Inverse Square-Law Possibly-Followed by Single Photons

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Abstract:

Inverse square-law is followed by electric charges, gravity, and light. Light has shown even an unexpected property, of double-slit-interference of single photons. So it is not unreasonable to expect inverse-square-law to be followed by single photons. Assuming that the single photon is emitted either from the surface of an electron, or a globular-cluster, or a galaxy, the derivation presented here suggests that even a single photon seems to follow the inverse square-law.

The Derivation:

The inverse square-law followed by star-light is well known. Luminosity of a star is expressed as:

$$L = \sigma \ A \, T^{4} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where A is the area of the star, σ is the Stefan–Boltzmann constant, with a value of: $5.670373(21) \times 10^{-8}$ Watt $m^{-2}\,K^{-4}$, and T the star's temperature.

And the flux F is:

$$F = L / (4 \pi r^2) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where: r is the distance from the observer to the star.

We intend to consider three different cases of a single photon either emitted from the surface of an electron, or a globular-cluster, or a galaxy. Let us express energy lost by a single photon as ($h\, f_0 - h\, f$) and assume that this is the energy radiated by it. We can take the initial area A in the expression-1, of emitting surface for electron as: $4\pi\ r_e^{\,2}$; for the globular-cluster, $4\ \pi R_{globu}^{\ 2}$; and for a galaxy $4\ \pi\ R_{gal}^{\ 2}$.

Since we will need to compare the proportion of increase of area, we can express a quantity with, different dimensions, comparable with luminosity of a star L , for the surface-area of a galaxy as:

$L' = (4\ \pi\ R_{gal}^{\ 2})\ (\ h\, f_0 - h\, f\ )$ …………………………(3)

And we can express a quantity comparable with the flux L in the expression-2 as:

$F' = L' / (\ 4\ \pi\ D^2\ )$, where D is a very long distance away from the source.

Assuming that F' is gravitational potential-energy of the photon received at that distance D:

$F' = [\ G\, M_{gal}\ (\ h\, f / c^2) /\ D\ ] = [(4\ \pi\ R_{gal}^{\ 2})\ (\ h\, f_0 - h\, f\ )] / (\ 4\ \pi\ D^2\ )]$

i.e. $[\ G\, M_{gal}\ (\ h\, f / c^2) / D\ ]\ [(\ 4\ \pi\ D^2\ ) / (\ 4\ \pi\ R_{gal}^{\ 2}\ )] = (\ h\ \ f_0 - h\, f\ )$

i.e. $[\ G\, M_{gal}\ / R_{gal}^{\ 2}\ ]\ D\ (\ h\, f / c^2\ ) = (\ h\, f_0 - h\, f\ )$ ……………………....(4)

Now, Sivaram C. [1] has numerically shown that:

$[\ G\, M_{gal} / R_{gal}^{\ 2}\ ] = [\ G\, M_{globu}\ / R_{globu}^{\ 2}] = [\ G\, m_e / r_e^{\ 2}\ ] = a_0$ of MOND = $H_0\, c$,

Where H_0 is Hubble's constant, and c is speed of light, and 'a_0 of MOND' stands for the critical-acceleration of Milgom's Modified Newtonian Dynamics. So we can write the expression-4 as:

$(H_0\ c) D (h f\ / c^2) = (h f_0 – h f)$

i.e. $(h f_0 - h f) / (h f) = (H_0 D / c)$ ……………………………..(5)

We know that the expression-5 is a well known expression for the 'cosmological red-shift'. Therefore, our initial assumption, that even a single photon may be following the inverse square-law, leads to familiar observation of the 'cosmological red-shift'. This derivation is valid, whether the photon is emitted from a galaxy, or a globular-cluster, or a single electron, because the accelerations:

$(G\ M_{gal} / R_{gal}^{\ 2}) = (G\ M_{globu}\ / R_{globu}^{\ 2}) = (G\ m_e / r_e^{\ 2}) = a_0$ of MOND = $H_0\, c$, as numerically found by Sivaram C.

This derivation leads us to a new possibility that the 'cosmological red-shift' may be due to the inverse square-law followed by single photons.

References:

[1] Sivaram, C. (1994) *Astrophysics and Space science* 215, 185-189