The mechanism of gravitational deflection of light

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Abstract. According to general relativity, the cause of the light deflection near the Sun is a geometric distortion of spacetime, regardless of the photon structure. Because Einstein had no photon model at his disposal, he used mathematical techniques. In his theory, Einstein did not explain the physical mechanism through which mass produces the spacetime curvature. However, a new paradigm has provided a photon model that can reveal the mechanism of photon deflection in a gravitational field, i.e., in Tesla's inhomogeneous primary substance.

Introduction

In 1915, Einstein published his general theory of relativity, which predicts the gravitational deflection of light to be twice the Newtonian value. Einstein did not explain the physical mechanism through which mass produces the spacetime curvature. However, the process has been illustrated by placing the Earth on a grid: the grid sags, and objects roll down to the bottom of the Earth, as if by gravity (Fig. 1 left).

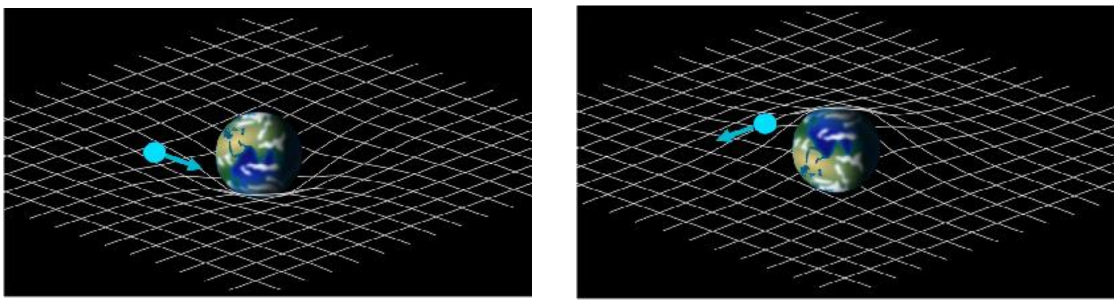

Fig. 1. A misleading illustration of how the curvature of spacetime creates gravity.

For reasons of symmetry, the grid above the Earth must arch/bend upward (Fig. 1 right); therefore, objects on that grid move away from the Earth, contrary to reality. Thus, the illustration is misleading.

Nevertheless, in 1919, a team led by Arthur Eddington sought [1] to test Einstein's prediction.

They considered three alternatives to be discriminated:
1. The path of a light ray is uninfluenced by gravitation.
2. The energy or mass of light is subject to gravitation in the same way as ordinary matter.
3. The course of a light ray is in accordance with Einstein's general relativity theory.

Their conclusion was as follows: "The results of the observations point quite definitely to the third alternative" [1].

After 100 years, a new physical paradigm was published [2], whose foundations had previously been laid in the article "What makes a photon move" [3], in which the photon structure was studied in detail.

Together with a new understanding of gravity, the new paradigm offered simple and obvious solutions to 10 unsolvable problems, including dark matter and dark energy. Thus, this paradigm provides a means to reveal the mechanism of vertical acceleration of a photon during its horizontal movement in a gravitational field. This new understanding is presented herein.

1. Deflection of a density wave in a gravitational field

Lee Smolin [4] formulated the main test to determine which requirements should be met by a candidate theory to replace the old paradigm: the main feature needed for a new paradigm is the ability to explain why atoms fall in a gravitational field. The new paradigm has refined the concept of the gravitational field and changed the standard model of particle physics. A gravitational field is a zone in which Tesla's invisible primary substance has an inhomogeneous density [5].

In the new paradigm, elementary particles are stable vortices, in which density waves of primary substance circulate; thus, all mass is made of the primary substance.
The speed of the density wave depends on the density of the medium through which the wave passes: a higher medium density corresponds to a lower speed of the density wave, and vice versa.

Figure 2 shows a density wave moving in a non-uniform primary substance, wherein the velocities of its edges differ.

