On the Cosmological Variation of the Fine Structure Constant

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Recently, evidence indicating cosmological variations of the fine structure constant, α, has been reported. This result led to the conclusion that possibly the physical constants and the laws of physics vary throughout the universe. However, it will be shown here that variations in the value of the elementary electric charge, *e*, can occur under specific conditions, consequently producing variations in the value of α.
Key words: Fine Structure Constant, Elementary Electric Charge, Cosmology, Physics of Black-Holes.
PACS: 06.20. Jr, 98.80.-k, 98.80.Jk, 04.70.-s.

The well-known Fine Structure Constant determines the strength of the electromagnetic field and is expressed by the following equation (in SI units) [1]:

$$\alpha = \frac{e^2}{4\pi\varepsilon_0\hbar c} = \frac{1}{137.03599958(52)} \tag{1}$$

However, recently, Webb, J.K *et al.*, [2] using data of the Very Large Telescope (VLT) and of the ESO Science archive, noticed small variation in the value of α in several distant galaxies. This led to the conclusion that α is not a constant [2- 4].

It will be shown here, that variations in the value of the elementary electric charge, *e*, can occur under specific conditions, consequently producing variations in the value of α. This effect may be explained starting from the expression recently obtained for the *electric charge* [5], i.e.,

$$q = \sqrt{4\pi\varepsilon_0 G}\; m_{g(im)}\; i \tag{2}$$

where $m_{g(im)}$ are the *imaginary* gravitational mass of the elementary particle; $\varepsilon_0 = 8.854\times10^{-12}F/m$ is the permittivity of the free space and $G = 6.67\times10^{-11}N.m^2.kg^{-1}$ is the universal constant of gravitation.

For example, in the case of the *electron*, it was shown [5] that

$$m_{ge(im)} = \left\{1-2\left[\sqrt{1+\left(\frac{U_{e(im)}}{m_{i0e(im)}c^2}\right)^2}-1\right]\right\}m_{i0e(im)} = \chi_e m_{i0e(im)} \tag{3}$$

where $m_{i0e(im)} = -\frac{2}{\sqrt{3}}m_{i0e(real)}\, i$, $m_{i0e(real)} = 9.11\times10^{-31}kg$ and $U_{e(im)} = \eta_e kT_e i$. In this expression $\eta_e \cong 0.1$ is the *absorption factor* for the electron and $T_e \cong 6.2\times10^{31}K$ is its internal temperature (*temperature of the Universe when the electron was created*); $k = 1.38\times10^{-23}J/^{o}K$ is the *Boltzmann constant*.

Thus, according to Eq. (3), the value of χ_e is given by $\chi_e = -1.8\times10^{21}$. Then, according to Eq. (2), the *electric charge of the electron* is

$$\begin{aligned} q_e &= \sqrt{4\pi\varepsilon_0 G}\; m_{ge(im)}\; i = \\ &= \sqrt{4\pi\varepsilon_0 G}\left(\chi_e m_{i0e(im)} i\right) = \\ &= \sqrt{4\pi\varepsilon_0 G}\left(-\chi_e \tfrac{2}{\sqrt{3}} m_{i0e(real)} i^2\right) = \\ &= \sqrt{4\pi\varepsilon_0 G}\left(\chi_e \tfrac{2}{\sqrt{3}} m_{i0e(real)}\right) = -1.6\times10^{-19}C \end{aligned}$$

As we know, the absolute value of this charge is called the *elementary electric charge*, e.

Since the internal temperature of the particle can vary, we then conclude that χ is not a constant, and consequently the value of e also cannot be a constant in the Universe. Its value will depend on the local conditions that can vary the internal temperature of the particle. The *gravitational compression*, for example, can reduce the volume V of the particles, diminishing their internal temperature T to a temperature T' according to the well-known equation: $T' = (V'/V)T$ [6]. This decreases the value of $U_{(im)}$, decreasing consequently the value of

χ. Equation (2) shows that e is proportional to χ, i.e.,

$$
\begin{aligned}
e &= \sqrt{4\pi\varepsilon_0 G}\;\; m_{g(im)}\; i = \\
&= \sqrt{4\pi\varepsilon_0 G}\left(\chi\;\; m_{i0(im)} i\right) = \\
&= \sqrt{4\pi\varepsilon_0 G}\left(-\chi \tfrac{2}{\sqrt{3}} m_{i0(real)} i^2\right) = \\
&= \sqrt{4\pi\varepsilon_0 G}\left(\chi \tfrac{2}{\sqrt{3}} m_{i0(real)}\right)
\end{aligned}
$$

Therefore, when the volume of the particle decreases, the value of e will be less than $1.6\times10^{-19}C$. Similarly, if the volume V is *increased*, the temperature T will be *increased* at the same ratio, increasing the value of χ, and also the value of e. The *gravitational traction*, for example, can increase the volume V of the particles, increasing their internal temperature T, and consequently increasing their electric charges (See Fig.1).

