A Proposed Recoil Interaction Between Photons and The Electrons In The Plasma Of Intergalactic Space Leading To The Hubble Constant And CMB

Lyndon Ashmore

webmaster@lyndonashmore.com

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ABSTRACT:
The Hubble diagram for type Ia Supernovae gives the value of the Hubble constant, H as 64±3 km/s Mpc^{-1} which, in SI units, is equal to 'hr_e/m_e per unit volume of space' ($2.1x10^{-18}$ s^{-1}). This coincidence could suggest a relationship between H and the electrons in the plasma of intergalactic space that act collectively and oscillate if displaced. The possibility that light from distant galaxies is absorbed and reemitted by the electrons is considered with the electron recoiling on both occasions. A double Mössbauer effect leads to a redshift in the transmitted light. Introduction of the photoabsorption cross section $2r_e\lambda$ leads to the relationship $H = 2n_e hr_e/m_e$ giving H = 12 km/s Mpc^{-1} when n_e has the reported value of $n_e \approx 10^{-7}cm^{-3}$. The small amount of energy transferred to the electron by recoil is radiated as bremstrahlung with a wavelength in the microwave region.

Key Words: Hubble constant, Intergalactic Plasma, CMB, Redshift.

Subject headings:
Cosmic microwave background --- Cosmology: Galaxies: distances and redshifts ---Intergalactic medium

1. The Paradox Of The Hubble Constant and The Electron.

Whilst the conventional interpretation of cosmological redshifts is an expanding universe, some have expressed doubts that this is caused by expansion alone [1, 2, 3, 4, 5, 6]. Marmet [7] proposed a recoil interaction between photons of light and the hydrogen atoms in Intergalactic (IG) space but this would seem to have problems when one considers the discrete nature in which atoms absorb and reemit photons. However, none have reported the remarkable coincidence between the Hubble constant and the parameters of the electron (H = hr_e/m_e per cubic metre of space). Nor, until now, has anyone derived a possible relationship between the two.

The Hubble diagram for type Ia Supernovae gives the value of the magnitude and dimensions as the Hubble constant. The HST key Project result for H of 72+/- 8 km/s per Mpc [9] gives a range of (2.1 – 2.6)exp(-18)s^{-1} is remarkably close to hr/m 'per cubic metre of space' when one considers that, if we are to believe in an expanding Universe, H could have had any value constant And measurements" were fed into the database and 'return 100 items' chosen. Of these, all the papers giving an actual value for H were selected and should include the most recent results. The results for H are given in terms of hr/m per cubic metre of space. To do this the symbol k was assigned to represent the constant 'hr/m per cubic metre of space'.

The average of all the results was then taken. It should be noted that uncertainties were not taken into account and for those papers giving a range of values for H the middle value was taken. The average of all these results for H found by several different techniques is equal to 1.0k i.e. hr/m per cubic metre of space. It is therefore proposed that this relationship between the Hubble constant and the electron is not a chance event. Table 1.

2. THE MEDIUM WITH WHICH LIGHT INTERACTS.

This coincidence could suggest a relationship between H and the electrons in the plasma of IG space, $n_e \approx 10^{-7}cm^{-3}$ [10]. Electrons in the plasma interact simultaneously with other electrons by means of long-range Coulomb forces giving rise to a collective behaviour. Significantly, a displaced electron in the plasma of IG space will perform Simple Harmonic Motion [12] and a system of electrons that is able to oscillate is able to absorb and emit electromagnetic radiation. It is possible that photons from distant galaxies could interact with these electrons.