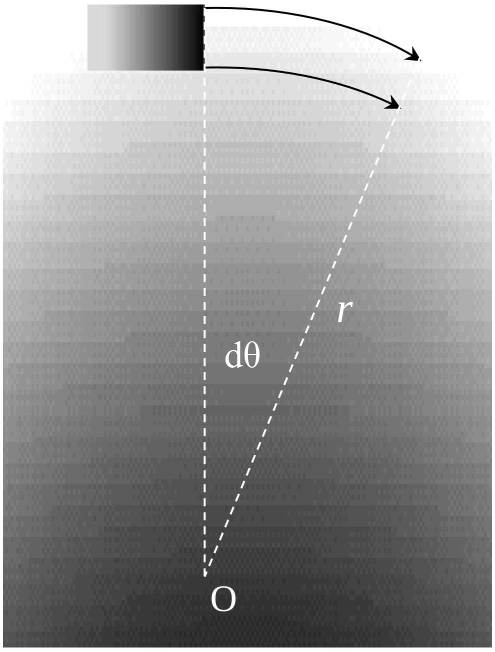

Fig. 2. A density wave deviates in a gravitational field because of a difference in the wave velocity of its edges.

In [6], the angle $d\theta$ of rotation of the density wave in a gravitational field is derived as

$$d\theta = \nabla u \sin \alpha \, dt$$

where u is the wave speed in free space, and α is the angle between ∇u and the direction of the wave velocity $\vec{v}$ inside the photon (Fig. 3 left). The rotation occurs in the plane parallel to ∇u and $\vec{v}$.

If the direction ∇u is fixed, then the change in the angle α depends only on the direction $\vec{v}$. Therefore, $d\theta = \ d\alpha$. Subsequently, we obtain

$$d\alpha = \nabla u \sin\alpha \, dt. \qquad (1)$$

This formula is also valid for angles $\alpha > \pi$, because in this case, $\sin\alpha$ is negative, thus leading to a decrease in angle α (Fig. 3 right).

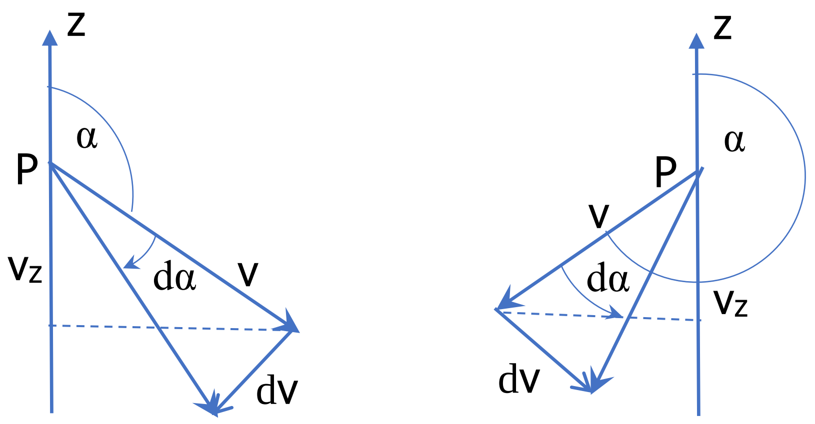

Fig. 3. Change in the vertical velocity component for point P on the wave front of a particle-vortex during free fall. The direction of the z-axis is vertical and coincides with the direction of ∇u.

For point P on the wave front, the vertical component of the velocity is

$$v_z = v\cos\alpha.$$

A change in angle α by $d\alpha$ leads to a change in the vertical component v_z of the velocity v by

$$dv_z = -v\sin\alpha \, d\alpha. \qquad (2)$$

Substitution of $d\alpha$ from Eq. (1) into Eq. (2) yields

$$dv_z = -v \, \nabla u \, sin^2\alpha \, dt.$$

Hence, the vertical acceleration of point P is

$$a_z = \frac{dv_z}{dt} = -v \, \nabla u \, sin^2\alpha \qquad (3)$$

In a uniform vacuum, $\nabla u = 0$; therefore, $a_z = 0$ for any angle α.

2. Calculation of vertical acceleration for a horizontally flying photon

A photon model is presented in Fig. 4.

