 doi:10.20944/preprints202009.0093.v1

Communication

Bridging Macro and Micro Cosmos by a New Sight on "Photon Aging" – A Simple Approach for Explaining Diracs Large Numbers

J. Michael Köhler [1]

[1] Techn. University Ilmenau, Institute for Micro- and Nanotechnologies/ Institute for Chemistry and Biotechnology, PF 10 05 65, D- 98684 Ilmenau, Germany, michael.koehler@tu-ilmenau.de

* Correspondence: michael.koehler@tu-ilmenau.de

Abstract: The energy loss of photons due to the cosmological red shift is interpreted, here, as a periodical process of transferring electromagnetic field energy into the space. The transferred energy portions are independent on photon energy if this transfer occurs with their frequency. The amounts of periodically released energy are so small that the related ultra-long wave length photons have to be understood as perfectly delocalized. Thus, the described point of view bridges the quantum micro cosmos with the macro cosmos. It is proposed to regard this energy exchange as a typical property of universal time arrow and to interpret the "large numbers", in particular the reciprocal of product of Hubbles constant and Planck time as the fundamental parameter describing cosmic evolution.

Keywords: Red shift; Photons; Quantum delocalization; Energy dissipation; Hubble constant; Large numbers

1. Introduction

It was about 80 years ago that Paul Dirac recognized a general numerical relation between micro and macro cosmos [1], and in his conclusions he was optimistically enough to say that a new cosmology could be based on this relation. But up to now, there is no general accepted explanation for the reason of the high numbers which connect the world of smallest particles with the extension and age universe. Despite a lot of theoretical investigations, the step by step improving of particle physics, astronomy and astrophysics, opening of new observation channels into the space and the accumulation of huge data sets, the number of non-understood fundamental problems of cosmology seems to increase.

The numerical ratio between electrostatic and electromagnetic energy reflected by the fine structure constant α (FSK) is one of the unsolved mysteries. This constant is directly related to the Rydberg constant and, therefore, also connected with the quantum character of electron orbits in atoms. Quantum cosmology tries to find the relations between macroscopic and microscopic world. But, Diracs observations and the deficiencies in explaining the connection between macro and micro world remains one of the most central problems of physics.

Here, there will be hint to the trivial fact, that quantum objects can be related not only to small, but also to very large spatial dimensions. Such a situation can be assumed for very low frequency electromagnetic waves, for example. In the following, the regular connection between the cosmological red sift of light and an energy release with a maximum of quantum delocalization will be discussed.

2. Large number ratios

The largest ratios can be concluded from the comparison of elementary and fundamental objects with cosmic dimensions. The age of the universe t_c is estimated with 13.8 Ga, recently [2]. A time-related ratio z_t can be estimated by comparing the cosmic age with the elementary hubble time t_p (G=constant of gravitation, h= Plancks constant, c= light vacuum velocity):

with $t_p = \sqrt{(G * h/(2*\pi*c^5)} = 5.4 * 10^{-44}$ s (1)

$z_t = t_c / t_p \approx 8 * 10^{60}$ (2)

Analogously, the ratio between the estimated cosmic mass m_c and Plancks mass m_p can be regarded. Cosmic mass was estimated on the basis of critical density [3] under the assumption that the total mass of universe is adapted to this value deciding the future between re-contraction and collapsing or infinite expansion of universe. The total mass is given by [4]:

$m_c \approx 1.5 * 10^{53}$ kg (3)

The Planck mass can be calculated from fundamental constants [5]:

$m_p = \sqrt{\{ [h/(2*\pi)] * c / G]\}} = 2.2 * 10^{-8}$ kg (4)

It corresponds to a fundamental energy E_p:

$E_p = m_p * c^2 = 1.98 * 10^9$ J (5)

Their ratio z_m is given by:

$z_m = m_c / m_p \approx 8*10^{60}$ (6)

It is obviously the same value as obtained above for the time ratio:

$z_m \approx z_t \approx z$ (7)

Using this value and the Planck length l_p, it is possible to derive a characteristic large length l_c:

$l_c = z * l_p \approx 8 * 10^{60} * 1.62 * 10^{-35}$ m $= 1.3 *10^{26}$ m (8)

The length l_c could be related to the recent diameter of the universe if a space model is assumed in which the space is imaged like the three-dimensional surface of a four- dimensional space. Otherwise – for the recently favoured flat universe – a cosmic diameter of 93 billion light years is estimated [6]. Despite the view that the product of cosmic age and Hubble constant might have no direct physical meaning [7], l_c can be interpreted by the wave length of the photon with the lowest thinkable energy E_0, for the first mentioned case, because a wavelength exceeding the distance of the visible horizon makes no sense:

$E_0 = h * c / l_c \approx 1.5 * 10^{-51}$ J (9)

 doi:10.20944/preprints202009.0093.v1

It is hardly to assume that such a small value can be measured in any future. But, it should be looked if this tiny amount of energy could play any role in the recent universe.

