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On the photon aging paradox

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1 Standard cosmological model and the photon observation

At the beginning of the 20th century the astronomers started to investigate the radial velocities of the distant galaxies using their spectra measurement. They revealed that the overwhelming majority of galaxies *recess from us*, so their spectra have a redshift. One believed that a spectrum shift could be due to *kinematic* factor, i.e., a *relative velocity* of a galaxy only.

However, in 1927 G. Lemaitre **[Lemaitre, 1927]** predicted such the phenomenon in the expanding Universe using General Relativity. Unfortunately, he also used the term “Doppler’s effect”, though in fact its model was based on the *distance* to a galaxy at the emission time, not on its *relative velocity*. This model states that the light propagates along a geodesic world line where 4-interval $ds^2=c^2dt^2 – a^2(t)dr^2$ is equal to *zero*. Then $|dt| \sim a(t)dr$, in other words, *time* “dilates” too during the Universe expands *spatially*. So, Lemaitre considered the emission and observation stages of the leading edge and the end of the wave packet and showed that the observation duration is longer than the emission one, i.e., a redshift of light should be present.

The observational data confirm the effect of the time dilation (see, for example, **[Longair, 2008]**, Sect. 5.5.1). For instance, the hypothetical standard time period between the basic stages of the supernova brightness curve turns out to be proportional to the distance from Earth. Thus, the explanation of redshift given by Lemaitre is now the conventional one.

2 Contradiction and doubt

However, such the explanation enter in the fundamental contradiction with the Universe energy conservation law: if the photon’s energy decrease during the Universe evolution (due to wavelength and time period dilation), then where this energy comes to? The Lemaitre’s theory predicts nothing about this, though the different possible empirical explanations were supposed (and refused).

Also I find reasonable another question. In any case a photon flies away from a source, and our photon does not know *why namely* the distance between it and an observer decreases, is its velocity due to galaxies recession or peculiar galaxy motion (or their combination). So, what we have to do with the “true” Dopplers’s effect due to relative moving off? If we do not have to take it into account, then why? If we have to account it, then how to combine the velocity and scale factor?

It is interesting to note that author of the recent work **[Melia, 2012]** found the same expression for the cosmological redshift in 6 different *static* metrics without the Universe expansion, so we could ask, is there a *real* connection between redshift and a time-space dynamics?

Furthermore, in the work **[Chodorowski, 2011]** its author gives the link to the paper **[Bunn and Hogg, 2009]** where was pointed out that in order to settle properly this problem, one has to transport parallely the velocity four-vector of a distant galaxy to the observer’s position. Performing such a transport along the null geodesic of photons arriving from the galaxy, they found that the cosmological redshift is *purely kinematic*. Also, Chodorowski in his own publication argues that one should rather transport the velocity four-vector along the geodesic connecting the points of intersection of the world-lines of the galaxy and the observer with the hypersurface of constant *cosmic time*. He also shows that the so-called *proper* recession velocities of galaxies, commonly used in cosmology, are in fact radial components of the galaxies' four-velocity vectors.

3 The critical analysis of the Lemaitre's model

The effect predicted by Lemaitre was implicitly deduced from one important *assumption*: one supposed that the light oscillations just have a classical (non-quantum) origin, and an observer is hypothetically able to receive some "instant" signals corresponding (*independently* one from another) to the maximums of wave pocket and then determine the time interval between them. However, one can doubt such the model – the light carries by the photons whose discrete nature was discovered at the beginning of the 20th century. So, we can suggest that physically the maximum's and minimum's locations (or two adjacent maximums) of the same time period are *dependent* on time between them and are some entity.

If so, then the single photon could be considered as some *pulsating* object (with constant or evolving wavelength) moving from a source to an observer. Furthermore, the evolution model should be specified. Let us consider the simplest versions:

(a) the wavelength and time period of a photon "*dilate*" during the Universe evolution;
(б) the wavelength and time period of a photon *do not change* during the Universe evolution.

The case (a) just corresponds to the Lemaitre's model and to conventional approach, however, the unsolved problems (energy loss and accounting of purely kinematic Doppler's effect) remain. In the case (b) the both problems are eliminated: the photon energy (and full the Universe energy) are conserved, and redshift could be explained by purely kinematic Doppler's effect.

If the cosmological redshift is indeed due to the *relative* velocity of the recessing galaxies, then on can easily answer another FAQs (Frequently Asked Questions).

Can a recession velocity even of the most massive object become close to the velocity of light? Of course, yes, because this velocity does not represent something extraordinary, it may be simultaneously very small for another observer, it is the *relative* effect.

And what about the very distant objects which go away and have a *superluminal* velocity? Answer is: nothing, because after they gain the velocity of light its photons were not able to reach an observer that resides on Earth, i.e., the object leaves our events horizon.

Sometime one states: *recently the astronomer were able to observe the very distant objects (with redshifts more than 10) whose radiation should be generated just after Big Bang. But these objects could not locate too far one from another because of small size of the earlier Universe, so, the photons between them could not travel so long*. However, it is not true: the light cone (and events horizon) exists always in the Universe, i.e., there are always a hypothetical objects whose radiation goes to us infinitely long.

4 Photons and alternative cosmology

I noted above that the Lemaitre's model of "dilating" light wave contradicts fundamentally to Energy Conservation Law. I proposed to eliminate this contradiction using the "constant" photon's model.

Meanwhile, since 1993 I develop the alternative cosmological model where the Energy Conservation Law is *not correct*. I state that our Universe is a black hole in an external hyper-universe from which it absorb the energy and matter (it is the *real* reason of our Universe's expansion). In this cosmological model the mass and energy of any particle (including photon) increases proportionally to the Universe's age (see **[Shulman 2004, 2008, 2011]**).

It turns out that in this model we also have to use a constant wavelength of light quanta during all it's the travelling time. However, the photon's *energy* linearly increases with time due to Planck's parameter *h* evolution (not due to a space-time parameter's evolution!). Thus, the term "Planck's constant" turns out to be incorrect in this model.

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