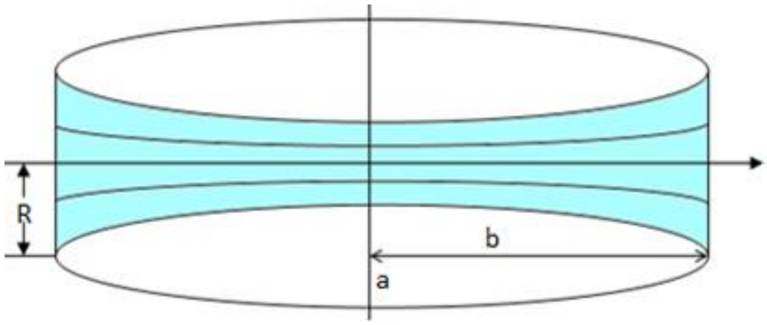

Fig. 4. Cross-section of a photon in free flight according to its proportions (from Ref. [3]).

A density wave circulates along the surface of a photon (Fig. 5).

Fig. 5. The density wave of a photon.

Animation of Figure 5 is presented in the video "Global Unification in Physics" [7].

Each point on the photon wave front moves along the trajectory of an "elongated cycloid" (Fig. 6).

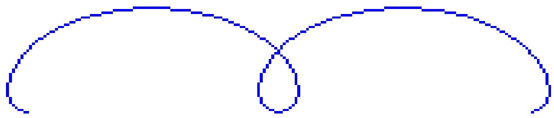

Fig. 6. The trajectory of an elongated cycloid. Because two cycles are depicted, the distance between the initial and final points of the trajectory is 2λ.

Its parametric equation is

$$\begin{cases} X = \frac{\lambda}{2\pi}\,\theta - b\sin\theta \\ Z = R - a\cos\theta \end{cases} \qquad (4)$$

where the parameters λ, a, b, and R have the dimension of length and for photons of different energies are associated with each other by the relation of direct proportionality. θ is a dimensionless parameter of the cycloid, i.e., the phase of the cyclic process.

<u>Assumptions</u>: The photon is assumed to move in a gravitational field with a constant vector ∇u, where u is the speed of a density wave in free space.

In [3], the following formula for photon wave speed was derived:

$$v(\theta) = v_0 \frac{R - a\cos\theta}{R + a}$$

where v_0 is a photon wave speed on its surface.

The assumption made allows us to substitute $v(\theta)$ in (3), and we obtain the vertical component a_z of the acceleration of one point on the photon wave front

$$a_z(\theta) = -v_0\,\nabla u\,\frac{k - \cos\theta}{k+1}\,sin^2\alpha$$

where the relation k=R/a is used (see Fig. 4 and [3]).

Using integration over $d\theta$, we average $a_z(\theta)$ over the period of one cycle $0 \le \theta \le 2\pi$, and obtain the acceleration of the photon as a whole:

$$\overline{a_z} = -v_0 \frac{\nabla u}{2\pi} \cdot \int_0^{2\pi} \frac{k - \cos\theta}{k+1} sin^2\alpha \, d\theta \qquad (5)$$

Now, we must find $sin\,\alpha$

$$sin\,\alpha = \frac{dX}{dL};\; dX = \frac{dX}{d\theta}\, d\theta$$

$$\frac{dX}{d\theta} = \frac{\lambda}{2\pi} - b\cos\theta\,; \qquad \frac{dZ}{d\theta} = a\sin\theta$$

$$dL = \sqrt{\left(\frac{dX}{d\theta}\right)^2 + \left(\frac{dZ}{d\theta}\right)^2}\, d\theta = \sqrt{\left(\frac{\lambda}{2\pi} - b\;cos\theta\right)^2 + (a\sin\theta)^2}\; d\theta$$

$$sin\,\alpha\,(\theta) = \frac{dX}{dL} = \left(\frac{\lambda}{2\pi} - b\;cos\theta\right) \Big/ \sqrt{\left(\frac{\lambda}{2\pi} - b\;cos\theta\right)^2 + (a\sin\theta)^2}$$

Now, we reduce the expression for $sin\,\alpha$ by a factor $\boldsymbol{\lambda}$

$$sin\,\alpha\,(\theta) = \frac{\left(\frac{1}{2\pi} - b/\lambda\;cos\theta\right)}{\sqrt{\left(\frac{1}{2\pi} - b/\lambda\;cos\theta\right)^2 + \left(\frac{a}{\lambda}\sin\theta\right)^2}} \qquad (6)$$

The values $\frac{b}{\lambda} = 0.5058;\; \frac{a}{\lambda} = 0.0666;\; k = 2.284$ were calculated for the photon in [3].