3. THE PROPOSED MECHANISM BY WHICH REDSHIFT OCCURS.

When photons travel through any transparent medium they are continually absorbed and reemitted by the electrons in the medium. French [13] states "the propagation of light through a medium (even a transparent one) involves a continual process of absorption of the incident light and its reemission as secondary radiation by the medium." Feynman [14]

Table 1 The Hubble ConstantIn Terms Of electron parameters

Author	Date	Bib. Code	Method Used	Value of H in terms of hr/m
Cardone et al.	00/2003	2003acfp.conf..423C	Grav. Lens	0.91k
Freedman et al.	00/2003	2003dhst.symp..214F	HST – Cepheids	1.1k
Tikhonov et al.	07/2002	2002Ap…45…253T	HST – Stars	1.2k
Garinge et al.	06/2002	2002MNRAS.333..318G	Xray emission	0.89k
Tutui et al.	10/2001	2001PASJ..53..701T	CO line T-F	0.94k
Freedman et al.	05/2001	2001ApJ..553..47F	HST Cepheids	1.1k
Itoh et al.	05/2001	2001AstHe.94.214I	Xray emission	0.94k
Jensen et al.	04/2001	2001ApJ.550..503J	SBF	1.2k
Willick et al.	02/2001	2001ApJ.548..564W	HST Cepheids	1.3k
Koopmans et al	00/2001	2001PASA..18..179K	Grav. lens	(0.94 – 1.1)k
Mauskopf et al.	08/2000	2000ApJ..538..505M	Xray emission	0.92k
Sakai et al.	02/2000	2000ApJ..529..698S	HST Cepheids	1.1k
Tanvir et al.	11/1999	1999MNRAS.310..175T	HST Cepheids	1.0k
Tripp et al.	11/1999	1999ApJ..525..209T	Ia Supernovae	0.97k
Jha et al.	11/1999	1999ApJS..125..73J	Ia Supernovae	1.0k
Suntzeff et al	03/1999	1999AJ..117.1175S	Ia Supernova	1.0k
Iwamoto et al.	00/1999	1999IAUS..183..681	Ia Supernovae	1.0k
Mason et al.	00/1999	1999PhDT…29M	Xray emission	1.1k
Schaefer et al.	12/1998	1998ApJ..509..80S	Ia Supernovae	0.86k
Jha et al.	12/1998	1998AAS..19310604J	Ia Supernovae	1.0k
Patural et al.	11/1998	1998A&A..339..671P	HIPPARCOS	0.94k
Wantanabe etal	08/1998	1998ApJ..503..553W	Galaxies T-F	1.0k
Salaris et al.	07/1998	1998MNRAS..298..166S	TRGB	0.94k
Hughes et al.	07/1998	1998ApJ..501..1H	Xray emission	(0.66 – 0.95)k
Cen et al.	05/1998	1998ApJ..498L..99C	Xray emission	(0.94 – 1.3)k
Lauer et al	05/1998	1998ApJ..449..577L	HST SBF	1.4k
			Average of all the values	1.0k

describes the transmission of light through a transparent medium simply as "photons do nothing but go from one electron to another, and reflection and transmission are really the result of an electron picking up a photon, "scratching its head", so to speak, and emitting a *new* photon." The plasma of Intergalactic space acts as a transparent medium and photons of light, as they travel through space, will be absorbed and reemitted by the electrons in this plasma. Since there is a delay at each interaction where the momentum of the photon is transferred to the electrons, the electron will recoil both on absorption and reemission - resulting in inelastic collisions [15].

A double Mössbauer effect will occur during each interaction between photon and electron. Some of the energy of the photon will be transferred to the electron and since the energy of the photon has been reduced, the frequency will reduce and the wavelength will increase. It will have undergone a 'red shift'.

Energy lost to an electron [16] during emission or absorption = $Q^2/2m_ec^2$.

Where Q is the energy of the incoming photon (hc/λ), m_e the rest mass of the electron and c, the speed of light.

This must be applied twice for absorption and reemission.

Hence, total energy lost by photon $= Q^2/m_ec^2 = h^2c^2/\lambda 2m_e^2$

(energy before interaction) – (energy after)= $h^2c^2/\lambda 2m_e^2$

$$hc/\lambda - hc/\lambda' = h^2/\lambda^2 m_e$$

λ = initial wavelength of photon, λ' = wavelength of the reemitted photon.

