Coincidences on the Speed of Light

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Abstract

There are theories related to the time dependence of the speed of light that predict that the speed of light is not constant but depends on the time. But they are not verifiable or demonstrable physically or mathematically with concrete results. In this study, based on simple assumptions on the microwave background and thermal electrons, a model of the time varying speed of light is presented, which is fully compatible with currently accepted results for the speed of light and the Hubble constant theories.

I. Energy density of space

Based on the idea of space as a continuum, the speed of light can be considered as a disturbance in this space, the same way as a wave is considered a disturbance on a rope. If we associate the concept of speed of light as the speed on a stretched string of length l and mass m, we can establish the following

$$c = \sqrt{\frac{F}{\mu}} = \sqrt{\frac{F}{\frac{m}{l}}} = \sqrt{\frac{Fl}{m}} = \sqrt{\frac{E}{m}} = \sqrt{\rho_m}$$

Obviously, the following relationship is also obtained:

$$E = mc^2$$

The energy density of space depends on the position, but considering that the universe expands, this density also depends on the time, so: $\rho = \rho(r, t)$

II. Speed of Light

The densities of the electric and magnetic fields are as follows:

$$\rho_E = \tfrac{1}{2}\varepsilon_0 E^2$$
$$\rho_B = \tfrac{1}{2\mu_0} B^2$$

We consider the hypothesis that the densities are equal and we apply the relationship between the electric field and the magnetic field: $E = cB$

In this case we obtain:

$$\tfrac{1}{2}\varepsilon_0 E^2 = \tfrac{1}{2\mu_0} B^2$$
$$\varepsilon_0 E^2 = \tfrac{1}{\mu_0}\left(\tfrac{E}{c}\right)^2$$
$$\varepsilon_0 = \tfrac{1}{\mu_0 c^2} \to c = \tfrac{1}{\sqrt{\varepsilon_0 \mu_0}}$$

Which is the speed of light in vacuum. Thus, we see that the speed of light is adjusted to maintain the energy density of the electric field and magnetic field equals.

III. Speed of light depending on time

Since the universe expands, the energy density depends on the time, and if the speed of light is related to this density, it is assumed that the speed of light also varies over time. We assume that the speed of light varies linearly with time, that is:

$$c_t = at$$

To determine the a constant, we impose the cosmological condition that the microwave background radiation comes from the time when the speed of light begins to be faster than the movement of the lighter particles: the electron. Before this moment, the photons interact with the electrons and are continuously absorbed and reabsorbed. When electrons are trapped in the nuclei forming atoms, photons are free to escape.

The speed of the electrons is the temperature corresponding to the microwave background, 2,725 K.

$$\frac{1}{2}m_e v_e^2 = \frac{1}{2}k_B T \Rightarrow v_e = \sqrt{\frac{k_B T}{m_e}}$$

Where m_e is the mas of the electron:$9,1094 \cdot 10^{-31} kg$ and k_B is the Boltzmann constant: $1,3907 \cdot 10^{-23} J/K$

The value of the speed of electrons at the time of separation is obtained with photons.

$$v_e = \sqrt{\frac{k_B T}{m_e}} = 6426,7\,\mathrm{m/s}$$

We believe that, at this time, 300,000 years after the Big Bang, the speed of light is the environment at this time, from this moment is always greater.

Given the time t = 300,000 years and speed $c_t = 6426.7 m/s$, from here we find the linear constant.

$c_t = at$
$a = \frac{c_t}{t} = \frac{6426,7 m/s}{9,46 \cdot 10^{12} s} = 6,793 \cdot 10^{-10}\mathrm{m/s^2}$

The current time of universe after the Big Bang, considering $14 \cdot 10^9$ years, is then:

$$c_t = at = 2,99 \cdot 10^8 \mathrm{m/s}$$

Which is the current speed of light with an accuracy of two decimals.

The value of the speed of light is obtained from the mass of the electron and from an observational data such as the microwave background radiation. Considering this as the temperature at that time.

IV. The Hubble Constant

What is the relationship with the Hubble constant?

$$\left.\begin{array}{l} v = Hd \\ v = at \end{array}\right\} \rightarrow \frac{d}{t} = \frac{a}{H}$$

$\frac{d}{t}$ considering that it is the current speed of light, what is the value of H?

$$H = \frac{a}{c} = \frac{6,793 \cdot 10^{-10}}{2,99 \cdot 10^8} = 2,27 \cdot 10^{-18} s^{-1}$$

passing to km/s/Mp, and 1 Mega Parsec are $10^6 \times 3,0857 \cdot 10^{16} m$ we find the Hubble constant

$$H = 70045,39\,\mathrm{m/s/Mp}$$

A value for the Hubble constant of about 70 km/s/Mp is obtained. The currently accepted value is 71 km/s/Mp. Which was obtained from the a constant in our hypothesis. There are many coincidences.

Given this result, what we understand as the Hubble constant is false (that distant galaxies are moving faster the farther they are).What really happens is that the speed of light that left from the galaxy to us has increased and it seems that the galaxy is further away than it really is.

Why haven't we detected this variation?

The variation is very small, in 100 years it will have increased by:

$\Delta c_t = \left(6,793 \cdot 10^{-10}\mathrm{m/s^2}\right)\left(3,153 \cdot 10^9 s\right)$

$\Delta c_t = 2,14\,\mathrm{m/s}$

V. The Pioner Acceleration

Another coincidence is related to the deceleration of the Pioner. Anderson and colleagues at JPL (Jet Propulsion Laboratory) found in 1998 an apparent acceleration of the Pioneer 10 and Pioneer 11 towards the sun [1] [2]. The analysis of Doppler signals from this two space crafts show a small slowdown of about $8,5 \cdot 10^{-10}\mathrm{m/s^2}$ similar to the acceleration that we have obtained from the variation of the speed of light, with the same order of magnitude.

VI. References

1.John D. Anderson. Quarterly Report to NASA/Ames Research Center, Celestial Mechanics Experiment, Pioneer10/11,22 July 1992.

2.John D. Anderson. Indication, from Pioner 10/11, Galileo, and Ulysses Data, of an Apparent Anomalous, Weak, Long-Range Acceleration. 2008. arXiv:gr-qc/9808081.