The calculation of the vertical component $\overline{a_z}$ of a photon's acceleration according to formula (5), performed with a computer program, indicated the following result:

$$\overline{a_z} = -v_0 \nabla u \;\cdot 0.6244. \qquad (7)$$

The minus sign in (7) means that the acceleration $\overline{a_z}$ is directed downward.

3. Calculating the free fall acceleration of an electron

The difference between an electron and a photon is that the shape of an electron is a regular toroid with a circular cross-section. Therefore, in parametric equation (4) b=a. Removing the term with λ cancels out the horizontal displacement of the electron (Fig. 7).

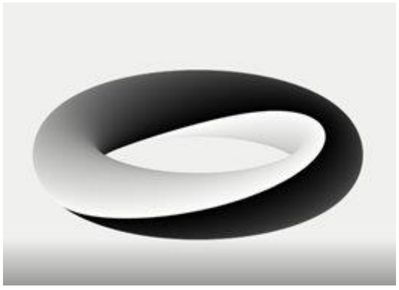

Fig. 7. The electron is a vortex with a toroidal shape. A high-density wave front (black) moves toward a rarefied region (white), which is the tail of the same wave. It closes on itself and a cyclic wave-vortex is obtained [5].

Consequently, formula (6) for $sin\,\alpha$ in the case of an electron is greatly simplified

$$sin\,\alpha\,(\theta) = \frac{-a/\lambda\,cos\theta}{\sqrt{(-a/\lambda\,cos\theta)^2 + \left(\frac{a}{\lambda}\sin\theta\right)^2}} = \,cos\theta. \qquad (6')$$

Then the free fall acceleration of the electron is equal to

$$g_e = -v_0\frac{\nabla u}{2\pi}\cdot\int_0^{2\pi}\frac{k_e - \cos\theta}{k_e + 1}cos^2\theta\,d\theta = \,-v_0\nabla u\,\frac{k_e}{2\,(k_e + 1)}$$

where $k_e = R/a$ for the electron.

In the absence of the electron proportions, to obtain an approximate result, we use the value of k for the photon. Then

$$g_e \approx -v_0 \nabla u \frac{k}{2\,(k+1)} \approx -v_0 \nabla u \, 0.3477,$$

and thus

$$\overline{a_z}/g_e \approx 0.6244/0.3477 \approx 1.8$$

instead of the value 2.0 according to general relativity. To obtain a more accurate result, the electron proportions must be clarified.

Conclusion

Knowledge of the photon structure enables the true cause of free fall acceleration to be revealed, and indicates that the acceleration need not be the same for all particles, particularly photons. For a photon, a range of possible accelerations exists, from zero during vertical fall to a maximum in the case of horizontal flight.

References

[1] Dyson F. W., Eddington A. S., and Davidson C., "A Determination of the Deflection of Light by the Sun's Gravitational Field, from Observations Made at the Total Eclipse of May 29, 1919," *Phil. Trans. R. Soc. A 220,* p. 291–333, 1920.

[2] Y. Bakman, "A New Physical Paradigm," 23 July 2020. [Online]. Available: https://vixra.org/abs/2008.0038. [Accessed 23 October 2022].

[3] Y. Bakman, "What makes a photon move? A paradigm shift in physics," 13 December 2017. [Online]. Available: https://www.physicsparadigm.com/home/what-makes-a-photon-move. [Accessed 2 June 2020].

[4] L. Smolin, Three roads to quantum gravity, NY: Basic Books, 2001.

[5] Y. Bakman, "Breakthrough in Understanding Gravity," 24 September 2023. [Online]. Available:

https://www.youtube.com/watch?v=fkGKLAOV32U. [Accessed 29 September 2023].

[6] Y. Bakman, "Solution to Quantum Gravity and Other Enigmas of the Dominant Paradigm," vixra, 29 September 2021. [Online]. Available: https://vixra.org/pdf/2109.0210v1.pdf. [Accessed 18 October 2021].

[7] Y. Bakman, "Global Unification in Physics," YouTube, 23 September 2023. [Online]. Available: https://www.youtube.com/watch?v=usbdMqmGIks. [Accessed 6 October 2023].