The Strict Proof that General Relativity can not Correctly Describe the motions of Lights in the Solar Gravity Field

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Abstract According to general relativity, the poles of light's motion equations in the solar gravitational field are determined by one element cubic equation. The paper discusses this problem strictly and proves that the poles of light's orbits are located at the places $2.95\times10^3 \sim 2.11\times10^4$ m far away from the solar center. So the lights omitted from stars outside space would disappear in the sun inner. The night sky on the earth would be black. But it is not true. Suppose that the poles of light's orbit are on the solar surface, the calculations of general relativity on light's deflection and radar wave's delay wave are wrong. The paper discusses the light's motion equation of general relativity and its approximate solutions. It is pointed that the solution is not real one and will lead to contradiction. The reason is that the Einstein's equation of gravity is nonlinear and does not satisfy the principle of superposition. According to the motion equation of general relativity, the force acted on light is actually repulsive force. The deflection direction is actually opposite to the present calculation. The further study reveals that there are two motions equation to describe light's motions in general relativity. One related to time is similar to the Newtonian equation. Another unrelated to time is completely different from the Newtonian equation which leads light enter the sun inner. These two types of equation contradict each other in physics. The conclusion is that the light's motion theory of general relativity can not hold in the solar gravitational field.

Key words: General relativity, Newtonian theory of gravity, Light's deflection, radar wave's delay, Roots of one element cubic equation

1. Introduction

Thought general relativity was raised a hundred years ago, the problem of pole positions of light's orbit in the solar system field were unnoticed. Physicists always suppose that the poles of light's orbits were located on the solar surface. However, this is untrue. The pole positions of light's orbits should be calculated based on the motion equation of general relativity, rather than being assumed in advance. The motion equation of general relativity to describe light's motion is one element cubic equation with one or three roots or poles. It is proved that the orbits of lights have one pole. The poles are located at the places 2950 ~ 21100m far away from the center of the sun. So lights omitted by stars outside space would enter the sun inner and are eliminated. The night sky of the earth would be black. However, it is not true.

Therefore, the calculation of general relativity on the deflection of light's orbit and the delay of radar wave in the solar system are wrong. General relativity has not been verified by the light's motions in the solar system. The liner superposition solution of motion equation of general relativity is discussed. It is pointed out that the solution will cause contradiction, so it is not real one. The reason is that the Einstein's equation of gravity is nonlinear one and the liner superposition principle can not be satisfied.

The author does further analyses on two light's motion equations of general relativity and indicate that the equation related to time can be considered as the approximation of Newtonian gravity theory. But the force acted on photon is not gravity. It is repulsive force direct in direct proportion to $1/r^2$. The equation

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Of orbit unrelated to time is completely different from the Newtonian equation and leads light to enter the sun inner. So two equation of general relativity to describe light's motion in gravitational field is contradict in physics. The result indicates that general relativity is invalid again.

2. The orbit's poles of light in the solar gravity field.

2. 1 The orbit equation of light of general relativity.

In the four experiment verifications of general relativity, three are light's motions in the solar system, i.e., light's deflection, radar wave's delay and light's gravity red shift. The first two are relative to the motion equations of gravity field. General relativity uses the Schwarzschild metric to describe the solar gravitational field. By eliminating arbitrary variation parameter from geodesic equations, two equations are obtained. One is unrelated to time and used to describe the deflection of light's orbit with form below [1]

$$\left(\frac{du}{d\theta}\right)^2 + u^2 = \frac{K^2}{J^2} + \alpha u^3 \qquad (1)$$

Here $u = 1/r$, K and J are integral constants. By the derivative of (1) with respect to angle again, the following the equation orbit unrelated to time is obtained.

$$\frac{d^2u}{d\theta^2} + u = \frac{3}{2}\alpha u^2 = \frac{3GM}{c^2}u^2 \qquad (2)$$