Multiplying through by $\lambda^2\lambda' m$ and dividing by h, gives:

$$\lambda\lambda' m_ec - \lambda^2 m_ec = h\lambda'$$

Increase in wavelength, $\delta\lambda = \lambda' - \lambda$, so:

$$\lambda(\delta\lambda + \lambda)m_ec - \lambda^2 m_ec = h(\delta\lambda + \lambda)$$

$$\lambda m_ec\delta\lambda + \lambda^2 m_ec - \lambda^2 m_ec = h\delta\lambda + h\lambda$$

$$\delta\lambda(\lambda m_ec - h) = h\lambda$$

since $h \ll \lambda m_ec$

$$\delta\lambda = h/m_ec$$

On their journey through IG space, the photons will make many such collisions and undergo an increase in wavelength of h/m_ec each time. On this basis red shift becomes a distance indicator and the distance - red shift relation becomes: photons of light from galaxies twice as far away will travel twice as far through the IG medium, make twice as many collisions and thus undergo twice the red shift.

Conservation of linear momentum will ensure the linear propagation of light.

4. THE HUBBLE LAW

The process whereby a photon interacts with an electron and gives all its energy to the electron is known as photoabsorption and the photoabsorption cross section, σ is known from the interaction of low-energy x rays with matter [17, 18, 19].

$$\sigma = 2r_e\lambda f_2$$

Where f_2 is one of two semi-empirical atomic scattering factors depending, amongst other things, on the number of electrons in the atom. For 10 keV to 30 keV X-rays interacting with Hydrogen, f_2 has values approximately between 0 and 1. 'One' meaning that the photon has been absorbed and the electron remaining in an excited state and 'zero' meaning that the photon was absorbed and an identical photon reemitted [13]. Since the photon frequency of light from distant galaxies is far removed from the resonant frequency of the electrons in the plasma of IG space, the photons will always be reemitted. The collision cross section for the recoil interaction considered here is therefore, $2r_e\lambda$ since f_2 only 'modulates' $2r_e\lambda$ for the atom.

On their journey through the IG medium, photons of radiation at the red end of the spectrum will encounter more collisions than photons at the blue end of the spectrum and thus undergo a greater total shift in wavelength. For a particular source, the ratio $\Delta\lambda/\lambda$ will be constant. The collision cross section for a particular photon will not be constant but will increase everytime it interacts with an electron. The photon travels shorter and shorter distances between collisions as it travels further and further and it is this that makes the red shift relation go non-linear for large red shifts.

If the initial wavelength is λ, then it will be $(\lambda + h/m_ec)$ after one collision, $(\lambda + 2h/m_ec)$ after two collisions, $(\lambda + 3h/m_ec)$ after three collisions and so on.

The mean free path of a photon in the plasma of IG space is given by $(n_e\sigma)^{-1}$ or $(2n_er_e\lambda)^{-1}$ since $\sigma = 2r_e\lambda$.
If the photon makes a total of N collisions in travelling a distance d:
Sum of all mean free paths = d
$\{2n_er_e\lambda\}^{-1} + \{ 2n_er_e(\lambda + h/m_ec)\}^{-1} + \{ 2n_er_e(\lambda +2h/m_ec)\}^{-1} + \{ 2n_er_e(\lambda + 3h/m_ec)\}^{-1} + \ldots + \{ 2n_er_e(\lambda + [N-1]h/m_ec)\}^{-1} = d$
$\{\lambda\}^{-1} + \{\lambda + h/m_ec\}^{-1} + \{\lambda +2h/m_ec\}^{-1} + \{\lambda + 3h/m_ec\}^{-1} + \ldots + \{\lambda + [N-1]h/m_ec\}^{-1} = 2n_er_ed$

$$\sum_{x=0}^{N-1} \left\{ \lambda + x\left(\frac{h}{m_e c}\right) \right\}^{-1} = 2n_e r_e d$$

Since N is large and h/m_ec is small (2.43×10^{-12}m), this approximates to:

$$\int_0^{N-1} \left\{ \lambda + x\left(\frac{h}{m_e c}\right) \right\}^{-1} dx = 2n_e r_e d$$

Or $1+h\{N - 1\}/m_ec\lambda = \exp(2n_ehr_ed/m_ec)$

$N = \lambda \exp(2n_ehr_ed/m_ec)(h/m_ec)^{-1} + 1 - \lambda(h/m_ec)^{-1}$ ……………… (1)

