DOI: https://doi.org/10.24297/jap.v20i.9234

Redshift As Slow-Light on Base of Frequency on Model of Galaxy GN-Z11

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Abstract.;

The calculation of the redshift on base of wavelength leads to the conclusion that the regression speed of some body showing a shift >1 can greatly exceed that of light. This research, taking as model the most far from us galaxy GN-z11, discovered in 2016, shows that results given on base of decreasing of frequency as consequence of slowed light-speed, could concretely solve the complex question of the redshift of bodies very distant from us. The results related to this model could be further substantially confirmed by performing an experiment briefly described here.

Keywords: Redshift; Doppler shift; expanding universe; Regression speed; Slow-light; frequency decrease; constancy of wavelength.

1. Slow-light.

In the last decades, several experiments [1-7] have shown that the speed of light can be slowed in different circumstances.

The last and most significant of these results is the one obtained by a team of researchers of the University of Glasgow (Giovannini et al. 2015), [8] managing for the first time to slow photons in free space.

What made this result surprising is given by the fact that unlike all the other "slow-light" experiments previously performed, the speed of the photons, once slowed down, continued at a lower speed than *c*, in free space. The question that arises in this research is: given that the speed of photons is exactly that of light, if this speed, meant to be constant and invariable can be slowed down by passing once through a material substance, even if by a very small extent of time and over very short distances, could it be substantially decreased over paths of billions of light years?

According to the cosmologic Standard Model, that would be hard to sustain, but leaving aside the consequences that these results could have in the relativistic context and the possible explanations that could be given on field of quantum mechanics remains the fact that this experiment has shown that the speed of photons can be slowed down and proceed at slower speed than light-speed. This research aims to find on that question an answer through a different model.

2. Method.

Postulating that:

a. the speed of light can progressively decrease in proportion to the travelled distance. I.e. the greater the distance the slower the speed registered in observation.

b. the distance between Earth as an observer and all the galaxies or other far bodies all around us remains globally unchanged (i.e. a globally stationary Universe as hypothesis) and reports the same proportional ratio in the redshift/distance in any direction we look (as a fact).

c. the wavelengths emitted by stellar masses billions of light years away remain globally constant with regard to the observation point (i.e. it does not vary or not significantly)

d. the decrease in frequencies is given by interpolating constant wavelengths with the extent of decreased speed of the observed light.

Research tools:

- Taking as a model the most recent and most far galaxy GN-z11[9] discovered in 2016, at a distance of about 32 billion l.y. [10] showing, on base of wavelength, the highest red-shift (z=11,09) ever detected and the highest recession speed.
- Recalculation of the redshift on base of constant wavelength and decreased frequency due to decreased light-speed.
- Indicating the critical points that sustain expanding universe and the Big-Bang Theory.
- Suggesting an experiment to finally and concretely confirm (or deny) the model proposed

3. Results on base of wavelength.

Legenda:

z = redshift on base of wavelength

z_f *= redshift on base of frequency*

λ_0 *= wavelength stationary*

λ_{obs}*= wavelength observed*

f_0 *= frequency stationary*

v = variability of speed

c = 299.792,458 original emitted speed of photons

c'= observed speed of light

The Hydrogen Balmer-Alpha-line of GN-z11, calculated on λ_0 = 656$_{\text{n.m.}}$ on base of wavelength, stands on **7931,04$_{\text{n.m.}}$** so that:

$$z = \frac{\lambda_{obs} - \lambda_0}{\lambda_0} = 11,09$$ Redshift on base of wavelength

$$v = (cz) = 3.324.700,04 km/s$$ Regression speed on base of wavelength (1)

N.B. the wavelengths recorded on the line of the spectrum are established on base of the received frequencies, which correspond to the number of wave crests registered in a unit of time. In fact, there is no device capable of measuring wavelengths in the order of nano-meters. The wavelengths are automatically deduced on the ground of the received frequencies:

Given that "*c*" is a constant speed remaining constant on relatively short distances:

$$c = \lambda f$$

$$f_0 = \frac{c}{\lambda_0} = \frac{c}{656} = 457 \quad (2)$$

$$f_{obs} = \frac{c}{\lambda_{obs}} = \frac{c}{7931,04} = 37,8 \quad (3)$$

i.e. a de facto observed decreased frequency of 37,8 has been interpreted on the spectrometer as an increased wavelength of 7931,04$_{\text{n.m.}}$.

4. Results on base of frequency.

$$f_{obs} = \frac{c}{\lambda_{obs}} = \frac{c}{7931,04} = 37,8 \quad \text{(frequency actually received)} \tag{4}$$

$$z_f = \frac{f_{obs} - f_0}{f_0} = \frac{37,8 - 457}{457} = -0,9172 \quad \text{(red-shift on base of slowing down of light-speed)} \tag{5}$$

N.B. by this way, the minus sign does not mean "blue-shift" but the measure of loss of speed over a distance calculated in circa 32 billion l.y., which must be deducted from the original light-speed. To clarify: the result obtained on base of wavelength increase, in the case of recession, must be positive (+) because it is assumed that when a source moves away from the observer (red-shift) the length increases. While when it approaches (blue-shift) it must be negative (-) because the length decreases. On the contrary, if we consider the shift calculated on unchanged length and frequency decreasing due to the progressive slowing down of the photons, the result in terms of red-shift should be negative (-) because in this case the frequency decreases.