Based on (2), the deflection angle of light in the solar system is calculated. The result is

$$\Delta\theta = \frac{2\alpha}{R} = \frac{4GM}{c^2R} = 1.75'' \qquad (3)$$

Another equation is related to time with form [1], [2]

$$\left(\frac{dr}{dt}\right)^2 + r^2\left(\frac{d\varphi}{dt}\right)^2 = c^2\left[1 - \frac{2\alpha}{r} + \frac{\alpha^2}{r^2} + \frac{\alpha J^2}{K^2r^3}\left(1 - \frac{\alpha}{r}\right)^2\right] \qquad (4)$$

(4) is used to calculate the delay of radar wave in the solar system. The result is [1]

$$\Delta t = \frac{2\alpha}{c}\left[1 + \ln\frac{4rr'}{R^2}\right] = \frac{4GM}{c^3}\left[1 + \ln\frac{4rr'}{R^2}\right] = 2.4\times 10^{-4}\,\text{s} \qquad (5)$$

Because (3) and (5) are consistent with practical observations, general relativity is considered to be tenable.

2. 2 The determination of integral constant

If the revised items αu^3 and $3\alpha u^2/2$ of general relativity do not exist, (2) and (3) become

$$\left(\frac{du}{d\theta}\right)^2 + u^2 = \frac{K^2}{J^2} \qquad (6)$$

$$\frac{d^2u}{d\theta^2} + u = 0 \qquad (7)$$

The solution of (7) is

$$u = \frac{\sin\theta}{D} \qquad D = r\sin\theta \qquad (8)$$

Here D is a constant. As shown in Fig1, (8) represent a straight line with $y = r\sin\theta = D =$ constant. At point $x=0$, we have $\theta=\pi/2$, $du/d\theta=\cos\theta/D=0$, $u=1/D$. Substitute them in (6), we get $K/J=1/D$. The integral constant is determined and (1) becomes

$$\left(\frac{du}{d\theta}\right)^2=\frac{1}{D^2}-u^2+\alpha u^3=f(u) \tag{9}$$

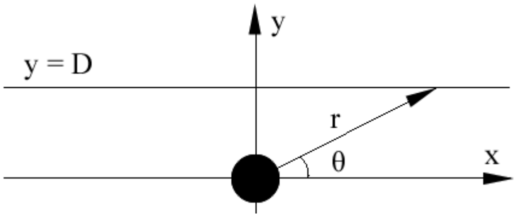

Fig. 1 Straight line motion of light when the revised item of general relativity does not exist.

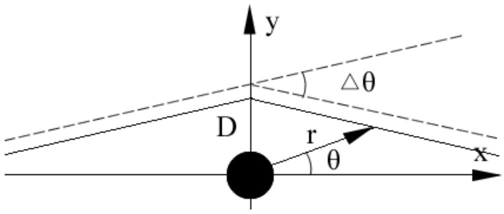

Fig. 2 The orbit deflection of Light moving in the solar system.

2. 3 The orbit's pole of light in the solar system

2. 3. 1 the root of one element cubic equation

According to the theory of one element cubic equation, the function $f(u)=0$ in (9) has one real root or three real roots. It is impossible for (9) to have two real roots. According to Fig. 2, the orbit of light has one pole when light coming from outside space enters the solar system. Let's calculate the position of orbit pole. Let $b=-1/\alpha$ and $g=1/(\alpha D^2)$. From $f(u)=f(u_1)=0$, we have

$$u_1^3-\frac{1}{\alpha}u_1^2+\frac{1}{\alpha D^2}=u_1^3+bu_1^2+g=0 \tag{10}$$

Let

$$u_1=y_1-\frac{b}{3} \tag{11}$$

(10) becomes

$$y_1^3+py_1+q=0 \tag{12}$$

Here

$$p=-\frac{1}{3}b^2=-\frac{1}{3\alpha^2} \qquad q=\frac{2}{27}b^3+g=-\frac{1}{\alpha^3}\left(\frac{2}{27}-\frac{\alpha^2}{D^2}\right) \tag{13}$$

