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:

\[ L = \sigma A T^4 \]  .........................................................(1)

Where \( A \) is the area of the star, \( \sigma \) 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:

\[ F = L / (4 \pi r^2) \]  .........................................................(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, \(4\pi R_{\text{globu}}^2\); and for a galaxy \(4\pi R_{\text{gal}}^2\).

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:

\[
L' = (4\pi R_{\text{gal}}^2) (h f_0 - h f) \ldots \ldots \ldots \ldots (3)
\]

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

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

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

\[
F' = \left[ \frac{GM_{\text{gal}}}{R_{\text{gal}}^2} \right] \frac{(h f_0 - h f)}{D} = \left[ \frac{(4\pi R_{\text{gal}}^2)}{(h f_0 - h f)} \right] / \left[ \frac{(4\pi D^2)}{} \right]
\]

i.e. \[
\left[ \frac{GM_{\text{gal}} (h f / c^2)}{D} \right] \left[ \frac{(4\pi D^2)}{4\pi R_{\text{gal}}^2} \right] = (h f_0 - h f)
\]

i.e. \[
\left[ \frac{GM_{\text{gal}}}{R_{\text{gal}}^2} \right] D (h f / c^2) = (h f_0 - h f) \ldots \ldots \ldots \ldots \ldots \ldots \ldots (4)
\]

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

\[
\left[ \frac{GM_{\text{gal}}}{R_{\text{gal}}^2} \right] = \left[ \frac{GM_{\text{globu}}}{R_{\text{globu}}^2} \right] = \left[ \frac{G m_e}{r_e^2} \right] = a_0 \text{ of MOND} = H_0 c,
\]

Where \(H_0\) is Hubble’s constant, and \(c\) is speed of light, and ‘\(a_0\) of MOND’ stands for the critical-acceleration of Milgrom’s Modified Newtonian Dynamics. So we can write the expression-4 as:
\((H_0c)D(hf/c^2) = (hf_0 - hf)\)

i.e. \((hf_0 - hf)/(hf) = (H_0D/c)\) \(...\)

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 = \(H_0c\), 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: