Gamma-Ray Lines of X-Class Solar Flare of July 23rd, 2002 Provide Direct Evidence for New Tired Light

Lyndon Ashmore
Dubai College, P.O. Box 837, Dubai, UAE
e-mail: webmaster@lyndonashmore.com

The solar flare of July 23rd, 2002 was the first γ – ray flare to be observed in high resolution by the Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI). The observations showed unexpectedly high redshifts in the γ – rays detected, but with no '*apparent pattern*'. The shifts appear to be intrinsic as they occur along a direct line of sight and not perpendicular to the solar surface as expected by Doppler effects. This paper looks at the wavelengths of the observed photons and, in particular, the shift in each wavelength suffered by the six nuclear de-excitation lines of ^{12}C, ^{56}Fe, ^{24}Mg, ^{20}Ne, ^{16}O, ^{26}Si. What is found is that the data falls into two distinct sets. Each set has the shift in wavelength $\Delta\lambda$ directly proportional to the wavelength λ as predicted by '*New Tired Light* (NTL)'. It is proposed that Si and Fe are at different levels in the solar atmosphere than the others and so photons from these interactions travel shorter distances through the solar plasma and thus undergo smaller redshifts. There also appears to be a quantisation in the shifts of the lines with five of the six lines showing shifts in wavelengths in multiples of 2.0×10^{-16} m. These results are an anomaly in the mainstream '*expansion*' theories of redshift but are consistent with the NTL theory. Here, collision cross-sections (and hence shifts in wavelength) are proportional to the wavelength of the photon and redshifts are caused by discrete shifts in wavelength when photons interact with electrons in the plasma through which they travel. That is, as the photons escape the solar plasma they undergo one, two, three, four (and so on) interactions where they experience a shift in wavelength of 2.0×10^{-16} m each time. Importantly, line widths also provide direct evidence for NTL which predicts that the line widths should experience a statistical broadening that increases as $\sqrt{N}$ - where N is the number of interactions suffered by the photons. For large shifts in wavelength the data shows a linear relation between FWHM (Full line Width at Half Maximum) and $\sqrt{N}$ as predicted by NTL where mainstream theories predict no variation. These results are compared to the measurements of the solar flare of October 2003 and are in good agreement.

1. Introduction

As we will see later, redshift has a precise mathematical definition, but for now let us just think of redshift as '*photons of light/radiation having a longer wavelength on arrival at the observer when compared with the observer's standard of wavelength for the same element – with the ratio of the shift in wavelength to the observer's standard having the same value for a particular source*'. There are several known causes of redshift such as gravitational redshift (caused by photons gaining Gravitational potential energy as they climb a gravitational field), or Doppler redshift caused by the source moving relative to the observer. Then there are the more exotic theories such as '*expansion*' where redshift is caused by the photons being 'stretched' as the space they are travelling through '*expands*' and '*stretches*' them; or '*New Tired Light*' (NTL) where the photons lose energy as they travel through space. Here the photons are constantly absorbed and re-emitted by the electrons in the plasma of space which recoil at each interaction. The photons lose energy to the recoiling electron, the frequency of the photon reduces and the wavelength increases. It has been redshifted.

There are several reasons that make the Solar flare of July 2002 interesting:

- The gamma emission lines were all created at approximately the same place on the solar surface and so should have suffered the same Doppler and gravitational redshifts - and yet they don't. The redshifts for each line are different.
- If the redshifts are caused by 'expansion' effects then again, since they were all created at the same distance from Earth, the intervening space would have '*stretched*' equally for all the gamma ray lines and so they should all exhibit the same redshift. But they don't, the redshifts for each line are different. In any case, the distance between the Sun and earth is not expanding.
- When compared to the solar flare of 2003, similar results in redshift are found – and yet if these redshifts are Doppler effects then they should have been very much different. Flares generally occur along magnetic field lines perpendicular to the solar surface and so, with Doppler effects, it is the component of velocity towards Earth that would cause the redshift. Since the Solar surface is a sphere, flares at different positions on the surface would have different radial velocities towards the Earth and hence a different redshift. But they don't. The redshifts of the lines are similar regardless of the heliocentric angle - and so they cannot be caused by Doppler effects. It is as if the redshifts are caused intrinsically by the intervening plasma as the photons travel directly towards us.
- This paper proposes that these intrinsic redshifts give direct evidence for the NTL theory.