The solutions (or roots) of (12) are

$$y_1=\left[-\frac{q}{2}+\sqrt{\left(\frac{q}{2}\right)^2+\left(\frac{p}{3}\right)^3}\right]^{1/3}+\left[-\frac{q}{2}-\sqrt{\left(\frac{q}{2}\right)^2+\left(\frac{p}{3}\right)^3}\right]^{1/3} \tag{14}$$

$$y_2=\frac{-1-i\sqrt{3}}{2}\left[-\frac{q}{2}+\sqrt{\left(\frac{q}{2}\right)^2+\left(\frac{p}{3}\right)^3}\right]^{1/3}+\frac{-1+i\sqrt{3}}{2}\left[-\frac{q}{2}-\sqrt{\left(\frac{q}{2}\right)^2+\left(\frac{p}{3}\right)^3}\right]^{1/3} \qquad (15)$$

$$y_3=\frac{-1+i\sqrt{3}}{2}\left[-\frac{q}{2}+\sqrt{\left(\frac{q}{2}\right)^2+\left(\frac{p}{3}\right)^3}\right]^{1/3}+\frac{-1-i\sqrt{3}}{2}\left[-\frac{q}{2}-\sqrt{\left(\frac{q}{2}\right)^2+\left(\frac{p}{3}\right)^3}\right]^{1/3} \qquad (16)$$

2. 3. 2 The approximate calculation of pole positions when $D > R >> \alpha$

We know that the solar radius is $R = 6.96\times10^8$ m and the solar gravity radius is $\alpha = 2.95\times10^3$ m. For the light coming from far away, we take $D > R >> \alpha$, $\alpha^2/D^2 \le 10^{-10} << 1$. If the item α^2/D^2 is neglected, (13) is calculated with

$$\sqrt{\left(\frac{q}{2}\right)^2+\left(\frac{p}{3}\right)^3}=\sqrt{\frac{1}{27^2\alpha^6}-\frac{1}{9^3\alpha^6}}=0 \qquad (17)$$

Substitute (17) in (14) ~ (16)，we get

$$y_1=\frac{2}{3\alpha} \qquad u_1=y_1-\frac{b}{3}=\frac{1}{\alpha} \qquad r_1=\frac{1}{u_1}=\alpha$$

$$y_2=y_3=-\frac{4}{3\alpha} \qquad u_2=u_3=-\frac{1}{\alpha} \qquad r_2=r_3=-\alpha \qquad (18)$$

So (9) has three real roots, one is positive and two are negative with the same values. In fact, by neglecting $1/D^2$ in (9), we get $u=\pm1/\alpha$ from $f(u)=0$ immediately. Negative root is meaningless in physics. Positive root is located at the point of the solar gravity radius. It means that when the light omitted from stars far away enters the solar system, they would enter the center region of the sun and disappear. Person on the earth surface can not see them and the night sky would be black. However, the fact is not like that.

2. 3. 3 The accurate calculation of pole position when $D = R$

Taking $R = 6.96\times10^8$ m, $D = R = 2.36\alpha\times10^5$ m, we get from (13)

$$q=-\frac{2}{27\alpha^3}\left(1-\frac{27\alpha^2}{2D^2}\right)=-\frac{2}{27\alpha^3}(1-\varepsilon_1) \qquad (19)$$

Here $\varepsilon_1 = 2.43\times10^{-10}$ is a small quantity. From (13) and (14)，we obtain

$$\sqrt{\left(\frac{q}{2}\right)^2+\left(\frac{p}{3}\right)^3}=\frac{1}{2\alpha D^2}\sqrt{1-\frac{4D^2}{27\alpha^2}} \qquad (20)$$

Substituting $D = 2.36\alpha\times10^5$ in (20), we get:

$$\sqrt{\left(\frac{q}{2}\right)^2+\left(\frac{p}{3}\right)^3}=\frac{\sqrt{1-8.25\times10^9}}{1.11\times10^{11}\alpha^3}=\frac{i\varepsilon_2}{\alpha^3} \qquad (21)$$

Here $\varepsilon_2 = 3.72\times10^{-2}$. Let $\varepsilon = 27\varepsilon_2$ and considering $\varepsilon_1 = 2.43\times10^{-10} << 1$, (14) becomes

$$y_1 = \frac{1}{3\alpha}(1+i\varepsilon)^{1/3} + \frac{1}{3\alpha}(1-i\varepsilon)^{1/3} \tag{22}$$

