Tired light hypothesis possibly got confirmation by direct observation of light scattering.

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Abstract.

The hypothesis of Big Bang is still predominates today but have more and more difficulties. Too many galaxies, galaxies too mature, galaxies have active nucleus due to very big black holes appeared faster than galaxy may be formed – all those facts discovered by James Webb Space Telescope seems to bring the Big Bang idea to the end. But the important question appears: what is instead? One of the old ideas resurrected now is tired light hypothesis. Indeed, there is no process found in the nature so far that has absolutely zero friction – the slow loss of energy by that or this mechanisms is present everywhere. Why would light be an exception (and the present understanding of light is counting on this assumption). However, the initial idea of tired light is not possible – the electromagnetic path to lose energy will not help (see the article). So the idea is to have light losing energy in very small steps – in this situation the energy loss is possible to explain while preserving the other properties of the observed light from the far galaxies. This idea also easily explains the “active” nuclei of the far galaxies by the direct observation of the light scattering in the vacuum. This scattering is actually too strong for gravitation and way too weak for electromagnetic force, so the fifth force is possibly involved here.

Introduction.

Among the many discussions concerning associated with Big Bang phenomena [10] (absence of Tolman effect is an example) mainly the disproves of the Big Bang hypothesis were indirect. One of the strongest confirmation of Big Bang, on the opposite was direct: the light is reddening and in the electromagnetic realm this is not possible to explain by scattering. Since the space telescopes demonstrated clear pictures of the nearby galaxies with easy to observe red shift, the only plausible explanation was: the red shift is due to Doppler-like effect (not necessarily the direct motion of galaxies away from observer, may be the creation of space between them, but that would look the same). Once the Doppler effect is confirmed, the only hypothesis left is some hot origin of the Universe, which is still in motion.

The best direct rejection of the Big Bang would be direct observation of the light scattering on an intergalactic distances. Obviously the light scattering due to Compton effect instantly creates the big change of direction of the light pulse and with such dominating process we would never see far galaxies. Indeed, due to relation E=p*c the change in energy necessary to recreate the red shift means the huge change in pulse (if the red shift is assumed to happen in one step). For example the red shift for galaxy 80 millions of light years away is 0.005 of the initial value (measured for the green light). The change of pulse would be also $0.005*p_o$ ($\Delta p/p_o=\Delta E/E_o$, here p_o is the initial pulse and E_o is the initial energy, directly from E=p*c formula). The resolution of the telescope would be also 0.005 radian. For the detection of the dwarf galaxy of IC 4653 with visible size of 1.6 arcmin at the distance of 80 millions of light years [1] the resolution necessary should be 0.0004 radian, which is order of magnitude below the value of 0.005. Yet the galaxy is easily observed by Hubble space telescope and may be visualized in the greatest details [2]. That was the reason why the initial idea of the light reddening caused by scattering was rejected 100 years ago. Doppler-like mechanism has no scattering issues and predominated. In a similar consideration other known mechanisms of the light scattering like Raman scattering experienced by photon many times may be also rejected on the same reasons – even for the smallest change in energy involved in the Raman scattering the light will be scattered only around N=100 times to reach the same level of energy loss like 0.005. That would lead the associated resolution being better approximately sqrt(N)=10 (see [3] for more details why the scattering angle will grow as sqrt of the number of scatterings) which is not much. Which makes the only way the tired light hypothesis may be valid is the presence of unknown yet mechanism of light scattering – the scattering in each step is so enormously small, that despite the light is reddening (energy is lost) the direction of propagation is not changing perceptibly (here is the statistical sqrt(N) law would be very helpful) [3].

Main part. Images of far galaxies demonstrate the light scattering present.