So, there are several reasons that make the Solar flare of July 2002 interesting as it may give us a test to discriminate between conflicting theories. The observational results are an anomaly in mainstream cosmology – and yet they are just that - repeatable results/observations that must be explained. So let us look at this in more detail.

Smith et al [1] reported the first high energy resolution measurements of nuclear de-excitation lines in the solar flare of July 23rd 2002 using data from the Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI) – a spacecraft designed to observe the solar flares with high resolution $X-ray$ and $\gamma - ray$ imaging spectroscopy. During solar flares, accelerated protons and alpha particles collide with the ambient nuclei, exciting them to a level above their ground state. Gamma rays are given off during the subsequent decays as the nuclei return to their original level - thus creating the observed nuclear de-excitation lines. Since the nucleus recoils both due to the interaction with the accelerated particles and due to the emission of the $\gamma - rays$, the lines can be Doppler shifted. However, Smith et al [1] found that the measured redshifts were much larger than expected from these Doppler mechanisms alone. Possible explanations put forward were either that the magnetic field lines are directed towards the Earth rather than being perpendicular to the solar surface or that the '*angular distribution of the interacting particles is closer to a forward beam than a forward isotropic distribution.*'

2. Shift in the Wavelength of the Lines

Isotope	Rest Energy (keV)	Fit Energy (keV)	% Redshift
^{56}Fe	847	$846.09^{+0.70}_{-0.60}$	$0.11^{+0.08}_{-0.07}$
^{24}Mg	1369	$1363^{+2.3}_{-2.0}$	$0.40^{+17}_{-0.14}$
^{20}Ne	1634	$1628^{+1.7}_{-1.7}$	$0.32^{+0.10}_{-0.10}$
^{28}Si	1779	$1776^{+1.9}_{-2.1}$	$0.12^{+0.11}_{-0.12}$
^{12}C	4438	4403^{+10}_{-10}	$0.79^{+0.23}_{-0.22}$
^{16}O	6129	6094^{+15}_{-18}	$0.58^{+0.24}_{-0.29}$

Table 1. Parameters of Nuclear Lines

The detectors on RHESSI measure the energies of the incoming gamma rays but it is the wavelengths and in particular the shifts in wavelengths that are of importance in theories on redshift. (Table 2).

Isotope	Rest λ /10^{-13} m	Observed λ /10^{-13} m	Shift in wavelength Δλ/10^{-16} m	Periodicity in shifts of 2.0/10^{-16}m
^{56}Fe	14.6482	$14.6639^{+0.0010}_{-0.0012}$	8.6^{+8}_{-8}	$4.3^{+4.0}_{-4.0}$
^{24}Mg	9.09871	$9.09871^{+0.01337}_{-0.01532}$	12^{+6}_{-5}	$6.0^{+3.0}_{-2.5}$
^{20}Ne	7.59302	$7.61727^{+0.00795}_{-0.00795}$	16^{+10}_{-12}	$8.0^{+5.0}_{-6.0}$
^{28}Si	6.97414	$6.98278^{+0.00826}_{-0.00746}$	22^{+7}_{-6}	$11.0^{+4.0}_{-3.0}$
^{12}C	2.79563	$2.81785^{+0.00642}_{-0.00638}$	24^{+8}_{-8}	$12.0^{+4.0}_{-4.0}$
^{16}O	2.02431	$2.03594^{+0.06030}_{-0.00500}$	36^{+13}_{-15}	$18.0^{+6.5}_{-7.5}$

Table 2. Parameters of Nuclear Lines in terms of wavelength

The redshift z is a scientific term defined as:

$$z = \frac{\Delta\lambda}{\lambda} \tag{1}$$

The lines give startling evidence of quantised shifts in wavelength. A quantisation of 2.0x10^{-16}m gives a good fit with five of the six lines giving precise quantisation whilst the sixth (^{28}Si) is very close and well within the confines of the uncertainties.