It can be written as

$$y_1 = \frac{1}{3\alpha}(Qe^{i\varphi/3} + Qe^{-i\varphi/3}) = \frac{2Q\cos(\varphi/3)}{3\alpha} \tag{23}$$

Here

$$Q = \left(\sqrt{1+\varepsilon^2}\right)^{1/3} \qquad \varphi = arctg\,\varepsilon \tag{24}$$

Because of $\varepsilon = 27\times 3.72\times 10^{-2} \approx 1.00$, we have $\varphi = 45^0$ and

$$Q = 2^{1/6} = 1.12 \qquad \cos\varphi/3 = \cos 15^0 = 0.96 \tag{25}$$

From (11), we get

$$u_1 = \frac{1.12\times 0.96}{3\alpha} + \frac{1}{3\alpha} = \frac{0.69}{\alpha} \qquad r_1 = \frac{1}{u_1} = \frac{\alpha}{0.69} = 4.28\times 10^3\,\text{m} \tag{26}$$

We calculate another two roots. By considering (20) and (23) as well as the formulas below

$$\frac{1}{3\alpha}(1+i\varepsilon)^{1/3} - \frac{1}{3\alpha}(1-i\varepsilon)^{1/3} = Q(e^{i\varphi/3} - e^{-i\varphi/3}) = 2iQ\sin(\varphi/3) \tag{27}$$

(15) and (16) become

$$y_2 = \frac{(-1-i\sqrt{3})(1+i\varepsilon)^{1/3}}{6\alpha} + \frac{(-1+i\sqrt{3})(1-i\varepsilon)^{1/3}}{6\alpha} \tag{28}$$

$$= -\frac{1}{6\alpha}\left[(1+i\varepsilon)^{1/3} + (1-i\varepsilon)^{1/3}\right] - \frac{i\sqrt{3}}{6\alpha}\left[(1+i\varepsilon)^{1/3} - (1-i\varepsilon)^{1/3}\right]$$

$$= \frac{-Q\cos(\varphi/3) + \sqrt{3}Q\sin(\varphi/3)}{3\alpha} = -\frac{1.12}{3\alpha}(0.96 - \sqrt{3}\times 0.26) = -\frac{0.19}{\alpha} \tag{29}$$

$$y_3 = \frac{(-1+i\sqrt{3})(1+i\varepsilon)^{1/3}}{6\alpha} + \frac{(-1-i\sqrt{3})(1-i\varepsilon)^{1/3}}{6\alpha} \tag{30}$$

$$= -\frac{1}{6\alpha}\left[(1+i\varepsilon)^{1/3} + (1-i\varepsilon)^{1/3}\right] + \frac{i\sqrt{3}}{6\alpha}\left[(1+i\varepsilon)^{1/3} - (1-i\varepsilon)^{1/3}\right]$$

$$= \frac{-Q\cos(\varphi/3) - \sqrt{3}Q\sin(\varphi/3)}{3\alpha} = -\frac{1.12}{3\alpha}(0.96 + \sqrt{3}\times 0.26) = -\frac{0.51}{\alpha} \tag{31}$$

We have

$$u_2 = -\frac{0.19}{\alpha} + \frac{1}{3\alpha} = \frac{0.14}{\alpha} \qquad r_2 = \frac{1}{u_2} = \frac{\alpha}{0.14} = 2.11\times 10^4\,\text{m} \tag{32}$$

$$u_3 = -\frac{0.51}{\alpha} + \frac{1}{3\alpha} = -\frac{0.18}{\alpha} \qquad r_3 = \frac{1}{u_3} = -\frac{\alpha}{0.18} = -1.64 \times 10^4 \text{ m} \tag{33}$$

When $D = R = 6.69 \times 10^8$ m, function $f(u) = 0$ has three real roots. Among them, two are positive and one is negative, representing individually by (26), (32) and (33).