What would be the direct observation of the light scattering confirming the tired light hypothesis based on such new mechanism looks like? Despite the energy and pulse change took place in enormously small steps they are not infinitely small and sooner or later the blurring of the image should be revealed. The analysis of the known image blurring caused by atmosphere may be helpful here. Indeed, before the creation of the space based telescopes the Earth based telescopes were known to have limitation induced by atmosphere (that is why the best place for Earth based telescopes is away from light sources and as high as possible – Chile mountains, Hawaii mountains etc). The thinner the atmosphere the better the image. Still the direct observation of the same galaxy by the Earth based telescope and space based telescope reveal the problem (do not pay attention to the supernova, this is nothing to do with the discussion):

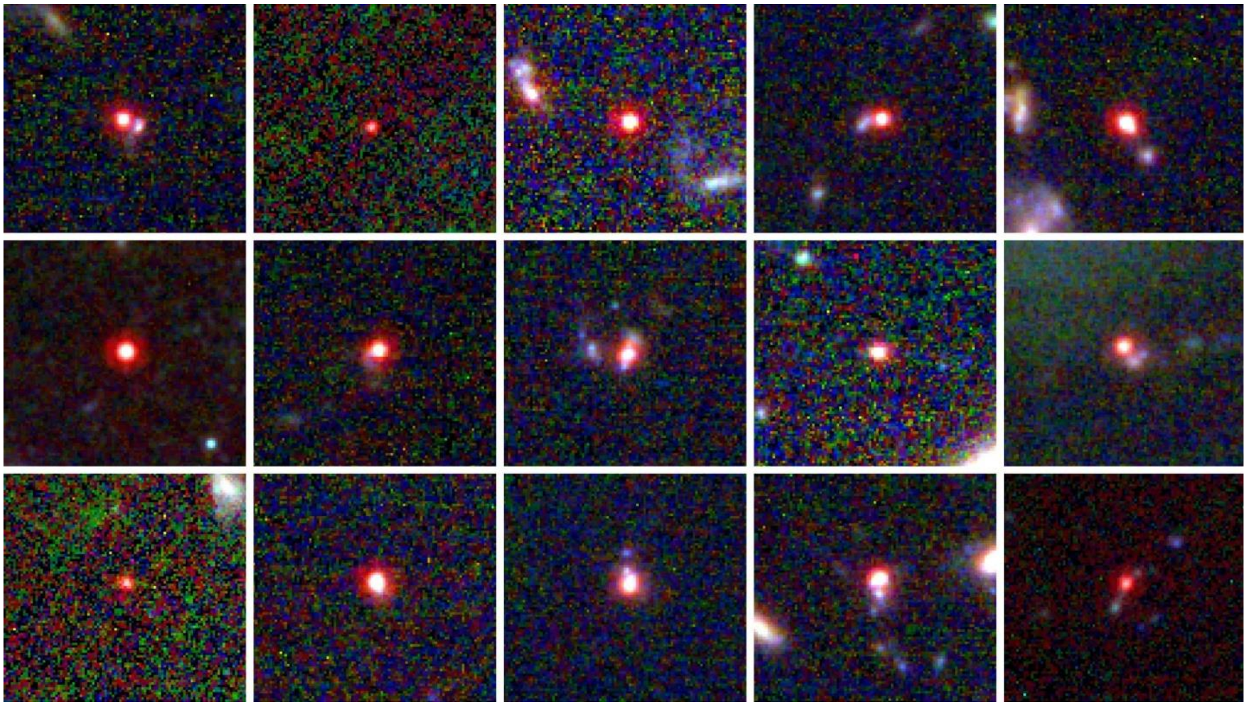
This picture is taken from [4]. The atmosphere-caused blurring blurs the bright center photons with much dimmer photons originated from the center of the galaxy and makes the nucleus looks gigantic. While the galaxy as imaged by the space based telescope shows no real active nucleus the image on the left looks like the galaxy is hosting enormous supermassive black hole with the size of active area almost ¼-1/3 of the total diameter of the galaxy.

The supermassive black holes are known to exist relatively close to Milky Way and are resolved by Hubble telescope in the greatest details (Seifert galaxies). Here is the well known picture of NGC 6573 (only 150 millions of light years away from Milky Way) made by Hubble [5]:

But even this known as having supermassive black hole galaxy does not have really big bright central spot. May be only around 1/7-1/5 of the total diameter of the galaxy.