3. New sight on "photon aging"

An "aging of photons" was originally regarded as a possibility for explanation of red shift. In this original imagination, an expansion of universe was not required, if the photons are thought to loose energy to their environment during their long journey across the universe. This type of thinking was coupled, for example, with the assumption of a kind of "cosmic ether" or "light ether" which was interacting with the photons and lowering their frequency. But, this model was excluded because there was no observation or experimental finding supporting such an aging by a medium.

The idea of an expanding universe substituted this transfer of photon energy to the environment by a continuous stretching of space resulting in a stretching of the wave length of travelling photons. This is the idea of "cosmological red shift". In this model, the decrease of photon frequency is only caused by the spatial expansion and the assumption of any interaction with a "light ether" is not further required. The shift in photon energy can be regarded as a "cosmological aging".

The concept of cosmological red shift by space expansion includes automatically an energy loss of travelling photons. Therefore, the question results, where we have to look for the lost energy of photons and for a general mechanism which can explain the transfer of the photon energy to somewhere. This mechanism should be valid for photons of all frequencies.

Photons are marked by their frequency and the interpretation of cosmological red shift by a space expansion demands for a continuous reduction of this frequency for all travelling photons. Therefore, the simplest general principle of energy loss should to be connected with the oscillation period of the electromagnetic field which is represented by the photon. A step-by-step energy loss in each oscillation period corresponds to a digital mechanism in the process of cosmological shifting of photon energy to higher wave length.

In same time intervals t, high energy photons lost more energy than low energy photons. The energy loss in a certain time interval ΔEt is dependent on the energy of photons:

$$\Delta Et \sim h * \nu \qquad (10)$$

But, low energy photons are marked by long oscillation periods, high energy photons by short oscillation periods. Therefore, the relative energy loss per oscillation period $\Delta E\tau$ is independent on the photon energy:

$$\Delta E\tau = const \qquad (11)$$

Each photon loses exactly the same absolute amount of energy during one oscillation period. The differences between photons consist only in the frequency of energy loss.

The energy loss of a photon during one oscillation period can be estimated by the ratio of the photon frequency ν to the Hubble constant. The Hubble constant H_0 is estimated to be about 70 km/Mpc. Recent observations report, for example, 68 km/sMpc [8] and 74 km/sMpc [9]. The value of 70 km/Mpc for H_0 is equal to a frequency of $2.27*10^{-18}$ s. The reciprocal of this value is about 14 billion years, what corresponds approximately with the above mentioned age of universe. The photon energy loss per oscillation period is given by:

$$\Delta E\tau = E_{photon} * (H_0/\nu) = h * \nu * (H_0/\nu) = h * H_0 \approx 1.5 * 10^{-51} \text{ J} \qquad (12)$$

This value is a universal value for all photons. Each photon releases this tiny amount of energy during each oscillation period.

If H_0 is understood as the reciprocal of the life time of the universe t_c, the characteristic length scale of the universe l_c is expressed by an approximation corresponding with eq. (8):

$$l_c \approx c / H_0 = 1.32 * 10^{26} \text{ m} \qquad (13)$$

This relation could help to understand where the small energy portions from photons are remaining. This question could be answered by a look to this length, to the character of oscillation process and the absolute amount of energy.

The oscillations of all photons are oscillations of a localized electromagnetic field. The degree of localization of each photon is given by their wave length. It describes the principle uncertainty of the position of a photon from the quantum mechanical point of view. This uncertainty corresponds to the length of travelling path of a photon in each oscillation period. High-energy photons are stricter localized then low-energy photons.

What should be the character of this release of ultra-weak photons? It is reasonable to assume, that the periodic energy release from the travelling photons by the "cosmological aging" proceed by an electromagnetic process. It is suggested here, that in each oscillation interval, each photon is split into a photon of very slightly reduced energy and a second photon carrying the very tiny amount of the energy difference between the state of photon before and after one oscillation period.

The universal periodic photon energy loss $\Delta E\tau$ is identical with the above mentioned smallest thinkable energy portion E_0 (eq. 9). The wave length of these photons corresponds to order of magnitude of the size of the universe, there frequency to the reciprocal of its age. That means under respecting the quantum character of this photonic energy loss, that the position of these ultra-weak photons has an uncertainty in the order of magnitude of the diameter of the universe. It can be said that the periodic photonic energy loss of cosmologically aging photons is immediately dissipated over the whole universe.

4. Irreversibility functions in evolving universe

One consequence of this interpretation of cosmological energy release from travelling photons is that the whole universe is permanently fed by photonic energy. The summation of the huge number of released small energy amounts of all photons leads to a significant global energy input, which balances the energy loss of photons, thus that the total energy of space and photons remains constant. It is to assume that the energy input into the space results into a superposition of field energy and finally into photons of enhanced, but still low frequency. In consequence, the number of photon in the universe increases while the mediate energy of photons is reducing over time. This effect corresponds to the spontaneous and non-reversible cooling of the universe due to the expansion process. Despite of increase of photon number, the density of photons decreases in this process.

