Frequency Decrease of Light

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Abstract

The phenomenon is so slow that its effect is undetectable in light emitted at distances as in our galaxy, but is significant in light coming from cosmological distances, hence the alias "Cosmological Degeneration/Decay of Light". An unprecedented case in physics is that the law governing the phenomenon results uniquely, through mathematical reasoning. As main consequences, it: solves *Digges-Olbers' paradox*, thus making possible cosmology with infinite universe; explains *Hubble's redshift* (or *cosmological redshift*), in agreement with *Hubble's constant's inconstancy*; explains the *Penzias & Wilosn* CMB; explains the unexplained non-uniformity in CMB; replaces the *Big-Bang theory/model/scenario*. Two new predictions are made.

Keywords: solving Digges-Olbers paradox; infinite universel; absolutely resting frame; Hubble constant inconstancy; tired-light model; replacing Big-Bang theory

Contents

1 Introduction

The existence of the phenomenon postulated herein is suggested by the following "photometric paradox" also called "dark night sky paradox".

Digges-Olbers' Photometric Paradox *In an infinite universe, uniformly full with sources of light, the nocturnal sky should be bright, not almost black as it is.*

Consequence *Any cosmology with infinite universe has been impossible because of this paradox.*

After the nature of light discovery (Maxwell, 1864), the paradox should have suggested the existence of a phenomenon of decrease in frequency, to be incorporated in Maxwell's equations, but this did not happen, not even after the discovery of the *cosmological redshift* (Hubble and Humason, 1929) [1]. Attempts to solve the problem by frequency decrease—called *tired-light* model—were made, however, but via some quantum mechanisms of collision with hypothetic particles [2].

The *cosmological redshift* was hypothesized (and still currently accepted) to be a Doppler effect, which has entailed a bunch of hypotheses herein referred to as the BBT[1] which, once known the phenomenon and its law we are dealing with, are no longer necessary, since the observational facts intended to solve become simple predictions, with no farther supposition.

As the phenomenon is extremely slow, proved by cosmological facts of observation only, an expressive synonymous is CDL[2].

2 Postulating the phenomenon and *deducing* its law

Digges-Olbers' paradox (above transcribed) as well as the full of hypotheses Big-Bang theory are decisive incentives to postulate the existence of a phenomenon of frequency decrease of light. The phenomenon appears as possible in two ways/mechanisms altogether different but, irrespective of the ambiguity on the mechanism, the law governing it is *certainly* one and the same, mathematically deduced. We first postulate the phenomenon irrespective of the mechanism, next deduce the law, and finally (section 2.1) discuss the two candidates for the mechanism.

Postulate of Frequency decrease or CDL *The frequency of electromagnetic waves slowly decreases during their travel, tending to zero as the distance tends to infinity,*

$$\nu = \nu_0 f(r)\,, \quad f(0) = 1\,, \quad \lim_{r\to\infty} f(r) = 0\,, \tag{1}$$

[1]BBT stands for *Big-Bang Theory/Model/Scenario.*

[2]CDL stands for *Cosmological Degeneration/Decay of Light.*

f being positive, strictly decreasing, and continuous together with all its derivatives in the interval $(0,\infty)$.

Note that none of the above mentioned two mechanisms are not invoked in the postulate, as nor are they in the following essential notice.

Optics notice *The law $\nu_0 f(r)$ must permit taking any point of the trajectory as origin, and the corresponding frequency as the initial value—just as if that point were the source (or emitter)*—that is, taking a new origin at $r_1 < r$ at which the frequency is ν_1 , one can write

$$\nu = \nu_0 f(r) = \nu_1 f(r-r_1) = \nu_0 f(r_1) f(r-r_1)\,, \tag{2}$$

or graphically,

	Origin (source)	New origin	Current point
$r=$	0	r_1	r
$\nu=$	ν_0 $=\nu_0 f(0)$	ν_1 $=\nu_0 f(r_1)$	ν $=\nu_0 f(r)$ $=\nu_1 f(r-r_1)$ $=\nu_0 f(r_1) f(r-r_1)$

This observation filters uniquely the function $f(r)$, as just going to see.

Theorem *The law of frequency decrease stated by the above homonymous postulate is*

$$\nu = \nu_0 e^{-\mathcal{H} r/c}, \tag{3}$$

where c is the speed of light in vacuum, and $\mathcal{H}$ is a positive constant.

We propose $\mathcal{H}$ to bare the name of the *earliest (value of) Hubble's constant*, since it is just the name says, as just going to see.