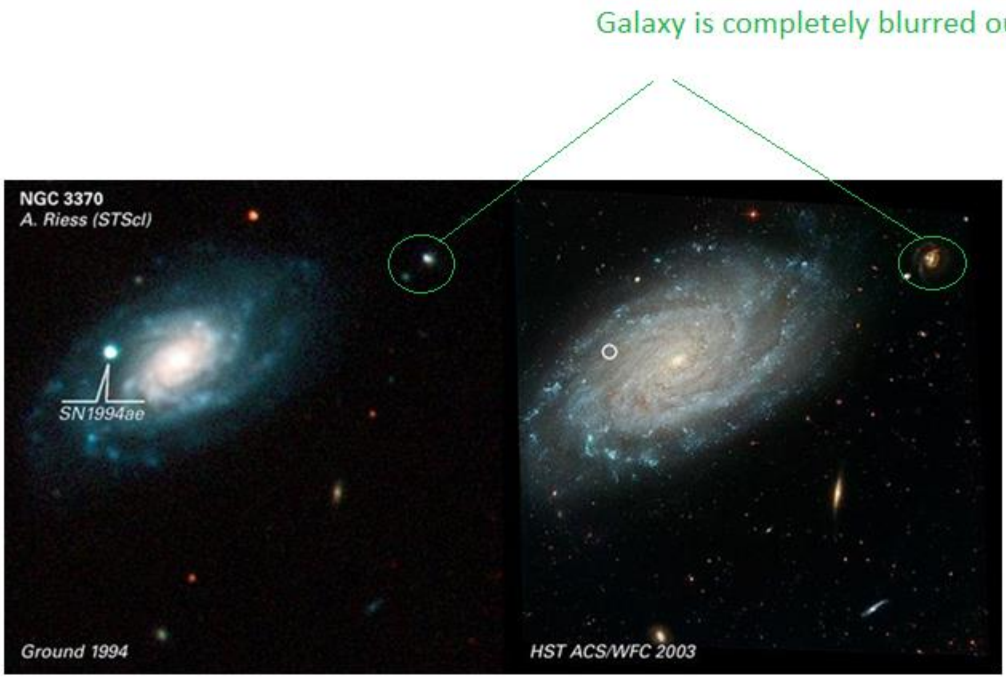
Therefore from the point of view of direct observation of scattering any picture made by space based telescope which would looked like the picture of NGC3370 (see above) made from Earth based telescope (the image is known to be subject of scattering) would create the necessary proof of the light scattering caused by something in the otherwise complete vacuum.

Recent debate about the abundance of the supermassive black holes 13 billions of light away observed by James Webb Space Telescope demonstrates the photos exactly like expected from the point of view of scattering present [6]:

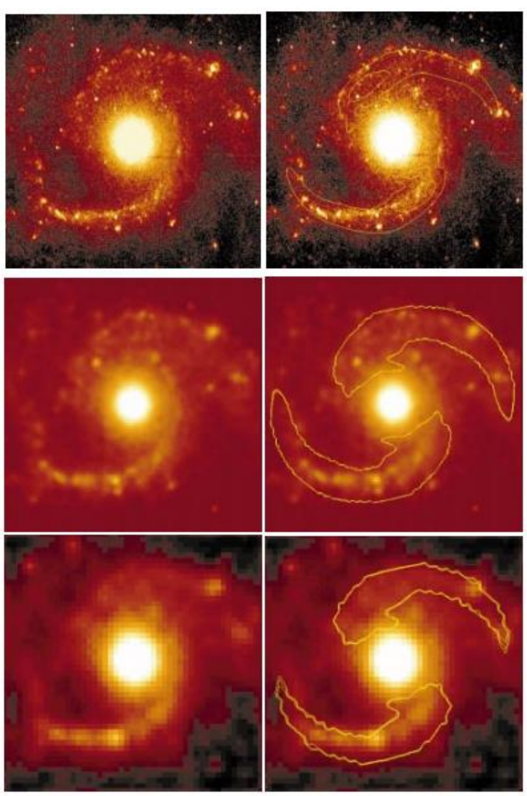


Not only the presence of such supermassive black holes in the “early” universe contradicts to any reasonable model of Big Bang (this is indirect disproof of the Big Bang), but the appearance of the galaxies itself causes huge doubts about interpretation. The bright area is reaching 1/3 or even ½ of the total diameter of the galaxy, well above what is expected for the space based telescope (may be 1/7-1/5 of the total diameter) and even larger than the known effect caused by the Earth atmosphere. Such extra super massive black holes are explained in [7] by the new mechanism of the formation of very large black holes from primordial black holes (instead of normal mechanism of merging). The authors forgot that if the black holes are so huge and abundant in the “early” universe they must be absolutely enormous (and even more abundant) in the present day universe, yet the best Hubble found is photographed in [5].