2. 3. 4 The extreme value of function $f(u)$ when $R \le D < \infty$

Let's calculate the extreme value of $f(u)$ when $D = R$. We have

$$f'(u) = -2u + 3\alpha u^2 = 0 \tag{34}$$

The extreme values of $f(u)$ at points $u = 0$ and $u = 2/(3\alpha)$ are individually

$$f(0) = \frac{1}{D^2} = 1.28 \times 10^{-18} > 0 \tag{35}$$

$$f(2/(3\alpha)) = \frac{1}{D^2} - \frac{4}{9\alpha^2} + \frac{8}{27\alpha^2} = 1.28 \times 10^{-18} - 1.70 \times 10^{-8} \approx -1.70 \times 10^{-8} < 0 \tag{36}$$

The shape of function $f(u)$ and the positions of extreme values are shown in Fig. 3 (without considering proportion) .

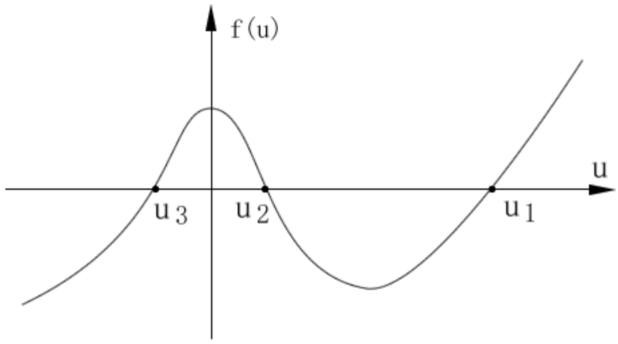

Fig 3. The allowed regions of light's motion in the solar system

In Fig. 3, in the region $-\infty < u < u_3$ with $f(u) < 0$, the equation (9) for light's motion is meaningless. In the region $u_3 \le u < 0$ with $f(u) \ge 0$, but because of $r < 0$, the motion equation is also meaningless in physics. In the region $0 < u \le u_2$ and $u_1 \le u < \infty$ with $f(u) > 0$, the motion equation is meaningful. The lights in the gravity field can only moves in these regions.

In the region $u_1 \le u < \infty$ with $0 < r < \alpha = 2.95 \times 10^3$ m, light's motion is limited within the solar gravity radius. Because the orbit is not continuous, the light outside the sun can not enter this region. In the region $0 \le u \le u_2$, we have $2.11 \times 10^4 < r < \infty$. The light coming from stars outside the solar system can enter this region. Because the pole of orbit is located at $r_2 = 2.11 \times 10^4$ m, the light would enter the sun inner and be eliminated. The observers on the earth can not see them.

The light's motions based on general relativity in the solar gravity field are shown in Fig. 4. Suppose that the original position of light at y-axis is $D >> R$, the orbit's pole is located at the point nearby $r = \alpha$ and light moves along the curve L_1. If the original potion is located at $D = R$, the orbit's pole is located at the point $r_2 = 2.11 \times 10^4$ m and light moves along the curve L_2. Suppose that the original positions of lights at y- axis is $D >> R$, the orbit's poles are located at the regions $2.95 \times 10^3 m \le r \le 2.11 \times 10^4 m$. All of them are in the sun inner. It is strange that if the value of D is greater, the position is more nearing the center of the sun. This violates the foundational law of physics, means that the motion equation can not describe the real motion of light.

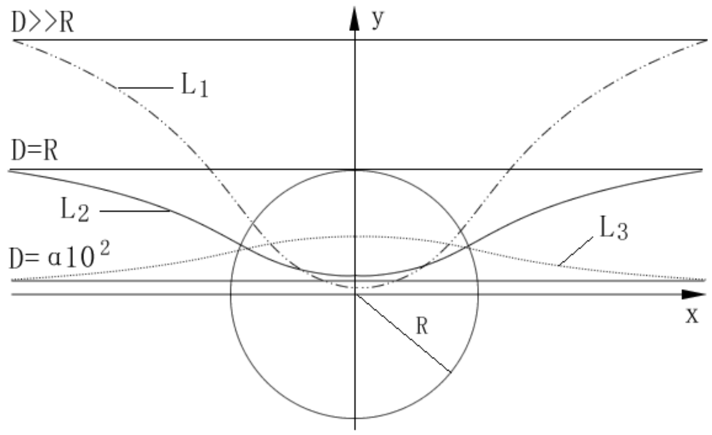

Fig 4. The orbit's pole of light in the solar system according to general relativity