The total increase in wavelength, $\Delta\lambda = N\delta\lambda$, or Nh/m_ec
$\Delta\lambda = \lambda \exp(2n_ehr_ed/m_ec) + h/m_ec - \lambda$
The red shift, z is defined as;

$$z = \Delta\lambda/\lambda$$

$z = \exp(2n_ehr_ed/m_ec) + h/m_ec\lambda - 1$

Since $h/m_ec\lambda$ (= $2.42\times10^{-12}\lambda^{-1}$) is small for all wavelengths below X-ray,

$$\underline{z = \exp(2n_ehr_ed/m_ec) - 1}$$

Using the power expansion of the exponential i.e.

$$e^x = 1 +x + x^2/2! + x^3/3! +\ldots$$

Gives:
$z = (2n_ehr_e/m_ec)d + (2n_ehr_e/m_ec)^2d^2/2! + \ldots (2n_ehr_e/m_ec)^3d^3/3! + (2n_ehr_e/m_ec)^4d^4/4! + \ldots$
In Hubble's Law, the radial velocity, v, is given as:

$$v = cz$$

$v = c(2n_ehr_e/m_ec)d + c(2n_ehr_e/m_ec)^2d^2/2! + c(2n_ehr_e/m_ec)^3d^3/3! + c(2n_ehr_e/m_ec)^4d^4/4! + \ldots$
Since $2n_ehr_e/m_ec$ is very small, the terms involving powers of two and above can be ignored until d becomes very large i.e. for nearby galaxies, the expression approximates to

$$v = (2n_ehr_e/m_e)d$$

and, as v = Hd (H = the Hubble constant) comparing the two equations gives
(2)…… $\underline{H = 2n_ehr_e/m_e}$
Consequently we have:

$$v = Hd + H^2d^2/2!c + H^3d^3/3!c^2 + H^4d^4/4!c^4 + \ldots$$

or $\underline{v = c\{\exp(Hd/c) - 1\}}$ and

$$\underline{z = \exp(Hd/c) - 1}$$

It should be noted that this relationship between redshift, z and distance, d is identical to that first proposed by Zwicky in 1929 [20].

5. COMPARISON WITH EXPERIMENTAL RESULTS.

This theory predicts (equation 2):

$$H = 2n_ehr_e/m_e$$

or $H = 4.10\times10^{-18}n_e\ s^{-1}$
As cited earlier, $n_e \approx 10^{-7}cm^{-3}$ [10,11] and using this value to predict H gives:

$H \approx 0.41\times10^{-18}\ s^{-1}$ ($H \approx 12$ km/s Mpc^{-1})
This is in good agreement with the experimental values ([8] i.e. $H = (2.1\pm0.1) \times 10^{-18}\ s^{-1}$.
To predict the experimentally derived value of H of $2.1 \times 10^{-18}s^{-1}$ (64±3 km/s Mpc) requires $n_e \approx 5\times10^{-7}\ cm^{-3}$ compared to the cited

value of $n_e \approx 10^{-7}cm^{-3}$. Light of wavelength $5x10^{-7}$ m would have a collision cross-section of $2.8x10^{-21}$ m^2 and each photon would, on average, make one collision with an electron in the plasma of IG space every 75,000 light year.

Published statistical tests on redshift data show that the Hubble diagram is straight up to $z \approx 0.1$, goes nonlinear at $z \approx 0.8$, is quadratic at $z \approx 2.8 - 3.6$ and for redshifts above this, follows a non simple power law ([8, 21, 22, 23]. However, it has recently been shown [24] that data from the Calan/Tololo Supernova survey can verify this exponential law with a value of H of 72 km/s per Mpc ie 1.13 hr_e/m_e per m^3 ifthe data is not 'corrected' for the relativistic effects of expansion first. That is the data fits this theory's predicted exponential Hubble law provided that we do not assume that the Universe is expanding and manipulate the data accordingly. This theory's predicted exponential Hubble curve is shown in Fig 1 for comparison