The opposing mechanism of the unusual look of “early” galaxies is of course the scattering of light. Despite the mechanism is not known, the final effect looks like the influence of the Earth atmosphere on the image in Earth based telescope: the bright but small (normally small) core is mixing the photons with the rest of the galaxy and slowly “spreading” toward the end of galaxy. For really strong scattering the whole galaxy would look like one uniform unresolved patch of light (see the excellent example of complete blurring in the picture above [4], shown by circles here:



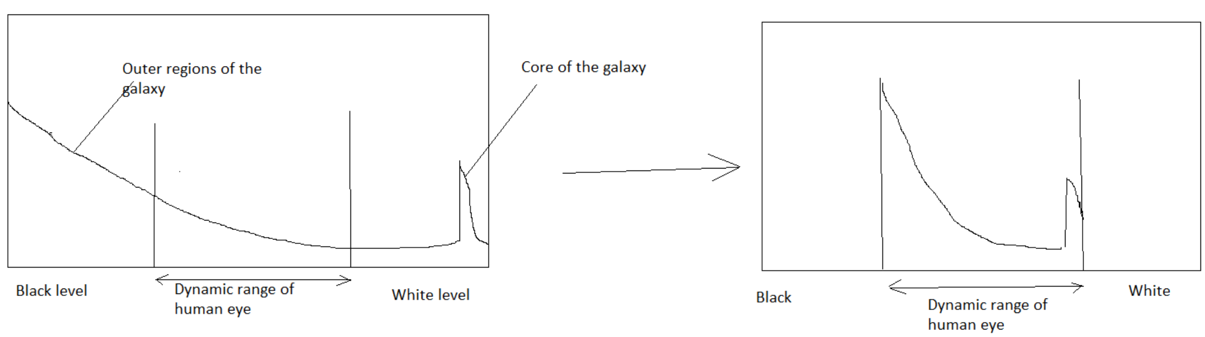
The remaining question is about the ultimate resolution of the telescope itself – if the resolution is approaching the limit but no scattering is present, how the galaxy should look like? The modelling of artificial red shift was already performed and published in many articles [7]:



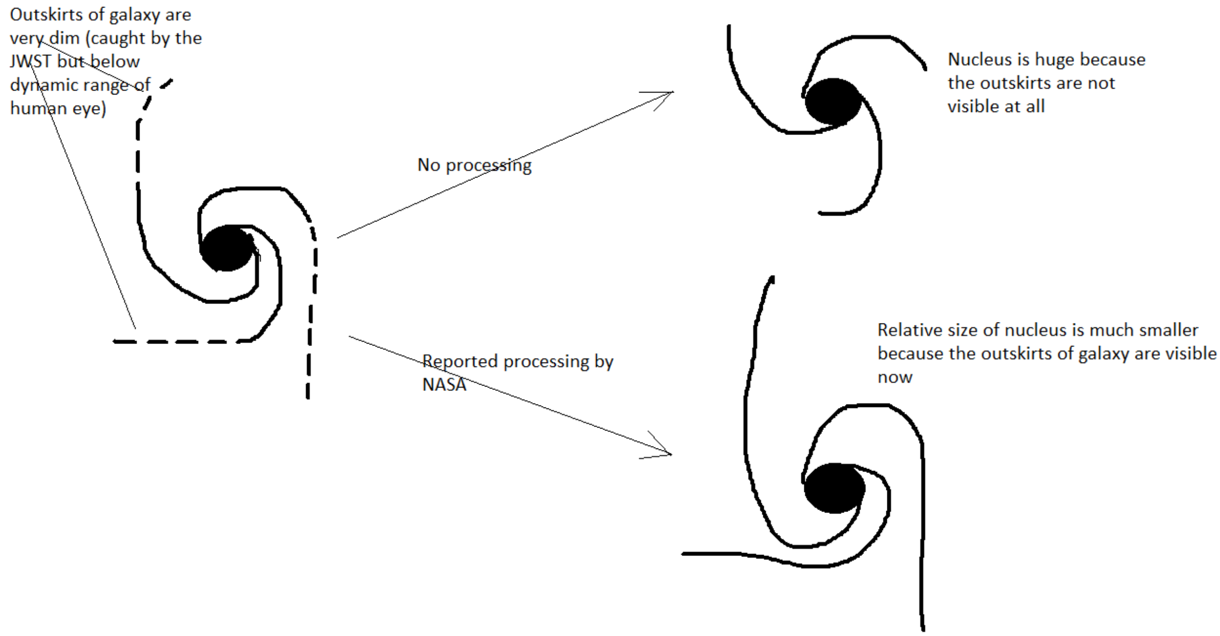
As it is possible to see the resolution is poorer and poorer, yet the center of galaxy is not “spreading”. A similar analysis is made in [8]. For even poorer resolution with assumption of now light scattering the bright center of the galaxy will go to the central pixels of the digital camera only while having the rest of the galaxy looks dimmer and dimmer. The last unknown factor here - it is possible that the images published in [6] are not raw images but rather images already processed by some kind of smoothing filter which of course will make the central core looks larger to make the image looking better. According to the NASA webpage a more gentle procedure takes place:

