Calculating the Redshifts of Distant Galaxies From First Principles – New Tired Light Theory

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Abstract. The repeating Fast Radio Burst FRB 121102 provides an exciting opportunity to test cosmological theories since, for the first time, we have an extra galactic source with a known host galaxy giving us a unique and independent data set for that galaxy. The Dispersion Measure (DM) found from the time delay between radio signals of different frequencies from the FRB gives us the mean electron number density of the IGM along the line of sight. We have the angular-diameter distance, D_A and the luminosity distance D_L of the host galaxy as measured by traditional cosmological means thus giving us the distance to the host galaxy. We also have the redshift of the host galaxy as measured spectroscopically. This gives the opportunity to test the New Tired Light (NTL) Theory as we can use the mean electron number density and distance to predict the redshift and then compare that predicted redshift to that measured from observations. Using the cited dispersion measure of $DM_{IGM} \approx 340\ pc\ cm^{-3}$ and the angular diameter distance of $D_A \approx 683\ Mpc$ gives a mean electron number density along the line of sight of $n \approx 0.498\ m^{-3}$. In NTL, the photons are absorbed by the electrons in the IGM which can, and do, perform SHM. The energy of the photon is transferred to the energy of the oscillations of the electron which then re-emits a *new* photon. However, since the plasma of the IGM is sparsely populated, the electron recoils both on absorption and re-emission and some of the energy of the photon is 'lost' to the kinetic energy of the recoiling electron. The re-emitted photon has less energy, a lower frequency and a longer wavelength – it has been redshifted. Consider a photon of wavelength $\lambda = 5.000000000x10^{-7}\ m$. When this is absorbed by an electron momentum is transferred to the electron as it recoils and we can calculate the recoil velocity ($v = 1{,}454.7790190975\ ms^{-1}$) and the energy transferred to the recoiling electron ($E_{recoil} = 9.6394676732628x10^{-25}\ J$). Since the electron recoils twice on each interaction we double this energy 'loss' before subtracting it from the initial energy of the incoming photon to give the energy of the re-emitted photon. Once the frequency ($E = hf$) of the re-emitted photon is calculated we can determine wavelength and increase in wavelength, $d\lambda$. This is found to be $d\lambda = 2.426x10^{-12}m$ (regardless of the wavelength of the incoming photon). Since the recoil takes place along the line of sight there is no scattering of the light as appears in Compton scatter. The photon will make many such interactions on its journey through the IGM and so the collision cross-section, σ must be determined. This is known and published from the interaction of low energy X-rays and matter ($\sigma = 2r\lambda\ , were\ r\ is\ the\ classical\ electron\ radius$) giving $\sigma = 2.818x10^{-21}m^2$ for our photon of wavelength $\lambda = 5.000000000x10^{-7}\ m$. Here we make the assumption that σ remains constant throughout the journey (though σ actually increases as the photon travels and interacts but it will suffice in this treatment). The mean free path, l is given by $l = (2r\lambda n)^{-1}$ and now we know n from FRB 121102 we find that the mean free path of out photon is $l = 7.126x10^{20}m$ – that is our photon interacts with an electron every $75{,}300\ year$. The distance to the host galaxy is $D_A \approx 683\ Mpc \approx 2.108x10^{25}m$ and we divide this by the mean free path to give the total number of interactions encountered by the photon: N =29,540. To find the total increase in wavelength suffered by our photon on its entire journey we multiply the total number of interactions by the increase in wavelength at each interaction to give $\Delta\lambda = 7.167x10^{-8}m$. Since redshift, z is $z = \Delta\lambda/\lambda$ we find the predicted redshift by NTL as $z = 0.143$. The measured redshift of the host galaxy is 0.19273 ± 0.00008 – a difference of 20%. Had we taken into consideration that the collision cross-section increased as the photon travelled it would have given a value for z closer to the predicted value. We calculate the same redshift whatever wavelength of initial photon we choose -which also agrees with observation. NTL also predicts the CMBR. In NTL, the energy transferred to the recoiling electron is re-emitted as a secondary photon. It is shown, again from first principles that a photon in the UV of wavelength $\lambda = 5x10^{-8}m$ transfers kinetic energy $9.639x10^{-23}J$ to the recoiling electron and when this is emitted as a secondary photon, the wavelength of that secondary photon is $2.06x10^{-3}m$. This is not only in the microwave region but is the wavelength at which the CMBR peaks. Photons of other wavelengths give out secondary photons of other microwave wavelengths and form the CMBR spectrum. It is known that plasma emits black-body radiation.