However, the quantisation is close to the precision of the data and we must worry in case these are 'rounding errors.' There is a 50/50 chance of the numbers being 'even' or 'odd' and the chances of getting five out of six even numbers are approximately one in ten and are thus not significant at the 5% level.

3. Observation of the Solar Flare of October 28th, 2003

On October 28th, 2003 occurred the second most powerful flare ever observed up to that point by SOHO (Solar and Heliospheric Observatory) and this flare was detected by the SPI and IBIS detectors on board the spacecraft INTEGRAL (European Space Agency's gamma, X-Ray and visible observational satellite) [2]. Measurements of the nuclear de-excitation lines produced in this solar flare enabled the redshift in two of the lines (^{16}O and ^{12}C) to be determined and so we can compare these results with those from the RHESSI for the July 2002 flare. The heliocentric angle Θ_{hel} is shown in Table 3.

Rest Energy (keV)	% redshift 2003 flare	% redshift 2002 flare
Θ_{hel}	30^0	73^0
4438.03 ($_{12}$C)	$0.632^{+0.097}_{-0.097}$	$0.79^{+0.23}_{-0.22}$
6128.63 ($_{16}$O)	$0.59^{+0.12}_{-0.12}$	$0.58^{+0.24}_{-0.29}$

Table 3. Comparison in wavelength shifts for the two flares

Isotope	Shift in λ 2002/10^{-16} m	Shift in λ 2003/10^{-16} m
$_{12}$C	22^{+7}_{-6}	$17.8^{+2.7}_{-2.7}$
$_{16}$O	12^{+6}_{-5}	$11.9^{+9.5}_{-9.5}$

Table 4. Parameters of the Oxygen and Carbon lines in 2002 and 2003 flares

It can be seen that whilst the redshifts for the $_{16}$O line is the same for both flares, there is quite a difference in the measured redshifts of the $_{12}$C line. Could it be that the Carbon element in the 2002 flare was lower in the solar atmosphere than that in 2003 and thus suffered a greater redshift as per the NTL Theory? It should be noted that the results for the two flares are similar regardless of the heliocentric angle - which is in disagreement with theoretical modelling of the lines that predict that the shifts should increase as heliocentric angle increases. Again, these measurements are in terms of photon energy and so to see if the same quantisation effects are present in the 2003 flare we need to convert to shifts in wavelength (Table 4). We now have a total of seven out of eight shifts in wavelength which are 'even' (a probability of one in thirty two, or approximately 3%). This is significant at the 5% confidence level.

The shift in the ^{16}O lines are consistent in both flares at a quantisation of 6x(2.0x10^{-16}m) - as before. However, whilst there is a significant difference between the energies and redshifts of the observed ^{12}C lines, the pattern of quantisation in the shift of wavelengths continues with a periodicity of 2.0x10^{-16} m. The shift in the ^{12}C line in 2002 being 11x(2.0x10^{-16} m) whilst that in 2003 being 9x(2.0x10^{-16} m).

4. Intrinsic Hubble Law

As has been stated earlier, there should be no cosmological effects on these gamma ray lines and any Doppler effects would be negligible compared to those detected. Thus any redshifts must be produced intrinsically by the solar plasma. That raises the question, '*do the intrinsic redshifts obey the Hubble Law?'*

To obey the Hubble Law, one of the criteria is that a graph of shift in wavelength $(\Delta\lambda)$ versus wavelength (λ) should be a straight line through the origin. Thus the redshift, z is the same for all wavelengths. The data falls into two distinct sets with O, C, Ne and Mg forming one set with $z = 4.3x10^{-3}$ and Si and Fe forming the other set with $z = 1.2x10^{-3}$.

The data is consistent with intrinsic redshifts provided that we assume that Si and Fe are higher in the solar atmosphere. The photons of the nuclear de-excitation lines of these two elements travel a shorter distance through the plasma, make fewer photon-electron interactions on their way to the Earth and thus experience a smaller shift in wavelength. However, in both cases, the shift in wavelength is proportional to the wavelength - as required by the Hubble law.

