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Arp's View of Cosmological Redshift Without the Second Postulate of Relativity

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Abstract **– This note shows that the Cosmological Redshift, in addition to the receding motion of galaxies away from each other resulting from the theorised expansion of the universe, can also result from a reduction in the speed of photons. This slowdown, which generates a reduction in the frequency of light, is predicted by Paolilli's function, which provides an alternative explanation of the Michelson-Morley experiment by assuming that photons can exhibit two motions: one away from the point of emission and another in a direction different from the first, due to external forces (motion of the emission source or gravity). The application of this function, while revaluing the vision of the astronomer Halton Arp who, believing in a stationary universe, contested the Big Bang Theory, does not, however, take into account the explanation he provided, which was essentially based on an assumed increase in the mass of particles over time. Furthermore, the predicted reduction in photon frequency could shed new light on phenomena such as the "cosmic microwave background" and why the night sky appears dark.**

Keywords **– Paolilli's Light Speed Function, Slowing Down of Photons, Arp's Viewpoint of Cosmological Redshift Revised.**

I. Introduction

In this note it is shown that the Cosmological Redshift, in addition to the receding motion of galaxies away from each other resulting from the theorised expansion of the universe, could also be determined by a reduction in the speed of photons. This slowdown, which generates a reduction in the frequency of light, is predicted by Paolilli's function [1] (derived from a first, more approximate function [2]), which presents an alternative explanation of the Michelson-Morley experiment. The application of this function, while revaluing the vision of the astronomer Halton Arp [3] who, believing in a stationary universe, disputed the Big Bang Theory, does not, however, take into account the explanation he provided, which was essentially based on an assumed increase in the mass of particles over time. Furthermore, this function could provide an alternative explanation for phenomena such as the "cosmic microwave background" and the darkness of the night sky.

II. The Michelson-Morley Experiment: A Paradigm Shift

Before presenting Paolilli's function and discussing its application to the Cosmological Redshift, it is appropriate to explain the reasons that led to the development of this function.

In the 19th century physicists believed that a medium was necessary for the wave motion of light and called this medium "luminiferous aether". To detect this luminiferous aether, Michelson [4] prepared an experiment, through the use of an interferometer that, by dividing and then recombining a beam of light, was supposed to show, in the case of the presence of ether wind, an interference phenomenon between the two recombined beams. The device showed no interference figure. The experiment was repeated and perfected in 1887 by Michelson in collaboration with Morley [5], with identical results.

One possible explanation of this result was furnished by FitzGerald [6] and formalised by Lorentz [7]. In it t-

-he hypothesis was put forward that moving bodies contract along the direction of motion due to the aether wind resulting from such motion, and that this contraction is exactly of the magnitude to compensate for the differences between the paths of light rays towards different directions.

Einstein's Theory of Special Relativity [8] incorporated the formulas of Lorentz transformations, but assuming the nonexistence of the aether. The exclusion of the existence of the aether is the main difference in Einstein's Special Relativity, not only with Lorentz's explanation of the Michelson-Morley experiment, but also with Poincaré's approach to relativity of time [9] [10]. The physical interpretation of Lorentz's transformations and the principle of relativity are in fact present in Poincaré's work even before Einstein's. Even the famous equation $e = mc^2$ does not first appear in Einstein's paper [11] immediately following and related to Special Relativity (note that in this Einstein's paper [11], as well as in the earlier papers mentioned immediately below, the speed of light was denoted by v [velocity], and not by c [celeritas] as will be the case later). Although in a context characterised by the assumption of the presence of the aether, this relation appeared in De Pretto's paper [12], and as early as 1900 in Poincaré's paper [13] (there presented in the following form: $m = \frac{e}{v^2}$).

However, as underlined by Auffray [14], Poincaré's and De Pretto's approaches are quite different from each other. Auffray noted that De Pretto hypothesised the existence of an aether made of “ultramundane particles” moving in space. On the contrary, Poincaré's approach has its roots in electromagnetic theory, and in particular in the Theorem of Poynting [15], a former student of Maxwell.