In any case, this formula (eq. 5), both in negative or in positive way (inverting the terms of the sum), gives us the same measure of loss of velocity, deducted by the extent of decreased frequency, that must be detracted from the original lightspeed:

$$v = cz = (c)(-0,9172) = -274970 km/s \quad \text{(loss in original speed)} \tag{6}$$

$$c' = (299792,458 - 274970) = 24.822 Km/s \quad \text{(observed speed of light)} \tag{7}$$

So that:

$$f_{obs} = \frac{1}{\lambda_0}(c - v) = \frac{1}{656}(24.822) = 37,8 \quad \text{(de facto recorded frequency)} \tag{8}$$

On the spectrometer translated into:

$$\lambda_{obs} = \frac{c}{f_{obs}} = \frac{c}{37,8} = 7931,04 \tag{9}$$

It should be clarified that from this angle the translation that is automatically carried out from a frequency de facto recorded into an increased wavelength would be due to the interpretation that is currently implemented on the basis of Doppler which bring to the conclusion that all light sources very far from us are regressing. In a model that sustains a globally static Universe must be assumed that the distance that separate our planet from them, remains unchanged. A stationary source of waves does not produce any variation of wavelength so that an observer receive a unchanged frequency. Of course, is also to take into account that in the universe everything moves, but the movements that every source does inside its system or local galaxy group is elliptical or in any case in the orbital sense around their respective gravitational averages, so that on a distance of billions l.y. from an observer, are totally irrelevant, as long the distance from this latter is globally maintained. Finally:

as a rule over short distances : $$f_0 = \frac{1}{\lambda_0} c \tag{10}$$

and:

$$f_0 = \frac{1}{656}(299792,458) = 457 \quad \text{as specific case.} \tag{11}$$

Over very great distances , taking into account a possible slowdown of light speed:

$$f_{obs} = \frac{1}{\lambda_0}(c - v) \quad \text{(as per eq. 8)} \tag{12}$$

5. Hubble's Law and the Cosmologic Standard Model.

The Law of Hubble is originally based on the calculations of Doppler grounded on the astronomical observations and relative spectrum analysis made since 1929. At the time of Hubble's publication, the most distant observable body was the galaxy NGC-7619 [11] discovered by William Herschel on September 26, 1785 ,which registered a redshift of 0,01324 and a regression speed of about 3.944km/s.: a surprising result, at that time, but still contained in the limits allowed by Relativity.

Successively, the discovery of galaxies showing a redshift much greater than1 put interrogatives about the way to calculate the shift. A very brief list of these bodies we can see here:

- the quasar 5C 02.56 discovered in 1970, shows a redshift of: *z= 2,399*, corresponding to a regression speed of: *v= 719.700km/s;*
- GB1428+4217: z= 4,72; recession speed = *1.416.000km/s;* -
- GRB090423: z= 8,2; recession speed = *2.460.000km/s*.

All light sources mentioned here above have a speed of recession that is no longer compatible with the ground of Special Relativity nor with the original ground on which Hubble's calculations are based, i.e. Doppler or Relativity Doppler.

Applying the recalculation shown above to these bodies, we will get the following results:

- 5C 02.56:

$$\lambda_{obs} = 2230;\ f_{obs} = \frac{c}{\lambda_{obs}} = 134,45;\ z_f = \frac{f_{obs} - f_0}{f_0} = -0,7058;\ v = cz_f = -211593,5;\ c' = (c - v) = 88199;$$

$$\frac{1}{656}(c - v) = 134,45 = \frac{c}{\lambda_{obs}}$$

- - GB1428+4217: $\lambda_{obs} = 3752,32;\ f_{obs} = 79,9;\ z_f = -0,8251;\ c' = 52414 km/s$
- GRB090423: $\lambda_{obs} = 6035,02;\ f_{obs} = 49,67;\ z_f = -0,8913;\ c' = 32583 km/s$

Evidently, as results by the Hubble's model, based on increase of wavelength, the recession speed of several bodies showing a shift > 1 exceeds that of light in such an extent that cannot be justified by Hubble's Low itself. From this angle the cosmologic Standard Model, appears to be lacking in providing convincing solutions. Even this latter – the standard model –is to consider a consistent theory in itself, today we know that there are some things, , that it can't explain: the baryon asymmetry, the lack of balance between matter and antimatter, even gravity is not described by the model. The major weakness of the Standard Model is dark matter . It is about five times larger than normal matter and should be made up of particles that have no place in the model. The universal expansion and the consequently formulated Big-Bang Theory, besides, there are still some unanswered questions: Hubble's law, according to which the speed of recession of expanding galaxies is directly proportional to the distance in which they are from us, means that the further a celestial body is from us, the faster it moves away. The question currently not yet clarify, is that to understand how and by which physical principle each body takes the energy to move away from us at a constant progressive acceleration. Apart from vague hypotheses proposed in conditional form, a convincing explanation has not yet been found.