Conclusions – Our theoretical results show that variations in the value of the elementary electric charge, *e*, can occur under specific conditions, consequently producing variations of the *fine structure constant*, α, as shown in Fig.1. This excludes totally the erroneous hypothesis that the laws of physics vary throughout the universe.

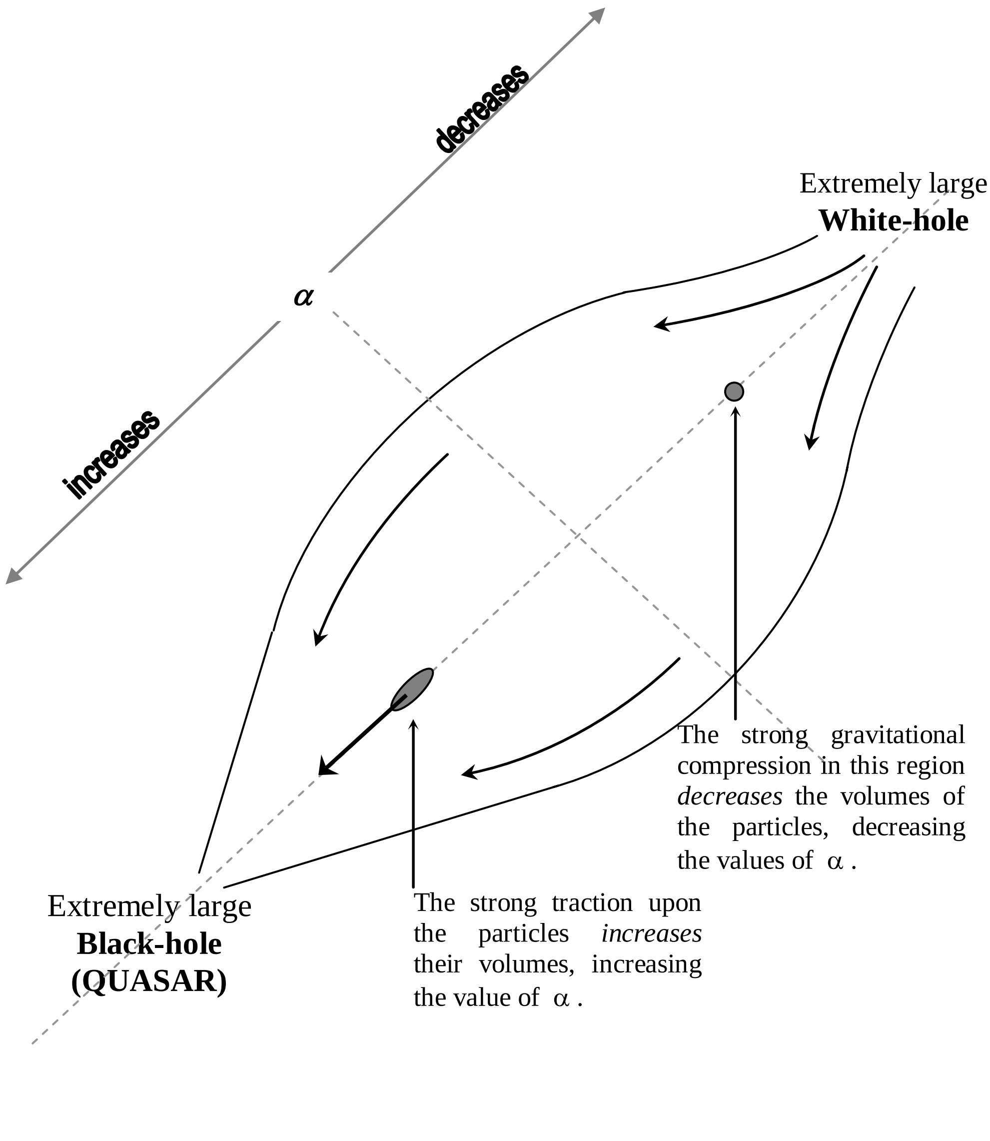

Fig. 1 – A spatial dipole that can explain the dipole variation of α reported by Webb. J.K. *et al*.

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