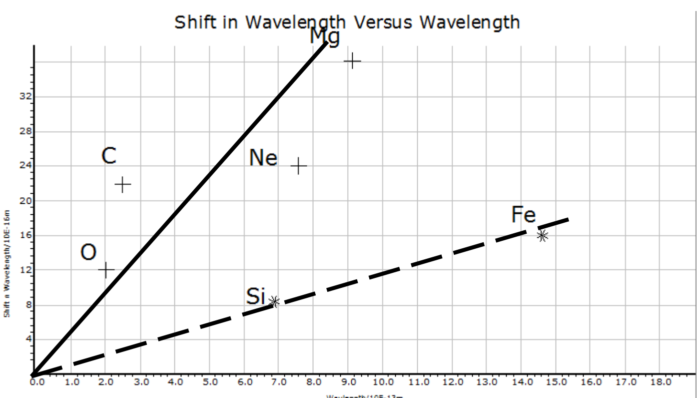

Fig. 1. Shift in Wavelength versus Wavelength

It must be remembered that the *Big bang/expansion* theory predicts no redshift in these lines at all. Mainstream Physics can offer no explanation for this phenomenon. NTL theory predicts a redshift in these lines and predicts that the shift in wavelength is greater for longer wavelengths since the collision cross-section, σ for photon-electron interactions is given by:

$$\sigma = 2r\lambda .$$

5. Line Widths and New Tired Light

Another way to discriminate between the NTL and the Big Bang models using this data is in the line widths [3]. Normally the Doppler parameter (b) is used as a measure of line widths. The Doppler Parameter (b) is related to the temperature and degree of disturbance of the emitting or absorbing gas by: $b^2 = b_{th}^2 + b_{nt}^2$ were b_{th} and b_{nt} are the thermal and non thermal broadening of the line. Since all the lines in the solar flares were emitted from approximately the same place we would expect the Doppler broadening to be the same for all emission lines (assuming elements at the same place on the solar surface to be in thermal equilibrium). The Big Bang model predicts no change in the line width of these lines with relation to wavelength. With the NTL theory, the lines broaden due to statistical fluctuations in the number of interactions 'N' encountered between photon and electrons in the plasma of space. The standard deviation in the number of interactions and hence 'line width' should increase with distance and redshift - as the square root of N to be precise i.e. the greater the number of interactions the wider the line.

$$\sigma_{tot} = \sigma_{th}\sqrt{N}$$

where σ_{tot} is the total standard deviation due to statistical and thermal line broadening and σ_{th} is that due to thermal effects alone. It can be seen from Fig 2 that for values of √N less than 3.2, the FWHM is similar for all points. It is proposed that in this region the effects of statistical line broadening due to the NTL theory are not significant when compared to line broadening due to thermal and or the degree of disturbance. However, for values of √N above 3.2 there is a linear relation between FWHM and √N as predicted by NTL. That is, the longer the wavelength of the photons, the more collisions they make, the greater the shift in wavelength and the greater the standard deviation in the number of collisions. Since each photon-electron interaction results in a quantised increase in wavelength the lines broaden as √N. In the Big Bang/expansion theory, there should be no difference in the line broadening - regardless of wavelength. Since the photons were produced at the same distance from Earth and at the same place and same time, they should all suffer the same Doppler line broadening. It is clear that they don't and thus the line broadening in this solar event of 2002 gives direct evidence in favour of *New Tired Light* and against expansion.

One could ask the question at this point "*Why don't the lines used to determine redshifts of distant galaxies broaden as the redshift increases?*" The answer to this is in two parts as we must treat emission lines and absorption lines separately. Absorption lines are an '*absence*' of photons and so one would not expect an '*absence of lines'* to broaden. What happens is the continuum broadens into the absorption lines making them narrow with increased redshift. A study of the literature on the Lyman α Forest shows just this. The Lyman α absorption lines for nearby Hydrogen clouds are, on average, broader than those from clouds at greater redshift – in fact there is a general trend of the absorption lines narrowing in the data z = 0.1 up to z = 3.6 [3]. Emission line widths are more complex as NTL does predict that these will broaden. An emission line from a galaxy twice as far away will travel twice as far through the plasma of intergalactic space, make twice as many collisions and thus the standard deviation will increase by a factor of $\sqrt{2}$. However, since the galaxy is twice as far away it will be dimmed by a factor of four due to the inverse square law, and thus we must collect more photons from that line (four times as many) - in order to make the 'exposure.'

