Is fine structure ratio – an index of cosmic expansion?

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Abstract: Within the expanding cosmic Hubble volume, Hubble length can be considered as the gravitational or electromagnetic interaction range. Product of 'Hubble volume' and 'cosmic critical density' can be called as the 'Hubble mass'. Based on this cosmic mass unit, authors noticed four peculiar semi empirical relations. With the observed relations it is possible to say that, in atomic and nuclear physics, there exists a cosmological physical variable. By observing its rate of change, the future cosmic acceleration can be verified. Fine structure ratio may be considered as the index of present cosmic expansion. By observing its cosmological rate of change, future cosmic acceleration can be verified.

Key words: Hubble volume; Hubble mass; Fine structure ratio; Cosmic thermal energy density; Cosmic critical energy density;

1 INTRODUCTION

If we write $R_0 \cong (c/H_0)$ as a characteristic cosmic Hubble radius [1] then the characteristic cosmic Hubble volume is $V_0 \cong (4\pi/3)R_0^3$. With reference to the cosmic critical density $\rho_c \cong (3H_0^2/8\pi G)$ and the characteristic cosmic Hubble volume, characteristic cosmic Hubble mass can be expressed as

$$M_0 \cong \rho_c V_0 \cong (c^3/2GH_0) \quad (1)$$

If we do not yet know whether the universe is spatially closed or open, then the idea of Hubble volume or Hubble mass can be used as a tool in cosmology and unification. This idea is very close to the Mach's idea of distance cosmic back ground. It seems to be a quantitative description to the Mach's principle. In understanding the basic concepts of unification of the four cosmological interactions, the cosmic radius (c/H_0) can be considered as the infinite range of the gravitational or electromagnetic interaction. Within the Hubble volume it is noticed that: 1) Each and every point in free space is influenced by the Hubble mass. 2) Hubble mass plays a vital role in understanding the properties of electromagnetic and nuclear interactions and 3) Hubble mass plays a key role in understanding the geometry of the universe.

2 FOUR PECULIAR RELATIONS

The current value of the Hubble's constant is $H_0 \cong 70.4^{+1.3}_{-1.4}$ Km/sec/Mpc [2,3]. Thus the magnitude of the present cosmic Hubble mass can be given as $M_0 \cong 8.84811\times10^{52}$ Kg. With this M_0 semi empirically it is noticed that,

$$\frac{G\sqrt{M_0\sqrt{m_p m_e}}}{c^2} \cong 1.38 \text{ fm} \quad (2)$$

where m_p and m_e are the rest masses of proton and electron respectively. This obtained length is close to the strong interaction range [4]. Whether it is the strong interaction range or something else, is not sure. In view of this relation authors made an attempt to understand the mystery of the fine structure ratio. If M_p is the Planck mass it is noticed that,

$$\ln\left(\frac{m_e R_0^2}{M_p R_s^2}\right) \cong \frac{1}{\alpha}. \quad (3)$$

where R_s is close to 1.5 fm. This relation is related with both the strong interaction range and the fine structure ratio. Note that large dimensionless constants and compound physical constants reflect an intrinsic property of nature [5,6]. If $\rho_c c^2$ is the present cosmic critical energy density and aT_0^4 is the present cosmic thermal energy density, it is noticed that,

$$\ln\sqrt{\frac{aT_0^4}{\rho_c c^2}\cdot\frac{4\pi\varepsilon_0 G M_0^2}{e^2}} \cong \left(\frac{1}{\alpha}\right) \quad (4)$$

At present if $\rho_c \cong (3H_0^2/8\pi G)$, independent of the gravitational constant, relation (4) takes the following form.

$$\ln\sqrt{\frac{2\pi}{3}\cdot\frac{4\pi\varepsilon_0 a T_0^4 c^4}{e^2 H_0^4}} \cong \frac{1}{\alpha} \quad (5)$$

At present if observed CMBR temperature [7] is $T_0 \cong 2.725\ ^0$K, obtained $H_0 \cong 71.415$ Km/sec/Mpc. Another peculiar relation can be expressed in the following way.

