives the rate of these incidences. For a small z we can use Hubble's law:

$$I_o = I_e(1-\beta t) = I_e\left(1 - \beta\frac{D}{c}\right) = I_e\left(1 - \beta\frac{cz}{H_0 c}\right) \tag{22}$$

$$I_o = I_e\left(1 - \beta\frac{z}{H_0}\right) = I_e\left(1 - \frac{\beta}{H_0}\right) + \frac{\beta}{H_0}I_e(1-z). \tag{23}$$

This can look good for small z but not for a larger z as the second term turns negative if $z > 1$. Let us modify the term to the form

$$I_o = I_e\left(1 - \frac{\beta}{H_0}\right) + \frac{\beta}{H_0}\frac{I_e}{1+z}. \tag{24}$$

The formula should look very much like that. This is because for small z is must agree with (23) and for very large z the received intensity must be inversely proportional to the distance, and for very large z, distance is proportional to z.

Equation (24) has an unknown β. We can fix β by boundary conditions. For $z = 0$ we should get $I_o = I_e$ and we do. For $z \to \infty$ we should get $I_o = 0$. This is only achieved if $\beta/H_0 = 1$. Inserting this result we have the formula

$$I_o = \frac{I_e}{1+z}. \tag{25}$$

This is not a strict derivation of the effect of intensity reduction. Measurements should be used to find the correct formula. It is a heuristic way to deduce what the formula should look like and probably the correct formula is rather similar. It can also be mentioned that measurements are not so clear if the correct exponent is exactly $n = 4$.

This heuristic formula gives the last $(1+z)^{-1}$ reduction term. It shows that it is possible to get the result $SB = SB_M(1+z)^{-4}$ from a tired light theory.

There remains some objections against a tired light theory that need to be answered. The first one is that any scattering of light causes blurring of images, but the Hubble Space Telescope has given extremely sharp images. It is claimed that this argument (with other arguments) refutes tired light theories.

This argument is easily shown invalid. The claim is that the following proposal holds:

Proposal: If photons are scattered then the images are blurred.

We know that there is matter in the space. There are larger objects like stars and planets, and smaller objects like comets and meteors, and even smaller, like dust, but there are even extremely small matter objects if the Standard Model is correct: the vacuum itself creates virtual particle-antiparticle pairs. As there is matter and light interacts with matter in many ways, light must interact with matter. We have two facts:

Fact: Light does interact with matter in the space and these interactions include various forms of scattering.

Fact: The images from the Hubble Space Telescope are not blurred.

Verdict: the Proposal is false. There is scattering and it does not cause blurring.

The reasons why scattering does not cause significant blurring is simple. Consider a galaxy at the distance D. Assume that there is a displacement of the size H perpendicular to D. H is kiloparsecs. In the telescope we see the displacement as having the size h, h is millimeters, much smaller than H. During the trip of the length D there are n interactions that cause displacement that would blur our image. Let us assume that these displacements are identical independent random variables. There are movements towards us, as the beam does reach us. This means that D is a sum of n random variables that have an average $\bar{x}$, i.e., $D = n\bar{x}$. The random variables also cause displacements in the perpendicular direction. They have a standard deviation σ. It is not the standard deviation of the movements towards us, but a standard deviation of the perpendicular movements (that are proportional to the movements towards us). The sum of n random variables has a standard deviation $\sqrt{n}\sigma$ of perpendicular movements. Then the visible displacement, h, has the standard deviation

$$h = \frac{d}{n\bar{x}}\sqrt{n}\sigma = \frac{d\sigma}{\bar{x}}\frac{1}{\sqrt{n}}. \tag{26}$$

For large n the standard deviation of h is negligible. As the displacement events are random, the average displacement of h is zero. This means: if some light does come to the telescope, it must have the direction of its momentum and the displacement in the perpendicular direction within a very small range of variation. As a consequence, there is very little blurring of the image in a telescope placed in the space.

Let us list the common objections to tired light theories:

1. There should be blurring if there is scattering. False.

2. A tired light theory cannot give the $(1+z)^{-4}$ factor. False.

3. A tired light theory cannot explain how the duration of type Ia supernova can depend on z. This is an open question, maybe α changes and it may explain it.

4. Where does the lost energy go? This is to be addressed in the next section.

5. Where does the energy go? Can it be, to the CMB radiation

The fourth argument against tired light theories asking were does the energy go is a confused argument. There is matter in the space and there is interaction of light with this matter. We know that there must be lost energy and this energy must go somewhere whatever theory we have for the Hubble redshift. This energy does not cause any paradox or objection to any theory. The lost energy goes somewhere, we do not know where, but it is not any objection to tired light theories.

Instead, it is a valid question to ask where did the energy of the Cosmic Background Radiation come from. The main stream claim is that it is a relict of the Big Bang.

The article has shown that the expanding universe theory is false. Therefore there is no basis for assuming that there was a Big Bang. There is no need for explaining that CMB is a relict from the Big Bang. If there was no Big Bang and there is CMB, then there is a valid question of what is the origin of CMB. There is lost energy of light from stars and this lost energy must have heated rare matter that there certainly is in the space. There is an unanswered question of where did this lost energy go. It is reasonable to ask if this energy did not incidentally go to make CMB.

The CMB corresponds to 2.7 K temperature. As there are hot and otherwise radiating objects in the space, like stars, the matter in the outer space does get heated. What temperature could this matter have if it is bombarded by CMB in 2.7 K? If it has the temperature 2.7 K, how do we know it is not the source of CMB?

Accknowledgements

One objection that I was given by Google AI is that in order to any matter in the outer space to emit radiation, like CMB radiation, it should be opaque and if the matter were opaque, then one could not see much anything in the space. But this is not a valid objection. A car has heater wires in the back window, and despite that it is still possible to see through the glass. Small and rare matter particles do not noticable obstruct a view, and we know that there is some matter in the space. Google AI invents when it does not know (but not as

well as a human) and AI thinks that tired light theories and also my papers are fringe. AI has all confidence in the main stream, relativity theory, Einstein, all that "scientific truth". But I have to acknowledge that two discussions that I had with Google AI were very interesting, many of the objections to tired light theory came from these discussions. AI is amazing, that one must admit. But it does not always know. Just a comment: this article was not written by AI, I found all objections from AI incorrect.

A note on the references

Today there is an insane style of adding many references to articles. There should not be any references that are not essentially needed. There is no sense in referring to articles that deal with the same topic but have not used in the arguments of the presented article, every reader can easily find such articles by googling/literature. There are also survey articles for that purpose. I also do not refer to articles that I find incorrect except in some few cases, like if they are directly relevant or they are e.g. from Einstein, long dead and immune to falsely referring to him by misunderstanding his argument, which can happen. In some fields, like the Relativity Theory, this rule prevents from referring to most main stream articles. My references are to my own papers and they are pointed out as source for finding the explanation for a claim that I make in the article.

6. References

[1] Jormakka, J., "Why the Schwarzschild metric is not a metric and reviews from General Relativity and Gravitation", ResearcGate, 2026.

[2] Jormakka, J., "Gravity is a field in flat space, not geometry of space-time", ResearchGate", 2025.

[3] Jormakka, J., "Explanation of time dilation in a GPS satellite without using the relativity theory", ResearcGate, 2026.

[4] Jormakka, J., "A Look at Sommerfeld's Fine Structure Formula", ResearcGate, 2026.