“A mathematical function is used to increase the brightness of the darkest pixels, while maintaining details within brighter pixels in the image. Stretching and compression are required because Webb’s images have a vast dynamic range.” [9]

From my perspective this procedure should not greatly mix the core pixels (presumably the brightest) and near core pixels (which are bright enough to be seen but not barely bright to be “enhanced’). Probably the mathematical algorithm described makes the histogram of brightness of pixels for the galaxy looking like this:



And this procedure is not moving the darker pixels into the core pixels. Rather it makes the opposite – make the core visibly **smaller** because the otherwise invisible outskirts of galaxy are enhanced:



Thus the postprocessing should make the relative size of the center of the galaxy smaller, not larger because the otherwise not visible very dim outskirts of the galaxy are now fully visible.

It only emphasizes that the “supermassive black holes” abundant in “early universe” [6] is in reality the first direct observation of the light scattering which is expected to cause such an effect. The galaxies are having the very large nucleus because the light is scattered in the vacuum. The reason is of course not electromagnetic interaction but something else [3,8]. Analysis outlined in [3] for gravitational interaction demonstrates that it is too weak for James Webb telescope to reveal it (many orders of magnitude weaker, JWST is still expected to deliver absolutely clear images). Thus most probable reason is fifth force [10] – stronger than gravity but many orders of magnitude weaker compare to electromagnetism (some researches long ago suspected the fifth force being present in the so-called “gap” – a huge separation between the gravitational and electromagnetic forces).

Theoretical interpretation based on statistical approach.

The idea is to use the formula universal for any photon E=p*c as the first approximation to the relation between the energy and pulse. Energy is supposed to be lost in discrete steps but each step is proportional to the energy of the quantum just before loss (this is necessary assumption because it will give the same dispersion as it should be for Doppler effect – energy shift is directly proportional to the frequency, that is energy of the photon because of E=hv). Let Eo is the initial energy of the photon.

1. $\Delta E_1=\alpha E_o$

2. $\Delta E_2=\alpha(E_o-\Delta E_1)=\alpha E_o-\alpha\Delta E_1=\alpha E_o-\alpha^2E_o=\alpha E_o(1-\alpha)$

3. $\Delta E_3=\alpha(E_o-\Delta E_2-\Delta E_1)=\alpha(E_o-\alpha E_o+\alpha^2E_o-\alpha E_o)=\alpha E_o-2\alpha^2E_o+\alpha^3E_o=\alpha E_o(1-2\alpha+\alpha^2)=\alpha E_o(1-a)^2$

4. $\Delta E_4=\alpha(E_o-\Delta E_3-\Delta E_2-\Delta E_1)=\alpha(E_o-\alpha E_o+2\alpha^2E_o-\alpha^3E_o- \alpha E_o+\alpha^2E_o-\alpha E_o)=\alpha E_o(1-3\alpha+3\alpha^2-\alpha^3)=\alpha E_o(1-\alpha)^3$

….