However, it is fundamental to note that, especially in its formulation by Einstein, Relativity Theory brought about a paradigm shift in physics, denying the existence of the aether. About the relativity of simultaneity (as we have seen, already introduced by Poincare), it leads to a conception of the universe in which “a single type of reality uniformly fills the past, present and future” (translation from the Italian text [16]), with the future therefore predetermined in every detail. However, even Einstein [17] partially reconsidered his position on the aether in the years of his maturity. Moreover, today, from the perspective of various scholars, although no longer defined as “aether”, the medium of electromagnetic waves is identified in a privileged inertial system that is ultimately space itself, no longer seen simply as nothingness.

III. The Paolilli's Function to Determine the Speed of Light Emitted by a Moving Light Source

Although many experiments have yielded results in line with the predictions of Relativity, it is also true that some of these results are not considered valid by all authors. For example, the Sagnac effect [18] [19] [20] casts doubt on the constancy of the speed of light in space, but its results, subsequently confirmed by various other experiments [21], were essentially ignored by the scientific community. Moreover, Hafele and Keating’s experiment [22] [23], on the one hand confirmed the slowing down of time on airplanes circumnavigating the earth to the east, thus confirming relativistic predictions, and on the other hand showed an acceleration of time on airplanes moving westwards. This contradicts the principle of (strong) relativity, according to which all systems of reference are equivalent.

As the Michelson-Morley experiment showed, light pulses emitted by a light source moving together with mirrors equidistant from it (thus forming an inertial system named S_1), even if they do not travel trajectories of equal length in the privileged system (named S_0), return to the light source simultaneously.

To explain this result without generating paradoxes and without resorting to the hypotheses of length contraction, it is necessary to exclude the constancy of the speed of light in every reference system (i.e the second postulate of relativity). For this purpose a new function has been presented [1] (derived, as mentioned above, from a first, more approximate function [2]). It takes into account the slowing down of time in a system (S_1) in motion with respect to a theorised privileged system (S_0). However, time is considered as a quantity used by the mind to compare successions of events of different or equal density. In this framework space-time does not exist as a physical entity, being only a graphic representation of events (“bodies do not move in space and time, they move in space taking time” [24]).

Assuming that the speed of light (c) emitted by a light source at rest in the privileged system S_0 is 1, the function which measures the speed of a photon emitted by a light source moving in the privileged system is the following:

$$c_{\theta S1,S0} = \sqrt{1-\sin\theta^2{}_{S1}\, v^2(1-v^2)} \tag{1}$$

In (1) $c_{\theta S1,S0}$ is the speed of photons, emitted by a light source moving (at the speed v) with respect to S_0, whose trajectory (in S_1) has an angle θ_{S1} with the trajectory of the light source in S_0. In Paolilli [1] [2] it was named $c_{\theta,S0}$ for simplicity.

$sin\,\theta_{S1}$ is squared: thus (1) gives the absolute value of the speed of light in S_0, whatever its direction and, treating θ_{S1} as an independent variable (given a certain value for v), the curve of $c_{\theta S1,S0}$ has no angles (see Paolilli [1]). The values obtained by (1) satisfy the result of the Michelson-Morley experiment (see Paolilli [1]) for each value of v (for $0 \leq v < 1$) and for each value of θ_{S1}. Figure 1 shows the values of $c_{\theta S1,S0}$ on dependence of v, for some different values of the angle θ_{S1}.