2. 3. 5 The orbit's pole of light with $D = \alpha \times 10^2$

If the initial position of light is located at $D = \alpha \times 10^2 = 2.95 \times 10^5$ m, we have $\varepsilon_1 = 1.35 \times 10^{-3}$ in (19) and $\varepsilon_2 = i1.44 \times 10^{-6}$ in (20), as well as $\varepsilon = 27\varepsilon_2 = i3.89 \times 10^{-5}$. From (23) and (24), we get

$$Q = \left[(1 - 1.25 \times 10^{-3})^2 + (3.89 \times 10^{-5})^2 \right]^{\frac{1}{3}} \approx (1 - 2.70 \times 10^{-3})^{\frac{1}{3}} = 1 - 9 \times 10^{-4} \quad (37)$$

We have $\varphi = 5.02 \times 10^{-3}$, $\cos\varphi/3 \approx 1$ and $\sin\varphi/3 \approx 1.67 \times 10^{-3}$. Comparing with (23), (29) and (31), we get

$$y_1 = \frac{2(1 - 9 \times 10^{-4})}{3\alpha} \qquad u_1 \approx \frac{2}{3\alpha} + \frac{1}{3\alpha} = \frac{1}{\alpha} \qquad r_1 = \alpha \quad (38)$$

$$y_2 = \frac{-(1 - 9 \times 10^{-4})}{3\alpha} \qquad u_2 = \frac{-(1 - 9 \times 10^{-4})}{3\alpha} + \frac{1}{3\alpha} = \frac{9 \times 10^{-4}}{\alpha}$$

$$r_2 = \frac{\alpha}{9 \times 10^{-4}} = 3.28 \times 10^8 \text{ m} \quad (39)$$

$$y_3 = \frac{-(1 + 9 \times 10^{-4})}{3\alpha} \qquad u_3 = \frac{-(1 + 9 \times 10^{-4})}{3\alpha} + \frac{1}{3\alpha} = -\frac{9 \times 10^{-4}}{\alpha} \quad (40)$$

$$r_3 = \frac{\alpha}{9 \times 10^{-4}} = -3.28 \times 10^8 \text{ m} \quad (41)$$

The function $f(u) = 0$ has three real roots, two is positive and one is negative. As shown in Fig. 3, only r_2 is meaningful to be the pole of light's orbit. Light coming from far away moves in the region $0 < u \le u_2$ along the curve L_3 in Fig. 4. The pole of orbit is located at point $r_2 \approx R/2$,

2. 3. 6 The orbit's pole of light with $D = \sqrt{27/2}\alpha$.

If the initial position of light is located at $D = \sqrt{27/2}\alpha$, according to (19), we have $q = 0$ and

$$\sqrt{\left(\frac{q}{2}\right)^2+\left(\frac{p}{3}\right)^3}=\left(-\frac{1}{9\alpha^2}\right)^{\frac{3}{2}}=\frac{i}{27\alpha^3} \tag{42}$$

$$y_1=\left(\frac{i}{27\alpha^3}\right)^{1/3}+\left(-\frac{i}{27\alpha^3}\right)^{1/3}=0 \tag{43}$$

$$y_2=\frac{-1-i\sqrt{3}}{2}\left(\frac{i}{27\alpha^3}\right)^{1/3}+\frac{-1+i\sqrt{3}}{2}\left(-\frac{i}{27\alpha^3}\right)^{1/3}=-i\sqrt{3}\left(\frac{i}{27\alpha^3}\right)^{1/3}=-\frac{\sqrt{3}}{3\alpha} \tag{44}$$

$$y_3=\frac{-1+i\sqrt{3}}{2}\left(\frac{i}{27\alpha^3}\right)^{1/3}+\frac{-1-i\sqrt{3}}{2}\left(-\frac{i}{27\alpha^3}\right)^{1/3}=i\sqrt{3}\left(\frac{i}{27\alpha^3}\right)^{1/3}=\frac{\sqrt{3}}{3\alpha} \tag{45}$$

