Ab Initio Calculation of the Anomalous Acceleration of Pioneer 10 *In Vacuo*

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Abstract:

The anomalous acceleration of Pioneers 10 and 11 while opposite, are both directed towards the Sun.[1] Using that both light and gravity are equally bent by gravity itself and independently of energy, the gravity from behind the Sun may be focused onto a test mass, such as Pioneer 10, and increase its deceleration towards the Sun. The bending of gravitational forces of objects behind the Sun is delineated in an optical model to calculate additional forces on Pioneer 10. The optical model contains no free parameters, and its predictions differ from the anomalous constant acceleration by less than 0.2%. Further observational implications are discussed. The need for dark matter in the solar system is now obviated.

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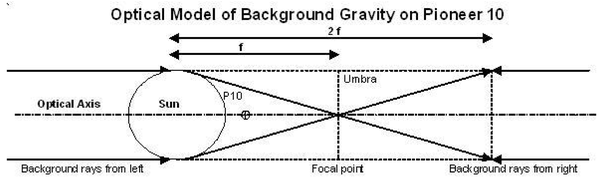
Introduction:

The force of gravity is bent as is light by a massive object such as the Sun.[2] Papini [3] established, in the weak field limit, that electromagnetism and gravity can both be placed into the same four vector potential. The four vector potential, of course, contains geometrical optics, so gravity and electromagnetism should be treated similarly: optically. Sommerfeld [4] established, in the static limit of electrostatics and magnetostatics, that they follow the standard rules of refraction and reflection of static forces in geometrical optics. Together then, electrostatics, magnetostatics, and gravitostatics all obey the same rules of refraction of forces in geometrical optics, in the weak field and static limits. Note: In the static limit, there is no far field diffraction since all optics are in the near field. The trajectories of the geodesics of massless particles that travel at the speed of light in the weak field limit do not depend on the energies of the particles and thus are bent equally[6].

$$F_0 = G \cdot M_\odot \left\{ \frac{-1}{r^2} - R\left[\frac{1}{(f-r)^2} - \frac{1}{f^2} \right] \right\}$$

Where F_0 is the force per unit mass on Pioneer 10
G is the Newtonian gravitational constant
M_0 is the mass of the Sun
f is the focal length of the Sun
r is the distance from the Sun to the right
R is the ratio of the background mass from the left to the mass of the Sun
$1/f^2$ represents the umbra of the Sun on the right

This figure represents the equation above.

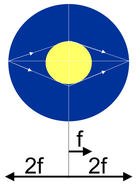


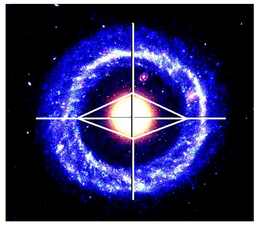
As Pioneer 10 moves to the right, it experiences an increasing anomalous acceleration to the left as the background gravity is evermore focused on it.

Observational implications of the optical bending of gravity in a galaxy.

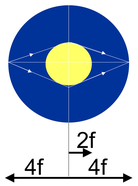
The effects in ringed galaxies from f and 2f are illustrated in the following figures where the radius of the core is taken as the focal length, f, and the radius of the ring is 2 f. In Hoag's Object type galaxies there is a single ring around a core. NGC 7742 is an example of a galaxy with two rings, one around the other and their radii are in proportion of 1:2 for inner and outer, thus exhibiting a f:2f:4f phenomenon.

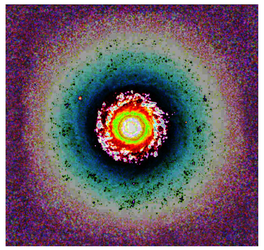
Hoag's Object[7]





NGC 7742[7]





Conclusions

The anomalous acceleration of Pioneer 10 has been examined via *ab initio* calculations according to first principles with no free parameters. The optical model is consistent with known physics and by implication produces known observational effects. This work represents a first approximation to an ideal model.

References

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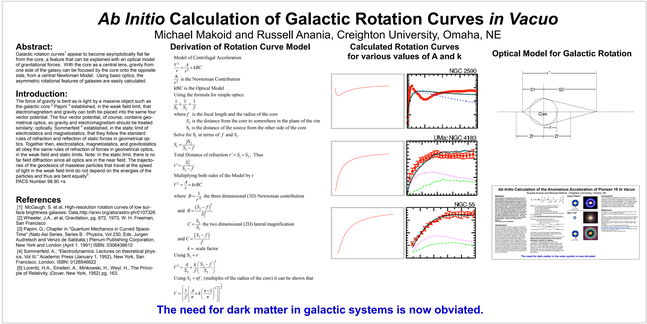
[6] Lorentz, H.A., Einstein, A., Minkowski, H., Weyl, H., The Principle of Relativity, (Dover, New York, 1952) pg. 163.

[7] Figures downloaded from http://heritage.stsci.edu/



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