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Bending of light due to the gravity of the sun

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ABSTRACT*: In this short research paper, the formula has been derived for the bending of light due to gravitation towards the sun. It is shown in this research paper that the starlight bends due to gravity by 1.74 arcseconds. This research has been done before by Einstein in 1911 and 1916. Here the derivation is done differently based on the acceleration due to gravity in the perpendicular direction and the acceleration due to light in the base direction by applying the Newton's law of motion with the particle perspective.*
KEYWORDS:*Acceleration, Force, Gravity, Light.*

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I. INTRODUCTION

Einstein developed the general theory of relativity up to 1915 after developing the special theory of relativity in 1905 taking him ten years. In order to prove his theory, he predicted the bending of starlight from the sun's gravity. The experiment was done sometime around 1919 during solar eclipse. The theory and experiment matched with the bending of light by an angle of 1.74 arcseconds, thus demonstrating the correctness of his theory. The theory is still in question for stability problems. The formula for the deflection of light is derived by the author again based on accelerations in the particle perspective and the calculation is shown as a result.

II. THEORY

It is shown by Einstein, first in 1911 and then corrected by doubling the deflection of light in 1916, that the star light bends by 1.74 arc seconds [1]. The derivation of the formula for the bending of light and its calculation is shown now, which Einstein corrected in 1916. It is as follows:

Equating F=ma for the photon due to the gravitational force gives the acceleration of the photon in the perpendicular direction as

$a_p = GM/r^2$.

The acceleration of the starlight in the direction of the base is given by

$a_b = c^2/2\ (2r)$ from Newton's equation of motion as $v^2 - u^2 = 2as$ where the initial velocity u is zero and v = c as the speed of light.

The deflection angle in radians is the ratio of the two accelerations as $a_p/a_b = \tan \beta$. β is small, so $\tan \beta$ is equal to β. Hence,

$\beta = a_p/a_b = (GM/r^2)/(c^2/4r)$

$\beta = 4GM/c^2r$.

After deriving the above formula for the bending of the starlight, the author was able to check it with the reference given below, where the formula is given but the derivation is not [1].

III. RESULTS AND DISCUSSION

Consider the formula for the bending of starlight presented in the theory section, the values of the parameters are as follows:

G = Constant of gravitation as $6.62 \times 10^{-11}\ m^3\ Kg^{-1}\ s^{-2}$.
M = mass of the sun as 2×10^{30}Kg.
c = speed of light as 3×10^8 m/s.
r = Radius of the sun as 0.69634×10^9 metres.

The above parameter values when substituted in the formula for the bending of starlight gives the angle of deflection in radians as below:

$\beta = (4 \times 6.6 \times 10^{-11} \times 2 \times 10^{30})/(9 \times 10^{16} \times 0.69634 \times 10^9)$.
$\beta = 8.42 \times 10^{-6}$ radians.

A minute of arc is π/10800 of a radian and there are 60 arcseconds in one arcminute. So, the deflection becomes:

$\beta = 8.42 \times 10^{-6} \times (10800/\pi) \times 60$ arcseconds.
$\beta = (8.42 \times 0.108 \times 6)/\pi$ arcseconds.
$\beta = 1.74$ arcseconds.

IV. CONCLUSION

The author derives the formula for the bending of light from the sun due to gravity and calculates the deflection to be 1.74 arcseconds.

REFERENCES

[1]. Jean-Marc Ginoux, "Albert Einstein and the doubling of the deflection of light", Foundations of Science, https://doi.org/10.1007/s10699-021-09783-4, Springer Nature 2021.

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