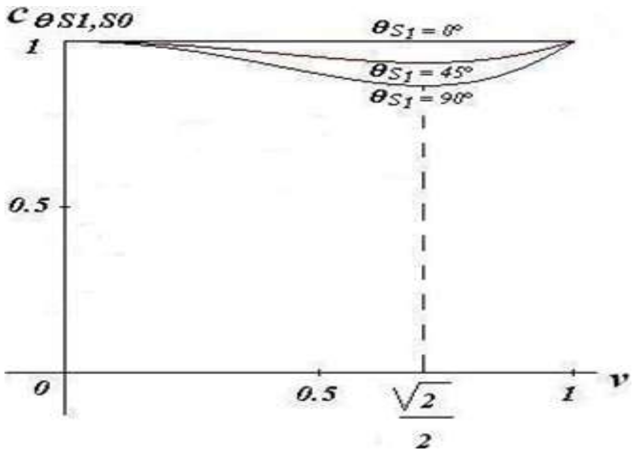

Fig. 1. The curves show the relation between v (for $0 \leq v < 1$, and $c_{S1,S0}$, for different values of θ_{S1}.

Function (1) was constructed taking into account the slowing down of time for moving bodies, which has been largely verified, and which is illustrated in Figure 2. Figure 2 in fact shows the relation between the velocity v (expressed in terms of c, with $c = 1$, and thus equal to cos (ψ) in the graph) of the inertial system S_1 with respect to the privileged system S_0, and the local time (in S_1). Local time (sin(ψ) in the graph), in accordance with the concept of time expressed above, is indicated by the ratio between the speed of the processes in S_1 (called S_1p) and the speed of identical processes in S_0: ($\frac{S_1p}{S_0p}$).

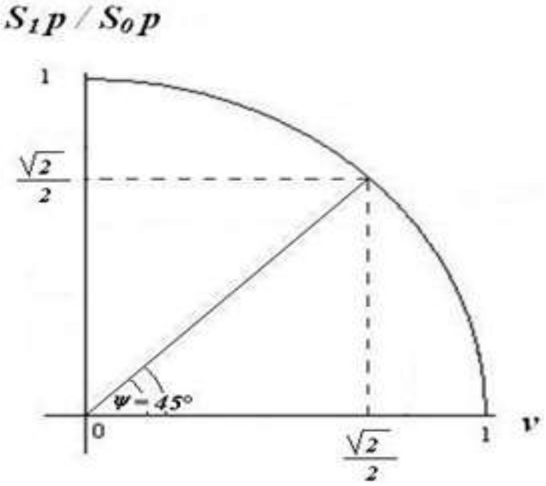

Fig. 2. The graph shows the ratio between the speed of the local processes in S_1 and the speed of identical processes in S_0 as a function of the speed v of the inertial system S_1 relative to the privileged system S_0.

Looking at the graph of Figure 2, we can see that the speed of processes in S_1 slows down slowly at first, then faster and faster. For $sin(\psi) = cos(\psi) = 45°$, the abscissa ($\frac{\sqrt{2}}{2}$) is equal to the ordinate and corresponds to the abscissa of v in Figure 1 for which the speed of light in S_0 is the lowest.

A photon emitted by a moving light source has a movement away from it and a movement along a direction parallel to the trajectory of the light source. During its emission, the photon undergoes a force due to the movement of the light source in space. If this force is exerted along the photon's trajectory ($\theta_{S1} = 0°$ or $\theta_{S1} = 180°$), it has the effect of shortening the photon (its wavelength) or lengthening it, depending on whether the direction of the photon's trajectory is the same as or opposite to that of the source. If, on the other hand, the angle θ_{S1} is other than 0° or 180°, approaching θ_{S1} at 90° or 270°, the speed of the photon in S_0 will slow down. The "resistance" that a photon encounters in its propagation is maximum when both the velocity v of the light source in S_0 and the ratio $\frac{S_1 p}{S_0 p}$ touch the value of $\frac{\sqrt{2}}{2}$, and above all if $\theta_{S1} = 90°$ or 270° (for more details: [2]).