Proof Transcribe from Eqs. (2) $\nu_0 f(r) = \nu_0 f(r_1) f(r-r_1)$, differentiate both sides with respect to r, denote by prime the derivative, and write the ratio of the two equalities,

$$\frac{f'(r)}{f(r)} = \frac{f'(r-r_1)}{f(r-r_1)}\,,$$

whence, as r_1 is arbitrary, these ratios are constant $f'(r)/f(r) = c_1$, whence $f(r) = c_2 \exp(c_1 r)$, hence $\nu = \nu_0 c_2 \exp(c_1 r)$, whence, as ν at $r=0$ is ν_0, obtain $c_2 = 1$, thus $\nu = \nu_0 \exp(c_1 r)$; since, by postulate, ν decreases, c_1 is negative, and it is preferable to take it in the form $c_1 = -\mathcal{H}/c$, hence just the law (3). QED

Of course, one can replace $r = ct$ in (3), but the resulting form hides the physical meaning, namely, it is space that physically counts, not time.

2.1 Dilemma on choosing the phenomenon's mechanism

Thinking on the mechanism of *frequency decrease of light*,

1. a first idea—we now put forward—is to postulate it as a fundamental phenomenon of classical electrodynamics, to be incorporated by modifying Maxwell's equations—which were regarded as taboo so far.

2. A second idea was put forward by Zwicky [2], the one who coined the phenomenon as "tired-light" model, consisting in that the light collides hypothetic particles and resumes its travel with a negative shift in frequency. This version of the mechanism involves two problems: one of cosmology, of existing particles in the universe to be encountered by light, and the other of quantum electrodynamics, consisting in the mechanism by which light does resume its travel, but with a negative shift in frequency. Technically, this version seems more difficult.

The writer, thanks to some (subjective) physical intuition, and for simplicity, inclines, as already asserted, to the version 1.

3 Explaining the effects related to Big-Bang

Each subsection below is a test of the law (3) and has two components: problem, followed by solution, including the one in the BBT.

3.1 Solving Digges-Olbers paradox

Solving the Digges-Olbers paradox has been the very motive to put forward the phenomenon and its law this article is dealing with. According to law (3) the frequencies of light coming from enough large distance is decreased/decayed below the threshold of visibility, i.e., an observer is not reached by light from the whole universe, but only from a (large) vicinity.

In the BBT the problem is solved hypothesizing the universe to be finite.

3.2 Explaining the Hubble redshift

As already mentioned in section 1, Hubble and Humason discovered (1929) [1] a redshift in light coming from distant galaxies—hence the name of *Hubble's cosmological redshift*—according to the formula

$$\frac{\lambda - \lambda_0}{\lambda_0} = \frac{H}{c} r \qquad \texttt{(Hubble formula fot his redshift)}, \tag{4}$$

where H is the *Hubble constant*, which later proved not to be a constant.

The law (3) leads to Eq. (4) as an approximation, as follows. Expressing $(\lambda-\lambda_0)/\lambda_0$ in terms of frequency, via $\lambda\nu = c$, i.e., $(\lambda-\lambda_0)/\lambda_0 = (\nu_0-\nu)/\nu = \nu_0/\nu - 1$, and replacing ν according to (3), yield

$$\frac{\lambda-\lambda_0}{\lambda_0} = e^{\mathcal{H}\,r/c} - 1 \quad \texttt{(exact formula for Hubble redshift)}\,, \tag{5}$$

instead of the above Hubble formula, (4); expanding the exponential in a power series and neglecting the powers higher than 1,

$$\frac{\lambda-\lambda_0}{\lambda_0} \approx \frac{\mathcal{H}}{c} r\,, \tag{6}$$

for $\mathcal{H}r/c \ll 1$, that is, for

$$r \ll c/\mathcal{H} \qquad \texttt{(condition for}(6)\texttt{)}. \tag{7}$$

Hence, indeed, the approximation (6) coincides experimentally with (4), *if the condition (7) is satisfied.* In other words, Hubble's formula (4) is an approximation of that exact (5) derived from the law (3).

In the BBT the Hubble/cosmological redshift is explained by hypothesizing it to be a Doppler effect—this being the basis of the Big-Bang idea in cosmology (Doppler effect implies in turn galaxies recession, finite and expanding universe, initial point and explosion, and the entire bunch of hypotheses making up the scenario itself).

