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Fundamental Quantum of Dark Matter, its Relation to the Temperature of the Cosmic Microwave Background Radiation and to the Hubble Constant

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ABSTRACT

This paper describes the derivation of the elementary quantum of Dark Matter, its relation to the Hubble constant, and to the Cosmic Microwave Background radiation. It is shown, based on the simple principles of physics, that the Hubble constant is not an independent cosmological parameter but that it is intimately related to the temperature of the Cosmic Microwave Background Radiation.

Key words: Cosmic Microwave Background Radiation, Temperature of the Cosmic Microwave Background Radiation, Hubble Constant, Repulsive Dark Matter, Hubble Mass of the Universe, Hubble distance, Elementary Quantum of Dark Matter, Hubble Time.

INTRODUCTION

In the previously published paper in the GSJ [1]: "Simple Dark Matter Model of the Universe (with GRB data)" it was shown that it is possible to develop a model of the universe that is based on the idea of repulsive dark (dark = transparent) matter, which agrees reasonably well with observations. In the paper it was also derived that the repulsive dark matter (DM) density is related to the Hubble constant by the following equation:

$$H_0 = \sqrt{\frac{8}{3}\pi\,\kappa\,m_0}\,, \tag{1}$$

where m_0 represents the DM mass density, H_0 the Hubble constant, and κ the Newton gravitational constant. From the simple dimensional analysis it is also possible to define other

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Hubble parameters that can be useful in simplifying various cosmological equations: For example, the physical Hubble distance ρ_h can be defined as:

$$\rho_h = 2c / H_0 \ , \tag{2}$$

where c is the speed of light. Similarly, the Hubble mass of the universe can be defined as:

$$M_h = 4c^3 / \kappa H_0 , \tag{3}$$

and finally, for the Hubble time we can write:

$$\tau_h = 1 / H_0 \ . \tag{4}$$

MORE HUBBLE PARAMETERS

The definitions of various Hubble parameters do not have to stop with the definition of the Hubble time, the definitions can be extended to other interesting parameters such as the fundamental Hubble DM mass quantum:

$$m_{qh} = hH_0 / c^2 = 1.625 \cdot 10^{-68} kg \ , \tag{5}$$

where h is the Planck constant. Once this parameter is known it is interesting to investigate its dimensionless ratio to the universe's Hubble mass defined above in the introduction:

$$\frac{M_h}{m_{qh}} = \frac{4c^5}{\kappa\, hH_0^2} = 1.127 \cdot 10^{121} , \tag{6}$$

and also to calculate the ratios to the neutron mass and to the recently published combined upper limit mass m_{ni} of the three neutrino variety estimated to be: $0.28eV$.

$$\frac{m_n}{m_{qh}} = 1.031 \cdot 10^{41} , \qquad \frac{m_{ni}}{m_{qh}} = 3.072 \cdot 10^{31} . \tag{7}$$

However, another more interesting DM mass quantum can be found by assuming that the DM forms a crystal consisting of cells with the standing wave vibrations. By considering that this crystal has most likely a diamond structure the equation for the DM mass quantum can be derived in the following way:

Defining the volume of the crystal primitive cell as V_0, the DM mass energy contained in this cell is:

$$m_0 V_0 c^2 = h \frac{c}{\lambda} , \tag{8}$$

where λ is the wavelength of the cell vibrations. The cell volume will now be related to this wavelength considering that the cell has some packing density ξ of vibrating elements:

$$V_0 = \xi \left(\frac{\lambda}{2}\right)^3 . \tag{9}$$

From Eq.8 and Eq.9 then follows the formula for the wavelength:

$$\left(\frac{\lambda}{2}\right)^4 = \frac{h}{2m_0 c\xi} . \tag{10}$$

It is now simple to find the equation for the DM mass quantum as follows:

$$m_{q\lambda} = m_0 \xi \left(\frac{\lambda}{2}\right)^3 = \sqrt[4]{\frac{\xi \, m_0 h^3}{8c^3}} . \tag{11}$$

For the diamond cell the packing density is well known and is equal to:

$$\xi = \frac{16}{\pi\sqrt{3}} = 2.940421 . \tag{12}$$

Knowing precisely the value of the Hubble constant it is then possible to find the precise value of the DM mass density and from that the value of the DM mass quantum. The most popular value for the Hubble constant found in the literature is: $H_0 = 68.606 km/\sec Mpc$. Using Eq.1 the value for the DM mass density is:

$$m_0 = 0.884108 \cdot 10^{-26}\,\mathrm{kg/m^3} , \tag{13}$$

and from that using Eq.11 and Eq.12 the DM mass quantum is:

$$m_{q\lambda} = 1.368619 \cdot 10^{-38} kg . \tag{14}$$

It will be assumed that this DM mass quantum is an universal constant valid anywhere in the entire universe, similarly as charge is in the Maxwell's EM field theory.

COSMIC MICROWAVE BACGROUND RADIATION TEMPERATURE

In the previous paper [1] it was also shown that the Cosmic Microwave Background Radiation (CMBR) is not the remnant of the Big Bang (BB) but it is an image of the border region that envelopes the entire universe. The universe is thus a solid DM sphere with a finite diameter. The galaxies and any visible matter then move in this sphere as defects do in a crystal, floating in the free fall from the bulk to the edge where they disintegrates. The border region has a deep negative gravitational potential and thus harbors the remnants of stars or the remnants of entire galaxy explosions and perhaps also various elementary particles such as neutrons that cannot escape. Only the Gamma Ray Burst radiation (GRB) can escape and is detected here on Earth. By extending the previous simple model of the universe to a model with the deformable DM it was possible to determine that the gravitational potential at the universe's edge is only:

$$\varphi_n = -1.744 \cdot c^2 , \tag{15}$$

instead of the previously derived value of: $\varphi_n = -2c^2$. This allows to find the value for the time metric coefficient as it is affected by the gravitational potential of the DM at the universe's edge:

$$g_{tt} = e^{\frac{2\varphi_n}{c^2}} . \tag{16}$$

It now simple to convert the DM mass quantum to energy and the energy to temperature at the edge of the universe. The CMBR temperature is then as follows:

$$T_{CMBR} = \frac{c^2 g_{tt} m_{q\lambda}}{k_B} = 2.72551^o K , \tag{17}$$

where k_B is the well known Boltzmann constant. This temperature agrees well with the measured CMBR temperature found in the literature [2]: $2.7255 \pm 0.0006\ ^oK$, and this, therefore, provides the necessary observational support for the existence of the DM mass quantum and for the validity of the developed DM models of the universe.

CONCLUSIONS

The DM model of the universe that is a finite sphere allows to find the value for the DM mass quantum and the relation between the Hubble constant and the CMBR temperature. It is not generally believed that these two parameters are in any way related to each other. This paper clearly shows that this is not so and that these parameters are related. Determination of one gives automatically the value for the other. Since the CMBR temperature is measured very precisely the Hubble constant is thus also precisely determined. This may provide an advantage when more sophisticated models for the universe and for the galaxies in it are considered.

REFERENCES

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