$N.\Delta E_N=\alpha E_o(1-\alpha)^N$

For simplicity $1-\alpha=\beta$, and $\alpha=1-\beta$, α is extremely small and β is very close to 1.

Then the total loss of energy by the photon after N scatterings is:

$\Delta E=\sum_1^N (\alpha E_o\beta^N)=\alpha E_o\sum(\beta^N)$

But the **finite** sum is the sum of the **finite** geometric series [11] and the equation becomes:

$\Delta E=\alpha E_o(1-\beta^N)/(1-\beta)=\alpha E_o(1-\beta^N)/\alpha=E_o(1-\beta^N)=E_o(1-(1-\alpha)^N)$

And the resulting energy of the quantum after N scatterings is:

$E_N=E_o-E_o(1-(1-\alpha)^N)=E_o-E_o+E_o(1-\alpha)^N=E_o(1-\alpha)^N$

For the change of pulse (vector quantity) in each step the formula would look like this:

$\underline{\Delta p_i}=\Delta p_i(angle_i)$

Here Δp_i is the absolute value of the change of pulse (at scattering number i) and $angle_i$ is an angle between the chosen direction (initial direction of light propagation) and the change of pulse (at scattering i). Since the scatterings are assumed to be stochastic (the assumption of the isotropy in the direction perpendicular to the direction of the light propagation is enough), the classical approach at the statistical analysis of polymer elongation is applicable here (ideal chain formula [12]):

$(\underline{\sum \Delta p_i})^2=\sum(\Delta p_i)^2+\sum_i \sum_j Cos[Angle(i)angle(j)](\Delta p_i)(\Delta p_j)$

And since the angles are all stochastic, all the members with Cos are summed to zero (exactly like in [12]).

Therefore, the absolute value of a change in pulse after N scatterings is (formula p=E/c is used here):

$\Delta p_N=\Delta E_N/c=\alpha E_o(1-\alpha)^N/c=\alpha p_o\beta^N$

$(\Delta p)^2=\sum(\alpha p_o\beta^N)^2=\alpha^2p_o^2\sum(\beta^2)^N= \alpha^2p_o^2(1-(\beta^2)^N)/(1-\beta^2)= \alpha^2p_o^2(1-(1-\alpha)^{2N})/((1-\beta)*(1+\beta))$

Since $1-\beta=\alpha$:

$(\Delta p)^2=\alpha^2p_o^2(1-(1-\alpha)^{2N})/(\alpha(2-\alpha))= \alpha p_o^2(1-(1-\alpha)^{2N})/(2-\alpha)$

$\Delta p=p_o sqrt(\alpha)sqrt[(1-(1-\alpha)^{2N})/(2-\alpha)]$

Finally two formulas appears for the change of energy and deviation of pulse away from the initial direction (scattering of light):

$\Delta p/p_o=sqrt(\alpha)sqrt[(1-(1-\alpha)^{2N})/(2-\alpha)] \quad E_N/E_o=(1-\alpha)^N$

The formula for energy can not be simplified further: if the expansion is used, for certain number of N energy may become negative. The formula for change of direction ($\Delta p/p_o$ is simply angle of scattering) may be simplified further ($(1-\alpha)^{2N}$~$1-2\alpha N$, since α is extremely small):

$\Delta p/p_o=sqrt(\alpha)sqrt[(1-(1-\alpha)^{2N})/(2-\alpha)]\sim sqrt(\alpha)sqrt[(1-(1-2N\alpha))/(2-\alpha)]\sim sqrt(\alpha)sqrt[(1-(1-2N\alpha))/(2-\alpha)]\sim$

$sqrt(\alpha)sqrt[(2N\alpha))/(2)]\sim sqrt(\alpha)sqrt[N\alpha]\sim sqrt(N)\alpha$

And final formulas for the analysis of the light scattering and galaxies blurring is here:

$\Delta p/p_o = \mathrm{sqrt}(N)\alpha$ $E_N/E_o=(1-\alpha)^N$

In this approximation the energy is slowly drained from the photon, but the direction changes much slower. If the α is very small, the value of N is gigantic, the total loss of energy of photon may be very big, but the deviation is still very small and the photon behaves like it is losing energy but not scattered.

