The origin of the Cosmic Microwave Background Radiation and the Ionization of the Early Universe

The law of selfvariations determines quantitatively a slight increase of the masses and electric charges as the common cause of quantum and cosmological phenomena. More specifically, the cosmological data are condensed into one equation, the only unknown being the rest mass of the material particles. This equation predicts and justifies the entirety of the cosmological data. In the present Letter we present the prediction of the Cosmic Microwave Background Radiation. We also predict that the early Universe underwent a phase of atomic ionization.

1. Introduction

The scientific knowledge possessed today by the science of Physics, together with the mathematical calculations we have performed, permits us to propose the law of selfvariations [1] as a common cause of the quantum phenomena and the cosmological data. The law of selfvariations determines quantitatively a slight increase of the rest masses and electric charges of the material particles. The consequences of the law of selfvariations extend from the microcosmic scales up to the scales of the observations we conduct billions of light years away.

Especially for the cosmological data, the law of selfvariations predicts and justifies the redshift of distant astronomical objects and Hubble's law, the Cosmic Microwave Background Radiation, the flatness of the Universe, the fact that the Universe has undergone a phase of ionization of the atoms, the increased luminosity distances of supernovae, a very slight variation of the fine structure constant, that the total energy content of the Universe vanishes, and the arrow of time in the macrocosm, which is nullified in the microcosm.

The Standard Cosmological Model is unable to justify the age of $80\times10^{9}\,year$ of Sloan's Great Wall [2] and the distribution of matter in the Universe, the variation of the fine structure constant [3], and it introduces the notion of dark energy [4,5,6] in order to justify the increased luminosity distances of supernovae [7]. The recent observations by the Planck satellite did not confirm what was expected regarding the inflationary Universe.

Since the 1980s the Standard Cosmological Model has been modified by a multitude of crucial interventions in order to bring it in agreement with the cosmological data. In reality, recent observations, such as the aforementioned ones, are not consistent with the cosmological model. Our time is reminiscent of the pre-Ptolemaics who, by adding ever more epicycles, were trying to interpret the orbits of the planets in a geocentric system.

The Standard Cosmological Model has prevailed over the other competing models mainly because it justified the redshift of distant astronomical objects and predicted the Cosmic Microwave Background Radiation. This success created great expectations and, to a certain degree, permitted the introduction into the theoretical background of the Standard

Cosmological Model, of any hypotheses that allowed it to remain in agreement with the cosmological data. The continuous improvement of these data was accompanied by a corresponding introduction of hypotheses that continues up to now. This is also the reason why different variants of the Standard Cosmological Model are being introduced. At their core they have the notion of the expansion of the Universe as the cause of the redshift of distant astronomical objects. The possibility that the redshift is due to microscopic and not macroscopic causes, was not entertained.

The law of selfvariations condenses the cosmological data within equation

$$\left(m_0 c^2 + i\hbar \frac{\dot{m}_0}{m_0} \right)^{\square} = 0$$

with the rest mass m_0 of material particles as the only unknown, and does not permit "maneuvers" and further hypotheses about the cosmological model it predicts. For this reason it is very important that this equation incorporates as information and justifies the totality of the cosmological data as recorded from the time of Hubble up to today. Furthermore, the predicted model is self-consistent since the law of selfvariations [1] predicts that the gravitational force cannot play the role attributed to it by the Standard Cosmological Model. The gravitational force in the Universe only has a role on a local level , in the formation of galaxies and clusters of galaxies. On a cosmological scale, it can lead the Universe to neither collapse, nor expansion.

2. The prediction of the Cosmic Microwave Background Radiation by the law of selfvariations

The law of selfvariations predicts [1] that between the Thomson scattering coefficient

$$\sigma_\tau = \frac{8\pi}{3} \frac{q^4}{m_0^2 c^4}$$

and the Klein-Nishina scattering coefficient

$$\sigma = \frac{3}{8} \sigma_\tau \frac{m_0 c^2}{E} \left[\ln\left(\frac{E}{m_0 c^2} \right) + \frac{1}{2} \right]$$

in the laboratory on Earth, and the corresponding scattering coefficients at a distant astronomical object located at distance r from Earth, the following relation holds:

$$\frac{\sigma_\tau(r)}{\sigma_\tau} = \frac{\sigma(r)}{\sigma} = \left(\frac{1 - Ae^{-\frac{kr}{c}}}{1 - A} \right)^2$$