Since we have an initial sample size increased by a factor of four, the initial standard deviation of our sample is now only half ($1/\sqrt{N}$) as wide as that of the closer galaxy. It is proposed that the effect of using a larger initial sample size from a more distant (dimmer) galaxy (and thus a smaller standard deviation to begin with) masks the line broadening due to NTL. This is to be the subject of a future paper - not ready at the time of going to press.

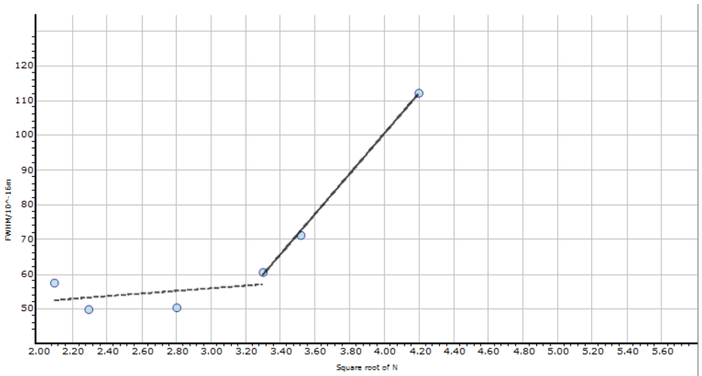

Fig 2. FWHM versus $\sqrt{N}$

6. New Tired Light Revisited

In order to see the importance of these results we need to revisit the NTL theory [4]. Electrons in the plasma of IG space (or any plasma for that matter) can perform SHM and any electron that can perform SHM can absorb and reemit photons of light. [5,6]. To quote, "*The electron just has a natural oscillation frequency equal to the local plasma frequency, and we get a simple picture of resonance absorption in terms of the driving field being in resonance with this natural frequency….*" [7]. The plasma in IG space is known to have a frequency of less than 30Hz [8] and so the driving field i.e. the photon of light, has a driving frequency far above resonance. In consequence, resonance absorption will not take place and the photon will always be re-emitted. In the sparsely populated plasma of intergalactic space the electron will not only absorb and reemit the photon but will recoil each time. The energy lost to the recoiling absorbing/emitting system is well known [9] and given by:

Energy lost to an electron during emission or absorption = $Q^2 / 2m_e c^2$, where Q is the energy of the incoming photon, 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 = $Q^2 / m_e c^2 = h^2 c^2 / \lambda^2 m_e{}^2$

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

$$hc / \lambda - hc / \lambda' = h^2 / \lambda^2 m_e \tag{4}$$

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

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

$$\lambda \lambda' m_e c - \lambda^2 m_e c = h\lambda' \tag{5}$$

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

$$\lambda(\delta\lambda + \lambda) m_e c - \lambda^2 m_e c = h(\delta\lambda + \lambda) \tag{6}$$

=> $$\lambda m_e c \delta\lambda + \lambda^2 m_e c - \lambda^2 m_e c = h\delta\lambda + h\lambda \tag{7}$$

=> $$\delta\lambda(\lambda m_e c - h) = h\lambda \tag{8}$$

since $h \ll \lambda m_e c$

$$\delta\lambda = h / m_e c \tag{9}$$

On their journey through IG space, the photons will make many such collisions and undergo an increase in wavelength of $h / m_e c$ 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.

7. 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 [10,11,12].

$$\sigma = 2 r_e \lambda f_2 \tag{10}$$

where r_e is the classical radius of the electron and 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 atom remaining in an excited state and 'zero' meaning that the photon was absorbed and an identical photon reemitted [13].