IV. Trajectory of the Photon in a Gravitational Field and the Arp's Universe

The Paolilli's function discussed above can be used to furnish some contributions to Cosmology. As we have mentioned in the Introduction, the astronomer Arp [3], believed in a stationary universe (based on Einstein's first vision of General Relativity [25]) and contested the Big Bang Theory (this theory was also more recently contested by Selleri [16], but following a different line of thought, i.e. excluding the existence of the fourth time dimension). Arp [3] advanced the hypothesis that the Cosmological Redshift is determined by the age of celestial bodies, explaining it by referring to Narlikar's theory [26], according to which the mass of particles increases with time. Arp argued that quasars, cosmic objects with a very high redshift, are not at the edge of the visible universe. In fact he noticed that many of them, which appear to be connected to neighbouring galaxies, show a very different red-shift from the connected galaxies, implying that their redshift is due to the speed at which they were ejected from these galaxies.

However, while we do not wish to propose an alternative theory to the Big Bang theory, we do point out that (1) allows us to give an alternative, or even just additional, explanation for Cosmological Redshift. In fact, by abolishing the second postulate of relativity, it is possible to introduce, among the explanations of the Cosmological Redshift, the deviations that the trajectories of photons undergo due to the gravitational fields they encounter on their path. In fact, function (1) provides different values for the speed of light depending on the motion of the light source in a privileged system and the angle between the trajectory of the light source and the trajectory of the photons. As explained in the previous section, the speed of the photon emitted by a moving light source varies depending on the speed of the source and the θ_{S1} angle.

The trajectories of photons, however, can also change as they travel due to gravity. A photon that encounters a gravitational field on its way is subject to a force that can deflect its trajectory. As is well known [27] [28], everything is subject to the acceleration of gravity to the same extent, regardless of its mass: hence also photons. Therefore, when a photon passes close to a mass, it "falls" towards it, albeit for a short time, given its speed, thus deviating a little its trajectory. This deviation is ultimately due to a force similar to that exercised on the photon by its moving source. The force that causes the photon to deviate also reduces its speed and thus its frequency. The variation, unless there is the remote possibility that the photon, whose trajectory is already altered with respect to its emission, undergoes a variation that restores it, even partially, to its initial motion condition, will be of a negative sign, in the sense that the velocity will decrease and thus also the frequency. Due to the fact that as the distance increases, the greater the chance of photons slowing down and consequently reducing their frequency, this could provide an alternative explanation for the Cosmological Redshifts which could re-evaluate, even if only partially, Arp's thesis.

The slowing down of the photons and thus their final frequency could be calculated by means of (1). Figure 3 shows the trajectory of a photon emitted by a light source *ls*, deflected by a gravitational field. Note that the angle θ_{S0} between the original and final trajectory should not be confused with the angle θ_{S1} in (1). In reality, θ_{S1}, i.e. the angle with respect to the direction of the pull experienced by the photon due to gravity, varies as it passes through the gravitational field. For simplicity, we will assume $\theta_{S1} = 90°$, i.e. the value of the angle between the photon's trajectory and the direction of the gravitational pull at the point closest to the centre of gravity. Therefore, since for $\theta_{S1} = 90°$ we have $sin^2\,\theta_{S1} = 1$, (1) will be simplified. The value of v will instead be derived by taking into account that it is the speed at which the photon moves away from the extension of the trajectory it was following before the interaction with the gravitational field (in Figure 3 represented by the dashed arrow).