For very large distances r $(r \to \infty)$, that is in the very early Universe, the above equation gives:

$$\frac{\sigma_\tau(r\to\infty)}{\sigma_\tau} = \frac{\sigma(r\to\infty)}{\sigma} = \left(\frac{1}{1-A}\right)^2$$

For the dimensionless parameter A it holds that $A \to 1^-$, since it obeys inequality

$$\frac{z}{1+z} < A < 1$$

for every value of the redshift z. Therefore, in the very early Universe the Thomson and Klein-Nishina scattering coefficients obtain enormous values, rendering the Universe opaque. The Cosmic Microwave Background Radiation that we observe today, originates from this phase of the evolution of the Universe,. Furthermore, the law of selfvariations predicts that, during this phase, the temperature of the Universe was slightly above $0K$, and that the Cosmic Microwave Background Radiation emanates from "everywhere", from the whole expanse of the Universe.

3. The Universe underwent an ionization phase

The law of selfvariations predicts [1] that between the ionization and excitation energy X_n of the atoms in the laboratory on Earth and the corresponding energies $X_n(z)$ at an astronomical object located at a distance corresponding to redshift z, the following relation holds:

$$X_n(z) = \frac{X_n}{1+z}$$

The dependence of the ionization and excitation energies by the redshift z affects the degree of atomic ionization at distant astronomical objects. Boltzmann's formula

$$\frac{N_n}{N_1} = \frac{g_n}{g_1} e^{-\frac{X_n}{KT}}$$

gives the number N_n of excited atoms populating energy level n in a stellar surface that is at a state of thermodynamic equilibrium. With X_n we denote the excitation energy from energy level 1 to energy level n, T is the temperature of the stellar surface in Kelvin, $K = 1.38\times10^{-23}\,\frac{J}{K}$ is Boltzmann's constant, and g_n is the multiplicity of energy level n, i.e. the number of energy levels into which level n splits within a magnetic field.

At distant astronomical objects, Boltzmann's formula is written as:

$$\frac{N_n}{N_1} = \frac{g_n}{g_1} e^{-\frac{X_n}{KT(1+z)}}$$

as a consequence of the dependence of the excitation energies on the redshift.

In the case of hydrogen for $n = 2, X_2 = 10.15eV = 16.24 \times 10^{-19} J, g_1 = 2,\ g_2 = 8$, and for solar surface temperature $T \approx 6000K$, Boltzmann's formula gives that just one atom in 10^8 occupies energy level $n = 2$. For the same temperature at distant astronomical objects, Boltzmann's formula, as modified by the law of selfvariations, gives that for $z = 1$ we have $\frac{N_2}{N_1} = 2.2 \times 10^{-4}$, for $z = 2$ we have $\frac{N_2}{N_1} = 5.8 \times 10^{-3}$, and for $z = 5$ we have $\frac{N_2}{N_1} = 0.15$.

For large values of the redshift z, that is, in the very early Universe, it follows that the Universe underwent a phase of atomic ionization [8]. We also come to the same conclusion through equation

$$X_n(r \to \infty) = X_n(1 - A)$$

predicted by the law of selfvariations [1]. Taking into account that $A \to 1^-$, we conclude that the atomic ionization energies vanish in the very early Universe.

4. The need for reevaluating the totality of the electromagnetic radiation we receive from distant astronomical objects

The dependence of the Thomson and Klein-Nishina scattering coefficients, as well as the degree of ionization of the atoms, on the redshift of astronomical objects, requires the reevaluation of the electromagnetic radiation we receive on Earth. Besides, the redshift itself results from the decrease of the excitation energies of atoms at distant astronomical objects due to the manifestation of the selfvariations.

One interesting prediction of the law of selfvariations is that today we only observe a small part of the Universe. The Universe extends to far larger distances beyond the limits set by the Standard Cosmological Model. Because of this, we have to reevaluate the data of the COBE and WMAP satellites and, more recently, of the Planck satellite. The law of selfvariations gives us the complete theoretical background needed in order to undertake such a reevaluation. We claim that the whole of the cosmological data confirms the predictions of the law of selfvariations.

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