Universe is marked by a general irreversibility. Globally, this function is reflected by the increase of size, the decrease of mean matter density, the decrease of mean global temperature, for example. Locally, this irreversibility is reflected by the increase of wave length of photons, by condensation of matter, processes of star formation and star development. The universal irreversibility suggests to asking if there might be really things which are not affected by irreversible changes. Obviously, there are some fundamental physical constants which are independent of the evolution of the universe. But, it should be asked if there exist real physical objects which show no change during the evolution of universe. Otherwise, we have to take in mind that even smallest objects like protons and other elementary particles could be subject to irreversible change.

The energy contents of photons are changing by a linear function, if the assumed acceleration of cosmological expansion is neglected. Eq. (12) can be used to define a power of energy loss ΔP_{photon} for all photons:

$$\Delta P_{photon} = h * H_0 * \nu \qquad (14)$$

Thus, corresponding to the well-known red-shift an energy loss function can be approximated for each photon:

$$E_{photon}(t) \approx h * \nu_0 (1 - t*H_0) \qquad (15)$$

For the temperature of electromagnetic cosmic background radiation, such a function can be approximated by an interpolation using the recent cosmic microwave background (CMB) under the assumption of a starting point at "Planck temperature" T_P of $1.42*10^{32}$ K [10]:

$$T_t = T_P / z^x \qquad (16)$$

$$x = - \ln(T_t/T_P) / \ln(z) \qquad (17)$$

with the recent CMB-related temperature ($T_t = T_{CMB}$):

$$x = -\ln(2.7K/1.42*10^{32}\ K) / \ln(8*10^{60}) = 0.52 \approx 1/2 \qquad (18)$$

resulting into:

$$T_t \approx T_P / \sqrt{z} \qquad (19)$$

Analogously, a function for the development of the proton mass from Planck mass could be formulated if a shift in mass of elementary particles during cosmic evolution would be taken in mind:

$$m_{proton} = m_P / z^y \qquad (20)$$

In this case the exponent y is obtained to be:

$$y = -\ln(1.67*10^{-27}\ kg/2*10^{-8}\ kg) / \ln(8*10^{60}) = 0.31 \approx (1/3) \qquad (21)$$

The cosmic time arrow is presented by the linear increase of z, obviously. This number is reflecting the cosmic age. It is possible to connect this number with a kind of numerical entropy S_n:

$$S_n = \ln(z) = 140.23 \approx 1/\alpha + \ln(8\pi) \qquad (22)$$

This value is in the order of magnitude of the reciprocal of FSK (α). Its increase could be regarded as the central parameter of cosmic evolution.

5. Conclusions

The energy loss in cause of the cosmological red-shift of photons can be discussed as to be compensated by an energy input into electromagnetic field energy which is blurred over the whole

 doi:10.20944/preprints202009.0093.v1

universe. This point of view results from the fact that the energy loss of single photons can be understood as a digital process in which a certain tiny energy amount is released in each oscillation period of the field. The portions of periodically released energy are equal for all electromagnetic wave length, what means for all photon energies. The amount of this energy corresponds with the energy of photon with wave length of the order of magnitude of diameter of the observable universe. With respect to quantum mechanics, photons of such extremely low frequency have to be regarded as perfectly delocalized. This effect, indeed, bridges the world of localized particles with the dimensions of the universe.

It is further concluded, that the energy loss of photons is a digital process reflecting the general cosmological time arrow. It is a challenge for future investigation to clear if this time arrow causes not only cosmological expansion and red-shift of photons, but might also change the energy content of other microscopic objects, which are mostly regarded to be stable, up to now.

References

[1] Dirac, P.A.M.: A new basis for cosmology. Proc. Royal Soc. London 1938, A165, 199-208.

[2] Planck Collaboration (2016). "Planck 2015 results. XIII. Cosmological parameters (See Table 4 on page 32 of pdf)". Astronomy & Astrophysics. 594: A13. arXiv:1502.01589

[3] Kaku, M. Parallel Worlds. Anchor Books 2005. p. 385. ISBN 978-1-4000-3372-0; cited by https://en.wikipedia.org/wiki/Observable_universe

[4] Davies, P. The Goldilocks Enigma. First Mariner Books 2006. p. 43–. ISBN 978-0-618-59226-5. ; cited by https://en.wikipedia.org/wiki/Observable_universe

[5] https://en.wikipedia.org/wiki/Planck_mass

[6] Bars, I.; Terning, J. Extra Dimensions in Space and Time. Springer 2009. pp. 27–. ISBN 978-0-387-77637-8.

[7] https://en.wikipedia.org/wiki/Observable_universe

[8] Domínguez, A. et al. A new measurement of the Hubble constant and matter content of the Universe using extragalactic background light γ-ray attenuation, 2019, arXiv:1903.12097v1

[9] Riess, A. G.; Casertano, S.; Yuan, W.; Macri, L. M.; Scolnic, D., Large Magellanic Cloud Cepheid Standards Provide a 1% Foundation for the Determination of the Hubble Constant and Stronger Evidence for Physics Beyond LambdaCDM, 2019, arXiv:1903.07603, doi:10.3847/1538-4357/ab1422

[10] https://de.wikipedia.org/wiki/Planck-Einheiten#Definitionen