However, contrary to case of infinitely small scatterings for the very small but finite ones (quantum mechanics should rule the scatterings anyway, so they can not be infinite number of scatterings) sooner or later the scattering should become visible. In [3] the calculations were done for gravity case and it turned out that JWST is not strong enough to see them. However, the pictures demonstrate that it is already visible, so the new mechanism should be present.

The values of N and α may be estimated as follows: for Z=13 (13 billions light years away) the energy left in photon is calculated as follows: $E_N/E_o=1/(Z+1)=1/14=0.0714$. Assuming the average galaxy has the size of 100000 l.y. (Milky Way) and the blurring is visible close to 1/3 of the size of the galaxy the approximate angle of scattering would be $\Delta p/p_o=30000/13*10\exp(9)=2.31*10\exp(-6)$.

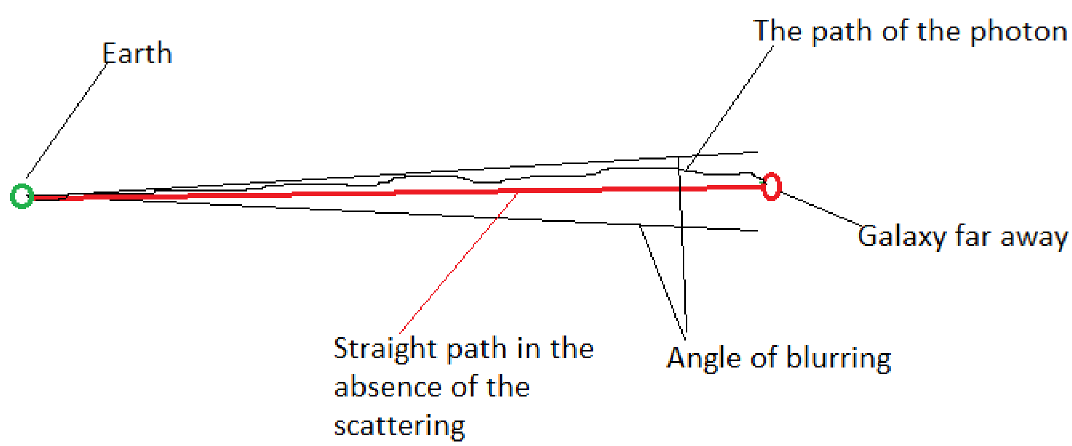
That corresponds to the equations:

$2.31*10\exp(-6)=\mathrm{sqrt}(N)\alpha$

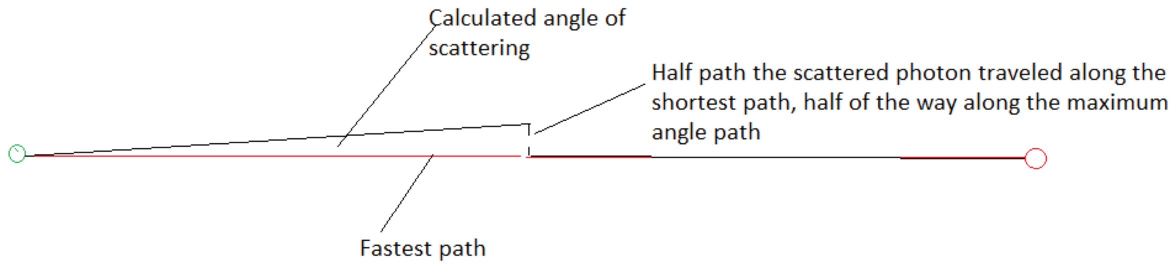
$0.0714=(1-\alpha)^N \rightarrow \ln(0.0714)=\ln(1-\alpha)^N=N*\ln(1-\alpha)\sim-N\alpha \rightarrow -2.639=-N\alpha$

Then N=1.31*10exp(12), α=2.01*10exp(-12)

The observed time dilation for the supernova at the high distances may be estimated as follows. The path of the photon, because of scattering is not straight line any more but rather scattered in the cone of the angle of scattering.