One should read quotations showing Hubble and Tolman's [3] quandary on the cause of the cosmological redshift: "... recession or some other cause for the red-shift." "observations ... are not yet sufficient to permit a decision between recessional or other causes for the red-shift." "Nevertheless, the possibility that the red-shift may be due to some other cause ... should not be prematurely neglected;" "... both the present writers wish to express an open mind ... and ... continue to use the phrase "apparent" velocity of recession. They both incline to the opinion, however, that if the red-shift is not due to recessional motion, its explanation will probably involve some quite new physical principles."
The ending sentence should be stressed: "some quite new physical principles".

3.3 Why Hubble's constant has not behaved as a constant

As just noted, Hubble's formula (4) is experimentally valid as long as the condition (7) is accomplished.
As observations advanced to more and more distant galaxies, the linear Eq. (4) became unsatisfactory, which made observers determine smaller and smaller values for H to satisfy (unawares) the condition (7), and the process continued up to the edge of visible universe. It is now clear why $\mathcal{H}$ in (6), i.e., in (3), is (as above called) the *earliest* value of Hubble's constant:

the subsequent values were forced, to use the same linear law (4) in the absence of that exact (5).
The value of the (pseudo)constant H has been debated for all 89 of the intervening years: as observations reached more distances, smaller values have been assigned to H, ranging from above $550\,(km/s)/Mpc$ to below 50 ($1\,Mpc = 3.08568025 \times 10^{22}\,m$). This is why the syntagmas *Hubble's constant's inconstancy* and *Hubble's pseudo-constant* are used herein.

3.4 Evaluating the known $10^{26}\,m$ edge of visible universe

Clearly, according to law (3), for any source of light there exists a distance beyond which its highest emitted frequency decays (on travel) below infrared, i.e., becomes microwave and even more degenerated, up to undetectability. In general, a source of visible spectrum of light also emits the neighboring bands—infrared and ultraviolet—by means of which the source can also be seen using adequate instruments. Naturally, *the visible universe edge*, r_{edge}, is the distance from which the whole ultraviolet band decays in frequency up to below infrared. In other words, r_{edge} is the shortest distance from which the whole spectrum infrared–visible–ultraviolet reaches the observer as cosmic microwave background radiation. The distance from which a wave comes is

$$r = \frac{c}{\mathcal{H}} \ln \frac{\nu_0}{\nu} = \frac{c}{\mathcal{H}} \ln \frac{\lambda}{\lambda_0} \ , \tag{8}$$

and to evaluate $r = r_{edge}$ we must take $\lambda_0 = 10\,nm$ (initial wavelength), and $\lambda = 1\,mm$ (received wavelength), while for $\mathcal{H}$ we take $550\,(km/s)/Mpc \approx 1.78 \times 10^{-17}\,s^{-1}$, thus finding $r_{edge} \approx 1.94 \times 10^{26}\,m$, a value rather too large, which makes us expect a greater value for $\mathcal{H}$, about $800\,(km/s)/Mpc \approx 2.60{\times}10^{-17}\,s^{-1}$. In other words, even at his first observations Hubble reached distances too large for the linear Eq. (4) without resorting to an H greater than the true $\mathcal{H}$.

Note that sources beyond r_{edge} emitting X-rays can also be seen in the infrared-visible-ultraviolet range; also, γ-ray bursts having taken place at even greater distances, can be seen in this range of frequencies. These sources appear as non uniformities in CMB[3], which were observed but currently unexplained—hence one more hypothesis(!) is expected in the BBT which in fact gives rise to more and heavier questions than it answers.

Currently the edge the visible universe has been evaluated observationally, as the BBT does not answer.

3.5 Explaining the CMB

This radiation, discovered by Penzias and Wilson (1965) [5], also called *relic radiation*, as interpreted/hypothesized (of course, another hypothesis,

[3]CMB stands for *Cosmic Microwave Background.*

maybe the oddest one) in the big-bang scenario. The CMB, whose origin is not within the edge of the visible universe, is, on average, isotropic, as the universe is, and its intensity distribution looks like that of a black-body radiation at 2.725 K temperature.

According to CDL, the existence of the CMB is an immediate consequence: light from sources at enough large distances (beyond *the edge of the visible universe*) does arrive with frequencies fallen below the infrared range—microwave and radio radiations—and must be isotropic, according to the *cosmological principle* (*"at cosmological scales, the masses and sources of light and particles are uniformly distributed"*, analogously to the molecules of a gas at thermodynamic equilibrium; the view arisen herein agrees with today's thermodynamical picture of the CMB, but the cause differs altogether).