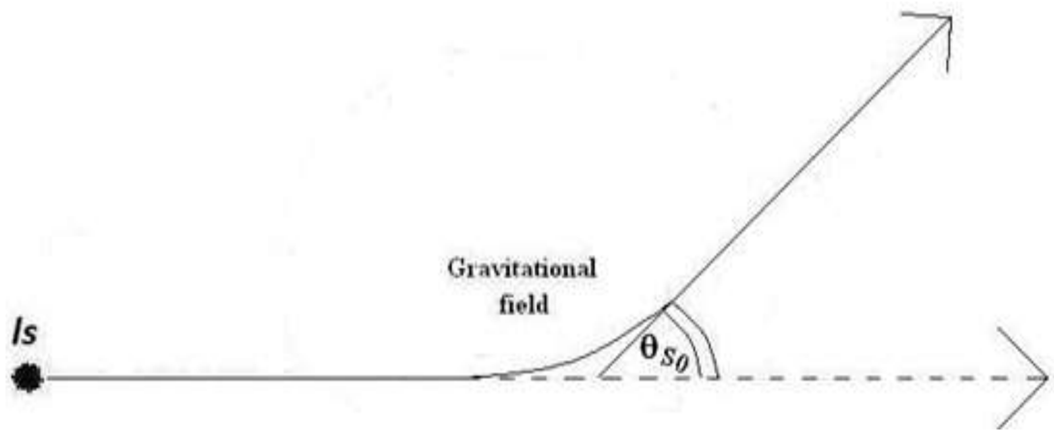

Fig. 3. The Figure shows the trajectory of a photon emitted by a light source *ls*, deflected by a gravitational field, with the angle θ_{S0} between the deviated trajectory (solid line) and the extension of the original trajectory (dashed line).

The value of v, given a certain θ_{S0} measured after the deviation has ended, can be so calculated:

$$v = c_{S0}\sqrt{1 - cos^2\,\theta_{S0}} \tag{2}$$

In (2) the speed of the photon is named c_{S0}, thus emphasising its variability.

We can set up a system consisting of (1) and (2), thus obtaining the values of v and c_{S0}. In Figure 4 some graphical solutions of the system are shown. The curve is the same as Figure 1 for $\theta_{S1} = 90°$. The values of θ_{S0} are indicated close to the corresponding values of c_{S0} and v.

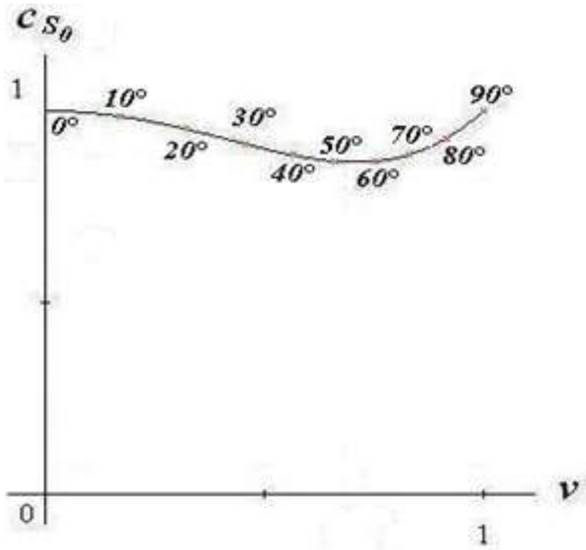

Fig. 4. The graph presents the values of c_{S0} and v associated with different θ_{S0}.

However, c_{S0} is the speed of photons in S_0. This speed, as we have seen for moving inertial systems, has two components: a movement away from the position of the light source at the moment of emission and a movement away from the original trajectory induced by gravity. The former, which can be considered an internal process in S_1 (a system consisting only of the photon), as shown by Figure 2, decreases as v increases and we think that only this component is linked to the frequency of the photon which therefore appears lengthened. For highly deviated trajectories of photons coming from the boundaries of the visible universe, it would perhaps be possible that they appear as a “cosmic microwave background”, with a redshift that certainly makes them not visible to human eyes, which would also explain why the night sky does not appear bright.

V. CONCLUSION

In this note an alternative or at least additional explanation of the Cosmological Redshift has been presented. It is made possible by a new approach to Relativity, according to which the second postulate of relativity is to be abolished and so is the contraction of lengths. Such an approach could be called “Time-Only Relativity”, even if time itself is redefined by excluding its reality as a physical dimension. Paolilli's Light Speed Function, already used to give a simpler explanation without paradoxical outcomes to the Michelson-Morley experiment, can be used to explain for the Cosmological Redshifts, which could derive from a progressive slowdown of the speed of photons due to their interaction with the gravitational fields they encounter in their path. It could also shed new light on phenomena such as the "cosmic microwave background" and why the night sky does not appear bright.

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