

THE COMPTON EFFECT AS AN EXPLANATION FOR THE COSMOLOGICAL REDSHIFT

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The usual interpretation of the cosmological redshift (Hubble’s law) is based on the Doppler effect connected with the recession of galaxies. This is the basis of the standard cosmological model and leads directly to the idea of the big bang when we reverse the time.

Recently some authors proposed a different mechanism to explain the observed redshifts: the Compton effect in a stationary model of the universe (1, 2). The Compton effect describes the scattering of photons by free electrons. As is well known, the relation between the wavelength of the incident photon, λ_0 , and that of the scattered photon, λ , is given by

$$\lambda - \lambda_0 = \frac{h}{mc} (1 - \cos \theta). \quad (1)$$

In this equation h is Planck’s constant, m is the mass of the electron, c is the velocity of light and θ is the angle of scattering.

Let us discuss this proposal. The first thing to observe is that for $\theta = 0$ there is no redshift, as $\lambda - \lambda_0 = 0$. This means that the larger the redshift produced by the Compton effect resulting from many interactions, the larger would be the average deviation from the straight line connecting the source to the Earth. Any redshift produced by the Compton effect would produce a blurring in the image of the galaxy. However, this is not usually observed.

Beyond this fact, there is a main objection for this new interpretation of the cosmological redshift. The fractional shift for one scattering is given by

$$z = \frac{\lambda - \lambda_0}{\lambda_0} = \frac{h}{mc} \frac{1 - \cos \theta}{\lambda_0}. \quad (2)$$

When the photon moves a distance r in a homogeneous medium the redshift will be given by

$$z = \frac{\lambda - \lambda_0}{\lambda_0} = \frac{h}{mc} \frac{1 - \langle \cos \theta \rangle}{\lambda_0} \frac{r}{r_0}, \quad (3)$$

where $\langle \theta \rangle$ is the average angle of scattering and r_0 is the average distance

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between free electrons in this medium. As h , m , c , $\langle \theta \rangle$ and r_0 are independent of λ_0 , a redshift caused by the Compton effect predicts z proportional to $1/\lambda_0$. On the other hand the cosmological redshift (Hubble's law) yields $z = H_0 r/c$, where H_0 is Hubble's constant which is independent of λ_0 . This seems to rule out the interpretation of the cosmological redshift as a Compton effect.

We have no doubt of the existence of the Compton effect and its importance in some astrophysical problems. Compton himself suggested this effect as an important fact in explaining the limb effect in the Sun (3). According to him this would result from the fact that the solar light coming to us from the limb would need to traverse a longer path through the atmosphere of the Sun than light coming from the centre. As the amount of scattering is larger for light coming from the limb, so is the amount of the observed redshift.

Even if Hubble's law is not the result of a Doppler effect, as has been claimed (1, 2, 4), it will not be because of a Compton effect, Eqn (3). The alternative might be another kind of interaction between the photon and intergalactic matter, or a "new principle of nature", as suggested by Hubble himself (5, 6).

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