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LETTER

Solar Gravitational Deflection of a Graviton

S. Ragusa and L. C. Céleri[1]

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The solar gravitational deflection angle of a graviton is calculated through the scattering cross section of the graviton by the sun and shown to be equal to the light deflection angle as calculated from the null geodesic equation of general relativity.

KEY WORDS: Graviton; geodesic equation.

When discussing light deflection from the sun in general relativity (GR) the light ray trajectory is taken as a null geodesic. No mention is made at all of the tensor character of the radiation. Therefore, the only property which is being used is that light travels with velocity c. One might then suspect that all kinds of massless waves, traveling then with velocity c, might be deflected by the same angle independently of its tensor character. Here we have checked this in the interesting case of the graviton.

The way of bringing up the tensor character of the field is to calculate the solar deflection through the scattering cross section for small angles. This was done in quantum field theory for the photon some time ago [1], giving the same geodesic GR result for the deflection angle. More recently [2] the calculation was done for the scalar boson field leading to the same result.

In this note we consider the deflection of the graviton through its scattering cross section by the sun. This quantity is already know having been calculated in

[1]Departamento de Física e Informática, Instituto de Física de São Carlos, Universidade de São Paulo, C.P. 369 13560-970 São Carlos, SP, Brazil, e-mail: ragusa@if.sc.usp.br

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field theory [3] and in a classically (general-relativistic) way [4]. The result is

$$\frac{d\sigma}{d\Omega} = \frac{G^2M^2}{c^4 \sin^4(\theta/2)}[\sin^8(\theta/2) + \cos^8(\theta/2)], \tag{1}$$

where M is the solar mass and θ the scattering angle. For small angles this reduces to

$$\frac{d\sigma}{d\Omega} = \frac{16G^2M^2}{c^4\theta^4}. \tag{2}$$

This has exactly the same value as for light [1] and the scalar boson field [2]. If b is the impact parameter we have for small angles $d\sigma/d\Omega = |bdb/\theta d\theta| = |d(b^2)/d(\theta^2)|$, giving for the deflection from the limb of the sun ($b = R$)

$$\theta = \frac{4GM}{Rc^2}, \tag{3}$$

This is equal to the light deflection value. This result gives some support to the conjecture that all massless field quanta will be deflected by the sun by the same angle, equal to the null geodesic prediction of GR.

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[2] Accioly, A. and Ragusa, S. (2002). *Class. Quantum Grav.* **19**, 5429. In this paper one can safely put the mass equal to zero in the cross section for the massive scalar boson field to get the massless result because of its spin zero value. But not so for the massive vector boson field because the cross section carries information of its two transverse polarization as well as the longitudinal one which is not present in the massless case.

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