Collision cross sections have the units of area and represent a probability that the interaction will take place. In a photon-electron interaction there are only two possible outcomes. Either the photon is absorbed and not re-emitted (resonance absorption, f_2 = 1, and probability of re-emission = 0) or the photon is absorbed and a '*new*' photon is emitted (transmission, f_2 = 0 and probability of re-emission = 1). Consequently when the photon frequency is well off resonance the probability of absorption is zero and the probability of re-emission is 'one'. For conditional probability were we need the photon absorbed AND re-emitted, $2r_e\lambda$ is the probability of absorption and f_2 is the probability of re-emission, and so we multiply the two separate probabilities. Since f_2 has the value of unity the collision cross-section for transmission is $2r_e\lambda$. The atomic scattering factor, f_2, only modulates the collision cross-section $2r_e\lambda$ and so this is the term we need.

Electrons in plasma behave in the same way as those in an atom. 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.

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.

For large distances or a large number of interactions, the collision cross-section increases as the photons are redshifted and this leads to an exponential Hubble diagram and the prediction of effects usually put down to '*acceleration*.' However, for these solar flares it is a good approximation to assume that it is constant as the percentage redshifts are small.

We have $\sigma = 2r_e\lambda$. The mean free path is given by $(n_e\sigma)^{-1}$ or $(2n_e r_e d\lambda)^{-1}$ where n_e is the mean electron density. The total number of interactions, N, suffered by the photon in traveling a distance, d, is simply the distance divided by the mean free path.

$$N = \frac{d}{(2n_e r_e \lambda)^{-1}} \quad \text{or} \quad N = 2n_e r_e d\lambda$$

The total shift in wavelength suffered by the photon, $\Delta\lambda$, is $N\delta\lambda$ and since redshift z is given by $z = \Delta\lambda / \lambda$ we have:

$$z = \left(\frac{2n_e h r_e}{m_e c}\right)$$

We have $v = cz$ and $v = Hd$ where v is a term attributed to velocity in the Big Bang theory and H is the Hubble constant. This leads to an expression for H as:

$$H = \frac{2n_e h r_e}{m_e}$$

Published values of the Hubble constant are around H = 64±3 km/s per Mpc or, in SI units, 2.1x10^{-18} s^{-1}. An estimated value of n_e in the IG space can be achieved from the WMAP data [14] and gives n_e = 2.2x10^{-7} cm^{-3} or an average of 0.22 electrons per metre cubed. Thus this NTL gives a predicted value of H as 0.9x10^{-18} s^{-1} or 27 km/s per Mpc. Thus the theory's predicted value of H from first principles is in good agreement with the observational value. However, it should be noted that in the solar flares n_e and the effective mass m_e are much different than IG space.

It should be noted that redshifts have now been induced in cold plasma in the laboratory. A pulsed laser was fired at a crystal producing plasma and the wavelength of the recombination lines measured. They were seen to be redshifted with the degree of redshift increasing with plasma free electron density [15]. There is thus evidence from the laboratory that cold plasma induces redshifts and therefore gives support to the NTL theory.

8. Cosmic Microwave Background (CMB)

Whilst not of particular interest to us here with regard to the solar flares, NTL also predicts the 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.

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:

$$hf_{cmb} = (1/2m_e)\left(p^2 - p'^2\right) \tag{24}$$

where $p = m_e v$ and $p' = m_e v'$ are the initial and final momentum of the electron [15]. The electron returns to rest after absorption and reemission and so the wavelength of the transmission radiation λ_{cmb} is given by:

$$\lambda_{cmb} = 2m_e \lambda^2 c / h \tag{25}$$

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} [16,17]. In this theory, these background photons (λ = 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.

Interestingly, the CMB has a black body form of radiation and it is known that plasma emit Black Body radiation as the clouds will be in thermal equilibrium. To quote, "*when every emission is balanced by an absorption by the same physical process – this is the 'principle of detailed balance. The radiation spectrum must have a black body form in thermodynamic equilibrium*." That is when the emission of a photon is due to the absorption of a photon, the emission will be black body [18].

There is good evidence for plasma being responsible for redshifts in IG space as intrinsic redshifts have been recreated in the laboratory within laser induced plasma with the degree of redshift increasing with free electron density [19].