3.6 Explaining the slight non-uniformity in CMB

By reason of importance for cosmology and physics in general—especially for the fact that *the CMB is an absolutely resting reference frame*—close theoretical and observational studies have been carried out. COBE (COsmic Background Explorer) satellite discovered (1992) [6] slight non-uniformities, randomly distributed, in the CMB. WMAP (Wilkinson Microwave Anisotropy Probe) mission has examined the CMB in finer detail, with greater sensitivity, and a full sky map has resulted [7], as well as that the CMB ranges—in terms of temperature—between 2.7251 and 2.7249 K.

Obviously, the CMB coming from sources beyond, but relatively near, the visible edge, are received individually, as spots (i.e., non-uniformities) on the compact background, that is, those sources are seen by means of radiation below the infrared range (microwave and radio). The CMB becomes compact, i.e., indiscernible sources, as distances tend to infinity (and frequencies to zero).

4 Predicting two new effects

The lower the frequency the less the non-uniformities in CMB Clearly, the highest frequencies of the CMB (long infrared) come only from the closest sources, near r_{edge} (defined in section 3.4). Therefore those sources are seen almost individually through long infrared, hence the greatest non-uniformity appears in long infrared—just as seen on the WMAP map—which the BBT fails to predict. On the contrary, frequencies lower than long infrared originate both from the nearest and farther sources, i.e., from more numerous sources (yielding greater angular density), hence *the non-uniformity is less than in infrared*. Three WMAP type maps would be relevant: in infrared; in microwaves; and in radio frequency. The evenness is thus expected to increase gradually, beginning with the map in infrared.

Light from sources beyond the visible universe edge Of course, sources beyond r_{edge} emitting frequencies above the visible range—as X-rays and γ-ray bursts—can however be seen in the infrared-visible-ultraviolet range.

5 Absolutely resting reference frame does exist

At any point in space, light comes degenerated to any value of frequency, from sources correspondingly distant, in particular as CMB, and is homogeneous and isotropic, as the distribution of sources are in the universe (according to the *cosmological principle* worded in section 3.5); the point under consideration lies in the absolutely resting reference frame; if the point moves, then the CMB becomes anisotropic because of the Doppler effect (so the Doppler effect is the basis for a kind of an absolute speedometer through the universe).

6 Discussion

Note that the six effects in section 3 are explained artificially in the BBT, each by one more hypothesis, while according to the CDL they are explained consistently, with no supposition. Note also how all scientists refrained from postulating the cosmological redshift to be caused by a fundamental electromagnetic phenomenon regarding Maxwell's electrodynamics as taboo. One should now reread the ending paragraph of section 3.2. It is hard to avoid irony.

The BBT appears as the most naive and spectacular theory in the history of Physics, Cosmology, Philosophy, and all the sciences, including the ancient times. It is an embarrassing error of the 20th century.

A rhetorical question arises: what kind of mind, can any longer accept the BBT, instead of a turnabout towards the CDL?

"The reason why scientists like the "big bang" is because they are overshadowed by the Book of Genesis" (Sir Fred Hoyle).

"Cosmologists are always wrong, but never in doubt" (Robert P. Kirshner).

The fact should be mentioned that the General Theory of Ralativity (GTR) does not stand on BBT, i.e., GTR does not stagger on removing the universe expansion (the positive—repulsive—term in the gravitational field's equation), it only having to shift to its status before the cosmological redshift discovery (Hubble and Humason 1929). The real problem of GTR is however the tough question [8] on *Perihelion advance.*

Finally, while the BBT is philosophically artificial (catastrophic), very complicated, and full of hypotheses, the FDL is of a natural philosophy, extremely simple, with no hypothesis.

6.1 On authorship upon the phenomenon and its law (3)

An interesting mention is the article [4] in which Geller and Peebles **pleaded against the exponential law**, which they took (with no demonstration) from opposers and analyzed it polemically **from the position of the cosmological redshift as a Doppler effect**.

The authorship is as follows.

1. The CDL was first proposed by Zwicky, in version 2 (as discussed in section 2.1), while the version 1—of frequency decrease as a fundamental phenomenon of classical electrodynamics—has been proposed by the undersigned (having difficulties in making the scientific community accept its existence).

2. The exponential law of the phenomenon circulated before the undersigned, but as a supposition, not mathematically deduced; it is the proof of the above theorem that belongs to the undersigned, thanks to the personal simple *Optics notice* (section 2).

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