By this alternative model, the problem of constant acceleration and the kind of energy necessary to achieve it, would cease to exist. A slowing down of existing motions due to friction agents (gravity or concentrations of atomic waste scattered over paths of many billions light years) is consistently contemplated by the laws of general physics.

6. A possible experiment:

To get a clear and final answer to these questions it would be necessary to perform an experiment aimed at a direct measurement of the speed of light observed by bodies that present an high degree of redshift:

Many of the most distant bodies from us have been detected in the last thirty years by Hubble telescope, which is located at an average distance of about 500 km. from the earth's surface. This distance would allow an accurate measurement of the time required for the signal to travel the distance from Hubble telescope to the connected lab on earth surface. A time that, according to this model, should relevantly be greater than what it would take at original speed c. According to this model the speed of light that we should register by GN-z11 would be about 25,000Km/s = f 37,8, which means, in terms of time 0,02" to cover this distance. While at original light-speed would be 0,00166". A difference that would leave no doubts.

Carrying out this experiment, whatever result comes out of it, (confirming or denying the model described) would still be of great importance both to know with certainty whether the universe is really expanding despite the doubts currently arose or whether to open a new chapter research in the field of physics and cosmology.

7. Conclusion.

The discussion surrounding the possibility of reviewing the calculations inherent to the redshift as a consequence of Doppler is not new and it is still open. Therefore it offers space for different interpretations. The model taken here, besides a correct mathematical analysis procedure, offers an advantage that other theories haven't: the current availability of technical tools to may suggest a direct measuring of the speed of light recorded in observation, coming from sources that on base of wavelength, have a redshift >1, which for some of these, the difference in speed with respect to *c* would be such as to allow a minimum margin of error. This, presumably, would be the only way to finally understand whether the Universe is expanding or it remains stable thanks to the fact that each body orbits around the gravitational mean it forms with other bodies. Just as our system remains stable, or, on a galactic scale, our local group as well. After all, the postulate of universal constancy of lightspeed is not a dogma. In the perspective, to may obtain with certainty new scientific knowledge on the origins and dynamics of the Universe, light-constancy should not be considered an obstacle for alternative experimental research.

References.

1. *Cromie, William J. (1999-02-18). "Physicists Slow Speed of Light". The Harvard University Gazette. Retrieved 2008-01-26.*
2. *"Light Changed to Matter, Then Stopped and Moved". Photonics.com. Retrieved 10 June 2013.*
3. *Ginsberg, Naomi S.; Garner, Sean R.; Hau, Lene Vestergaard (8 February 2007). "Coherent control of optical information with matter wave dynamics" (PDF). Nature. **445**(7128): 623–626. doi:10.1038/nature05493. PMID 17287804. S2CID 4324343.*
4. *Kanellos, Michael (2004-09-28). "Slowing the speed of light to improve networking". ZDNet News. Archived from the original on 2008-02-28. Retrieved 2008-01-26.*
5. *Kanellos, Michael (2005-11-02). "IBM slows light, readies it for networking". ZDNet News. Archived from the original on 2007-12-19. Retrieved 2008-01-26.*
6. *Lee, Myungjun; et al. (2010). "Systematic design study of an all-optical delay line based on Brillouin scattering enhanced cascade coupled ring resonators" (PDF). Journal of Optics A. **12** (10): 104012. arXiv:1002.0084. Bibcode:2010JOpt...12j4012L. doi:10.1088/2040-8978/12/10/104012. S2CID 18504919.*
7. *Wentao T. Lu, Savatore Savo; B. Didier F. Casse; Srinivas Sridhar (2009). "Slow microwave waveguide made of negative permeability metamaterials" (PDF). Microwave and Optical Technology Letters. **51** (11): 2705–2709. CiteSeerX 10.1.1.371.6810. doi:10.1002/mop.24727.*

8. Giovannini, J. Romero, V. Poto ek, G. Ferenczi, F. Speirits, S. M. Barnett, D. Faccio, M. J. Padgett. **Spatially structured photons that travel in free space slower than the speed of light**. *Science*, 2015; DOI: 10.1126/science.aaa3035

9. *Griffin, Andrew (4 March 2016). "Most distant object in the universe spotted by Hubble Space Telescope, shattering record for the farthest known galaxy". The Independent. Retrieved 17 December 2017*

10. *Wright, Edward L. (August 2, 2013). "Why the Light Travel Time Distance should not be used in Press Releases". University of California, Los Angeles. Retrieved March 10,2016.*

11. Humason, Milton L. (March 15, 1929). "The Large Radial Velocity of N.G.C. 7619". *PNAS*. **15** (3): 167–