9. Discussion

We see that the NTL theory predicts a quantised redshift of $h/m_e c$ on each photon – electron interaction where m_e is the effective mass of the electron. In IG space where the plasma is very sparse m_e has the value close to the rest mass of the electron. However, as the plasma increases in density, electrostatic forces between the ions increase the effective mass of the electron and so the quantised shift in wavelength on each interaction decreases. This is why we observe no redshift when light travels through glass. The electrons are bound in atoms which are bound in the block of glass. Just as in the Mössbauer effect, the effective mass becomes the mass of the block of glass and no recoil takes place and thus no energy is lost by the photons. The plasma around the Sun is denser than that in IG space but not too dense so as to prevent redshifts taking place. However, the quantised shift on each interaction will be less and thus the results of both flares are consistent with NTL but not the BB theory. All lines support a quantization in shifts in wavelength of 2.0x10^{-16} m. Interestingly, whilst the 12C lines of 2002 and 2003 differ in their redshifts and actual shifts in wavelength, the two results still demonstrate the quantisation pattern with the 2003 result showing a periodicity of eleven whilst the 2003 result shows a periodicity of nine.

The redshifts in the gamma emission lines give direct evidence for the NTL theory not only in their quantisation. The redshifts are too big to be due to any mainstream property (Doppler, gravitational, expansion) and act in a direction on a direct line of sight. The redshifts are intrinsic and we see that they obey the essential property that the shift in wavelength is directly proportional to the actual wavelength in order to comply with the Hubble law. *New Tired Light* explains since collision cross sections are proportional to the wavelength of the photon. A photon with twice the wavelength makes twice as many collisions in traveling the same distance and thus undergoes twice the shift in wavelength. The data falls into two sets with each set forming their own value for the redshift z. ($z = 4.3x10^{-3}$ and $1.2x10^{-3}$). Again, this is inconsistent with the Big Bang theory but consistent with NTL which explains the data sets as being due to the elements being at two different heights in the solar plasma. O, C, Ne and Mg being lowest and thus these photons travel furthest through the plasma and undergo greater shifts in wavelength than those produced by Si and Fe.

Isotope	Shift in λ Δλ/10-16 m	Periodicity in the shifts of 2/10-16 m
^{28}Si (2002)	8.6^{+8}_{-8}	$4.3^{+4.0}_{-4.0}$
^{16}O (2002)	12^{+6}_{-5}	$6.0^{+3.0}_{-2.5}$
^{16}O (2003)	$11.9^{+9.5}_{-9.5}$	$5.8^{+4.7}_{-4.8}$
^{56}Fe(2002)	16^{+10}_{-12}	$8.0^{+5.0}_{-6.0}$
^{12}C(2002)	22^{+7}_{-6}	$11.0^{+4.0}_{-3.0}$
^{12}C(2003)	$17.8^{+2.7}_{-2.7}$	$8.9^{+1.4}_{-1.4}$
^{20}Ne(2002)	24^{+8}_{-8}	$12.0^{+4.0}_{-4.0}$
^{24}Mg(2002)	36^{+13}_{-15}	$18.0^{+6.5}_{-7.5}$

Table 5. Periodicity in redshift for all data

Of particular importance is the line widths. In the Big Bang Theory, Doppler etc the shift in wavelength should not affect the line width – but it does. For lines undergoing large shifts in wavelength there is a linear relationship between $\Delta\lambda$ and $\sqrt{N}$ as predicted by NTL. This is clear, direct evidence for *New Tired Light*.

10. Conclusion

These solar flares form an enigma in mainstream astrophysics as they produce redshifts which cannot be explained. However, they provide direct evidence in favour of *New Tired Light*.

- The flares give evidence of quantisation in the shifts of wavelength – as predicted by *New Tired Light* but not by mainstream theories.
- The redshifts appear to be intrinsic since they occur along a line of sight and not perpendicular to the solar surface.
- The intrinsic shifts in wavelength are proportional to the actual wave length as predicted by *New Tired Light* even though the data falls into two distinct data sets.
- The Big Bang Theory and other mainstream theories do not predict a link between line width (FWHM) and shift in wave length $\Delta\lambda$. *New Tired Light* predicts FWHM values to be directly proportional to $\sqrt{N}$. For large shifts in wavelength this data shows there is a linear relationship between the two and thus supports *New Tired light* over other theories.
- To these results we must add the previous successes of New Tired Light such as successfully predicting the Hubble Law and value of the Hubble constant and the CMB.

