David Chuphay Plotz November 3, 2015

A New Way to Calculate the Movement of Photons Near a Massive Object

I propose that a massive object induces a "field" in the surrounding space. I propose that when a photon travels through this "field," the momentum of the photon is shifted in an additive and linear manner – in accordance with the following equation:

[1] $$\Delta \vec{p} = \int_{path} \vec{P} \, d\ell$$

where we integrate along the path of the photon and $\vec{P}$ is defined as

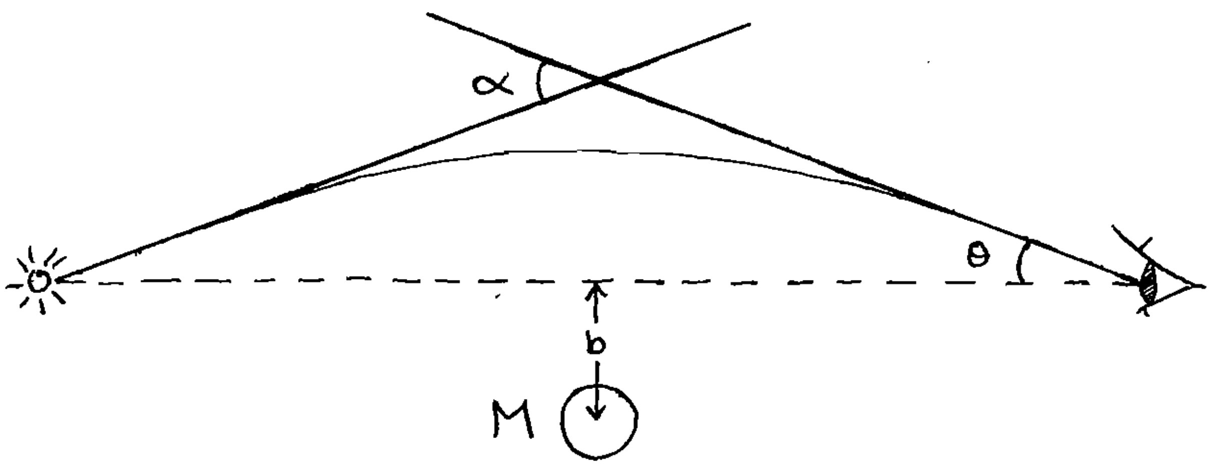
[2] $$\vec{P} = \hat{r} \frac{GM\hbar}{r^2}$$

in units where c = 1.

Based on this proposition, we can make various calculations without using General Relativity. The results accord with empirical observation, thus "saving the appearances."

Bending of light

We imagine a photon that emanates from a distant source, passes close by a massive object, then continues beyond the object to an observer. The closest point while passing, i.e., the impact parameter, is at a distance of b from the center of the object. For ease of calculation, we say that both the point of emanation and the observer are infinitely far from the massive object.



We assume that to a first-order approximation the trajectory of the photon is a straight line. To calculate its change in momentum, we integrate along the straight-line path of the photon:

[3] $$\Delta \vec{p} = \int \vec{P}\, d\ell = \int_{-\infty}^{\infty} \frac{GM\hbar}{r^3}\, \vec{r}\, (\omega dz)$$

We divide the problem into two parts: the momentum change in the direction parallel to the direction of travel of the photon and the momentum change perpendicular to the direction of travel. In calculating the momentum change in the direction parallel to the direction of travel, we note that as the photon approaches and then recedes from the massive object, the change in momentum cancels out to leave zero net change in the parallel direction. We can calculate the change in momentum in the direction perpendicular to the direction of travel:

[4] $$\Delta p_y = \int_{-\infty}^{\infty} \frac{GM\hbar}{(z^2+b^2)^{3/2}}\, b\,(\omega dz)$$

This yields:

[5] $$\Delta p_y = \hbar\omega \frac{2GM}{b}$$

We therefore get:

[6] $$\theta \approx \frac{\Delta p_y}{p_z} = \frac{2GM}{b}$$

which yields the deflection angle:

[7] $$\alpha = \frac{4GM}{b}$$

Equation [7] is the same result as in the theory of General Relativity.

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Blue-shift of light

Using the same initial proposition, we can calculate the blue-shift of light. As a photon falls into a gravity well, the momentum and hence the energy of the photon are shifted. Because the energy of a photon is generally expressed as a frequency, we say that the frequency of the photon observed at infinity is changed compared to when it is observed in a gravitational field at a distance *R* from the center of the massive object. We use the following equation to express this change:

[8] $$\hbar\omega' = \hbar\omega + \Delta p$$

To calculate the change in momentum, we again integrate along the path of the photon:

$$[9] \quad \Delta p = \int_{\infty}^{R} \hat{r} \cdot \vec{P}\, \omega\, dr = \int_{\infty}^{R} \frac{GM\hbar}{r^2}\, \omega\, dr = \hbar\omega \frac{GM}{R}$$

This yields:

$$[10] \quad \hbar\omega' = \hbar\omega \left(1 + \frac{GM}{R} \right)$$

In the theory of General Relativity the equation is given as:

$$[11] \quad \hbar\omega' = \hbar\omega \left(1 - 2GM/R \right)^{-1/2}$$

As GM/R approaches zero, equations [10] and [11] converge. As GM/R approaches one, the equations diverge. This could be a testable difference between my theory and Einstein's.

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