$$\frac{\hbar c}{G m_p \sqrt{M_0 m_e}} \cong 0.9975 \cong 1 \quad (6)$$

With this relation, obtained value of the present Hubble's constant is $H_0 \cong 70.75$ Km/sec/Mpc. The fine structure ratio can be expressed as

$$\alpha \cong \sqrt{\frac{m_e}{M_0}} \cdot \frac{e^2}{4\pi\varepsilon_0 G m_p m_e} \qquad (7)$$

Thus the 'Bohr radius of hydrogen' atom can be expressed as

$$a_0 \cong \left(\frac{4\pi\varepsilon_0 G m_p M_0}{e^2}\right)\frac{G m_p}{c^2} \cong \frac{1}{2}\left(\frac{4\pi\varepsilon_0 G m_p^2}{e^2}\right)\cdot\frac{c}{H_0} \qquad (8)$$

This relation is free from the famous $\hbar$. From all these relations it can be interpreted that, in the presently believed atomic and nuclear "physical constants", there exists one cosmological variable! By observing its cosmological rate of change, the "future" cosmic acceleration can be verified. Thus independent of the cosmic redshift and CMBR observations, with these coincidences it is possible to understand and decide the cosmic geometry. With reference to the Planck mass

$$M_P \cong \sqrt{\hbar c / G} \qquad (9)$$

and the elementary charge e, a new mass unit

$$M_C \cong \sqrt{e^2 / 4\pi\varepsilon_0 G} \qquad (10)$$

can be constructed. With M_C and M_0 it can be assumed that, cosmic thermal energy density, matter energy density and the critical energy density are in geometric series and the geometric ratio is $1+\ln\left(M_0 / M_C\right)$. Thus,

$$\left(\frac{\rho_c c^2}{\rho_m c^2}\right)_0 \cong 1+\ln\left(\frac{M_0}{M_C}\right) \cong 143.0 \qquad (11)$$

where ρ_m is the cosmic matter density.

$$\left(\frac{\rho_c c^2}{aT^4}\right)_0 \cong \left[1+\ln\left(\frac{M_0}{M_C}\right)\right]^2 \cong (143.0)^2 \qquad (12)$$

At present, this relations takes the following trial-error form.

$$\left[1+\ln\left(\frac{c^3}{2GH_0 M_C}\right)\right]^{-1} H_0 \cong \sqrt{\frac{8\pi G a T_0^4}{3c^2}} \qquad (13)$$

From this relation, if T_0 is known, by trial–error present value of H_0 can be estimated. Note that, obtained matter density ρ_m can be compared with the elliptical and spiral galaxy matter density. Based on the average mass-to-light ratio for any galaxy [8]

$$(\rho_m)_0 \cong 1.5\times10^{-32}\eta h_0 \ \text{gram/cm}^3 \qquad (14)$$

where for any galaxy, $\langle M/L\rangle_{Galaxy} = \eta\langle M/L\rangle_{\text{Sun}}$ and the number:

$$h_0 \cong \frac{H_0}{100 \text{ Km/sec/Mpc}} \cong \frac{70.75}{100} \cong 0.7075$$

Note that elliptical galaxies probably comprise about 60% of the galaxies in the universe and spiral galaxies thought to make up about 20% percent of the galaxies in the universe. Almost 80% of the galaxies are in the form of elliptical and spiral galaxies. For spiral galaxies, $\eta h_0^{-1} \cong 9 \pm 1$ and for elliptical galaxies, $\eta h_0^{-1} \cong 10 \pm 2$. For our galaxy inner part, $\eta h_0^{-1} \cong 6 \pm 2$. Thus the average ηh_0^{-1} is very close to 8 to 9 and its corresponding matter density is close to (6.0 to 6.67) $\times 10^{-32}$ gram/cm^3.

3 CONCLUSIONS

Fine structure ratio can successfully be implemented in cosmology and the subject of elementary particle physics and cosmology can be studied in a unified manner [9]. It is true that the proposed relations are speculative and peculiar. But if one is able to derive them with a suitable mathematical model, independent of the cosmic redshift and CMBR observations, the future cosmic acceleration can be verified from atomic and nuclear physical constants. Whether to consider them or discard them depends on the physical interpretations, logics, experiments and observations. Some scientists may say: this is a clever thought, but a common misconception. But in most of the critical cases, 'time' only will decide the issue. The mystery can be resolved only with further research, analysis, discussions and encouragement.

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