For evaluations the data from Internet are used: the time dilation for the galaxy at Z=1 (light traveled for 7.731 billions of years [14]) is measured to be around 20 days [13] (for Z=1 the width factor is around 2). For evaluation the time delay between the fastest photons and average ones is calculated as follows:



For the galaxy with Z=1 the value of N may be calculated as follows:
N_1=1.31*10exp(12)*7.731/13=7.80*10exp(11)

And angle of deviation is sqrt(N)*α=8.83*10exp(5)*2.01*10exp(-12)=1.77*10exp(-6). The difference in path between the straight photon and wandering photon would be the difference between the hypotenuse and cathetus of the corresponding right triangle (b>>a):

$c=\mathrm{sqrt}(b^2+a^2)=\mathrm{sqrt}[b^2(1+a^2/b^2)]\sim b*(1+a^2/b^2)\sim b+a^2/b$ and $c-b\sim a^2/b$

For the example chosen the value of b=3.87*10exp(9) light years, a=1.77*10exp(-6)*3.87*10exp(9) =6850 light years and distance difference is approximately $(6850)^2$/3.87*10exp(9)=12.1*10exp(-3) light years, which corresponds to time delay of 0.0121 of year, 4.4 days. This is smaller compare to 20 days expected but the accuracy of the estimation is not large, too. Still the time delay and corresponding dilation of any event due to pure statistical interpretation is present (time dilation is the second frequently mentioned proof of the Doppler-like explanation of the red shift).

The largest problem with such interpretation is the dependence of the energy loss at each step on the energy. This assumption is contradict to the quantum mechanics to some extent: the value of the energy loss should be in exact quanta independent of energy. For example the Raman scattering involving virtual states allow to explain the energy loss which is much less than the energy of the quantum, but the position of the line for Raman scattering is at exactly the same shift from the main line independently of the energy of the light quantum of the exciting laser. It means that the energy at this process, whether it is 5-th force or electromagnetism or gravity must be lost at the quantities independent of the energy [3] what instantly will lead to the wrong dispersion of the red shift. On the contrary the dispersion of the red shift (frequency dependence of the red shift) created by Doppler-like effect describes the experiment absolutely (and actually this fact, not the absence of the scattering is the strongest argument toward Big Bang and Doppler-like nature of red shift). The only way to introduce the energy dependence is to use the probability of the quanta loss being dependent upon the energy. In this case the photon will encounter many potential "5^{th} force agents" but the **probability** of energy loss is proportional to the energy of quanta (the energy transfer still takes place in the same quantum, but the smaller the energy of photon the less frequently. Still this is the hardest problem to solve in the tired light explanation.

Another phenomenon to be expected is the spectral line broadening – this is not possible to observe even for farthest galaxies with angle of 2.31*10exp(-6). The expected line broadening is determined by the statistical law 1/sqrt(N), where N is the number of interactions. That would be 1/1.4*10exp(6)~ 10exp(-6) for relative line width. Unfortunately even the relative line width from the He-Ne laser [16] is still too broad to see this effect: 1.5GHz/4.74*10exp(14)=3.16*10exp(-6). And the typical line width for the green line from galaxy is merely 10exp(-4) due to inevitable presence of the velocity based broadening – for common temperatures the velocity is around 10 km/s and broadening should be v/c~3*10exp(-5) plus other ways to broaden the line. This also means that the discussed in some places line broadening in connection with tired light hypothesis through the scattering is not so far relevant – the number of interactions is so high, that the statistical deviation in the number of interactions still preserves the line width intact (other mechanisms may be investigated easily).

Conclusions.

In the present publication the idea of the statistical approach to the tired light hypothesis is presented. When the hypothetical interaction is so small that the number of scatterings for the light arrived from the farthest galaxies is more than trillion, the angle of scattering is very small and the closest galaxies are clearly seen – no direct observation of light scattering is possible. When however, the James Webb Space Telescope is observing the far galaxies, the effect starts to reveal itself and from that phenomenon the evaluation of the number of scattering and how big each one may be made. It turned out the JWST is observing such phenomenon well before the predicted in [3] range – it means that the scattering is too strong for gravitational interaction discussed in [3]. Tentative conclusion is that it is 5th force involved here – the interaction is way too weak for any electromagnetic mechanism.

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