Acknowledgement

I would like to thank John Kiernan for bringing the paper *"High-Resolution Spectroscopy of Gamma-Ray Lines from the X-Class Solar Flare of 2002 July 23"* by Smith et al [1] to my attention.

References

[1] D. M. Smith et al, *ApJ* **595**: L81-L84 (2003).
[2] M. Gros et al, "INTEGRAL/SPI Observation of the 2003 Oct 28 Solar Flare", http://www.mpe.mpg.de-gamma-instruments-integral.spi-www-papers-SolFlare031028_Gros_IWSO4.pdf.url.
[3] L. E. Ashmore, "Hydrogen Cloud Separation as Direct Evidence of the Dynamics of the Universe", in Frank Potter, Ed., *ASP Conference Series* **413**: 3 (2nd Crisis in Cosmology Conference, CCC-2, 2009) http://adsabs.harvard.edu/abs/2009ASPC..413....3A.
[4] L. E. Ashmore, *Galilean Electrodynamics* **17** (S3): 53-57 (2006).
[5] M. Mitchner, C. H. Kruger, **Partially Ionized Gases**, p. 138 (Wiley, 1973).
[6] W. S. Kurth, "Waves in Space Plasmas", http://www-pw.physics.uiowa.edu/plasma-wave/tutorial/waves.html.
[7] R. A. Cairns et al, *Physica Scripta* **T75**: 99-103 (1998).
[8] M. V. Zombeck, **Handbook of Space Astronomy and Astrophysics**, p. 286 (Cam Uni. Press, 2010), http://ads.harvard.edu/books/hsaa/idx.html.
[9] A. P. French, **Special Relativity**, p 176-182 (London: Nelson, 1968).
[10] B. L. Henke, E. M. Gullikson, J. C. Davis, **Atomic Data and Nuclear Data Tables**, Vol. 54, pp. 181-342 (1993).
[11] B. L. Henke, E. M. Gullikson, J. C. Davis, **X-Ray Data Booklet**, chap 1, p 44/52 (LBNL/PUB-490 Rev. 2 Lawrence Berkeley National Laboratory, University of California, Berkeley, CA 94720, 2001) http://www-cxro.lbl.gov/optical_constants/intro.html.
[12] J. H. Hubbell, W. J. Veigele, E. A. Briggs, R. T. Brown, D. T. Cromer, R. J. Howerton, *J. Phys. Chem. Ref. Data* **4**: 471-538 (1975); erratum in **6**: 615-616 (1977).
[26] A. P. French, **Special Relativity**, p 128 (London: Nelson, 1968).
[13] F. Zwicky, *Proc. Nat. Acad. Sci.* 773–785 (1929).
[14] A. M. Soltan, *A&A* **408**: 39-42 (2003).
[15] K. Yu. Platonov, G. D. Fleĭshman, *Uspekhi Fizicheskikh Nauk* **172** (3) 241-300 (2002).
[15] V. B. Berestetskii, E. M. Lifshitz, L. P. Pitaevskii, **Quantum Electrodynamics**, Vol. 4, 2nd Ed., p. 389 (Butterworth Heinemann, 1982).
[16] P. J. E. Peebles et al, "The case for the relativistic hot Big Bang cosmology", *Nature* **352**: 769-776 (29 Aug 1991), doi:10.1038/352769a0.
[17] M. Nagano & A. A. Watson, *Reviews of Modern Physics* **72** (3): 689-732 (July 2000).
[18] M. S. Longair, **High Energy Astrophysics**, Vol. 1, 2nd Ed. (Cambridge University Press, 1981).
[19] C. S. Chen et al, "Investigation of the mechanism of spectral emission and redshifts of atomic line in laser-induced plasmas". *Optik* **120**: 473-478 (2009).