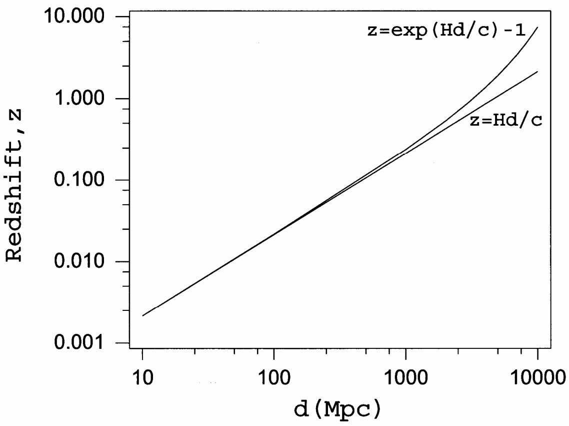

Fig 1

6. COSMIC MICROWAVE BACKGROUND (CMB).

The recoiling electron will be brought to rest by Coulomb interactions with all the electrons contained within a Debye sphere of radius λ_D. The decelerating electron will emit transmission radiation (TR) i.e. bremstrahlung. There are two emission channels of the system, 'intrinsic emission' by the decelerating electron, and 'emission by the medium' where the background electrons radiate energy.

Intrinsic radiation arises when the recoiling electron exchanges a virtual photon with the external field (set up by the large number of coulomb centers) with momentum **q** and emits a quantum with momentum **k**. The medium or external field in which the recoiling electron is moving radiates when the virtual photon of momentum **q** results in the production of radiation by background electrons contained within the Debye sphere [25].

The interactions between light and the electrons are non-relativistic and the initial and final states of the electron belong to the continuous spectrum. The photon frequency of the transmission radiation f_{cmb} is given by:

$$hf_{cmb} = (1/2m_e)(p^2 - p'^2)$$

Where $p = m_e v$ and $p' = m_e v'$ are the initial and final momentum of the electron [26].

The electron returns to rest after absorption and reemission and so the wavelength of the transmission radiation λ_{CMB} is given by:

$$\lambda_{CMB} = 2m_e\lambda^2 c/h$$

Light of wavelength $5x10^{-7}$m gives rise to TR of wavelength 0.21m. In IG space, the dominant background photons are microwaves, having peak energy of $6x10^{-4}$eV and a photon density of about 400 per cm^{-3} [27, 28]. In this theory, these background photons ($\lambda = 2.1x10^{-3}$ m) would be given off as TR by a photon of wavelength $5x10^{-8}$ m (i.e. Ultra Violet radiation) interacting with an electron.

7. DISCUSSION.

This proposed theory has successes in predicting values of H and λ_{CMB} that have the same magnitude as experimental values. As to whether this proposed interaction makes up the whole of the redshift or just a part of it will not be known until n_e has been determined to a greater accuracy. It also shows a relationship between H and 'hr_e/m_e per unit volume' which could explain the remarkable coincidence between their magnitudes. As scientists, we must always be suspicious of quantities that are equal but do not appear to be related. The theory still has to explain the 'surface brightness test' [29] and the time dilation in supernova light curves [30, 31, 32, 33, 34].

However, the value of H quoted here (64±3 km/s Mpc^{-1}) is only one value and other techniques and other workers give differing values. A value of 70±7 km/s Mpc^{-1} can be said to represent present data from all areas [35] and thus all agree that values of H lie in the range 1.0 to 1.2 times 'hr_e/m_e per unit volume of space'. With the 'big bang' theory, H could have had any initial value (as far as we know) and the effects of gravity and 'vacuum energy' make H time dependent, changing in magnitude from this original value. How probable is it that the first time we measure H with some accuracy it has the same value as 'hr_e/m_e per unit volume of space' (especially when these constants carry such importance in the scattering of light). To complicate matters further, the age of the Universe is often quoted as H^{-1} which we now realize to be equal to between 0.8 and 1.0 times m_e/hr_e - this is a test that the expanding universe 'fails' and now has to explain.

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National Laboratory, University of California, Berkely, CA
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