$$u_1=\frac{1}{3\alpha} \qquad r_1=3\alpha=8.85\times10^3\,\text{m}$$

$$u_2=\frac{1-\sqrt{3}}{3\alpha} \qquad r_2=\frac{3\alpha}{1-\sqrt{3}}=-1.21\times10^4\,\text{m}$$

$$u_3=\frac{1+\sqrt{3}}{3\alpha} \qquad r_3=\frac{3\alpha}{1+\sqrt{3}}=3.24\times10^3\,\text{m} \tag{46}$$

The function $f(u)=0$ has three real roots, in which two are positive and one is negative. Substituting $D=\sqrt{27/2}\alpha$ in (35) and (36), we get the extreme value of function $f(u)$ with

$$f(0)=\frac{1}{D^2}=\frac{2}{27\alpha^2}=8.51\times10^{-9} \tag{47}$$

$$f(2/(3\alpha))=\frac{2}{27\alpha^2}-\frac{4}{9\alpha^2}+\frac{8}{27\alpha^2}=-\frac{2}{27\alpha^2}=-8.51\times10^9 \tag{48}$$

The sharp of function $f(u)$ and the pole positions are similar to that shown in Fig. 3. but the order on the coordinate axis becomes u_2, u_1 and u_3 from left side to right side. Light only moves in the region $0<u\le u_1$ and the pole r_1 is in the sun inner, 8.85×10^3 m far away from the solar center.

2. 3. 5 The orbit's pole of light with $D=\alpha$

If the initial position of light is located at $D=\alpha$, according to (19) and (20),we have

$$q=-\frac{1}{\alpha^3}\left(\frac{2}{27}-1\right)=\frac{0.9259}{\alpha^3} \qquad \sqrt{\left(\frac{q}{2}\right)^2+\left(\frac{p}{3}\right)^3}=\frac{1}{2\alpha^3}\sqrt{1-\frac{4}{27}}=\frac{0.4615}{\alpha^3} \tag{49}$$

$$y_1=-\frac{1}{\alpha}(0.4630-0.4615)^{1/3}-\frac{1}{\alpha}(0.4630+0.4615)^{1/3}=-\frac{1.0887}{\alpha} \tag{50}$$

$$u_1=-\frac{1.0887}{\alpha}+\frac{1}{3\alpha}=-\frac{0.7554}{\alpha} \qquad r_1=-1.3238\alpha<0 \tag{51}$$

$$y_2=\frac{0.1145(-1-i\sqrt{3})}{2\alpha}+\frac{0.9742(-1+i\sqrt{3})}{2\alpha}=-\frac{0.5444-i0.7436}{\alpha} \tag{52}$$

$$y_3 = \frac{0.1145(-1+i\sqrt{3})}{2\alpha} - \frac{0.9742(1+i\sqrt{3})}{2} = -\frac{0.5444+i0.7436}{\alpha} \quad (53)$$

The function $f(u)=0$ has one negative root and two conjugated imaginary roots. For light's motion, these poles are meaningless in physics. However, it is normal for light moves from the initial position $D=\alpha$ toward the sun. How does the motion become meaningless?

2. 3. 6 The orbit's pole of light with $D << \alpha$

If the initial position of light is located at $D << \alpha$, (19) and (20) become

$$q = -\frac{1}{\alpha^3}\left(\frac{2}{27} - \frac{\alpha^2}{D^2}\right) = \frac{1}{\alpha D^2} \qquad \sqrt{\left(\frac{q}{2}\right)^2 + \left(\frac{p}{3}\right)^3} \approx \frac{1}{2\alpha D^2} \quad (54)$$

$$-\frac{q}{2} + \sqrt{\left(\frac{q}{2}\right)^2 + \left(\frac{p}{3}\right)^3} = 0 \qquad -\frac{q}{2} - \sqrt{\left(\frac{q}{2}\right)^2 + \left(\frac{p}{3}\right)^3} = -\frac{1}{\alpha D^2} \quad (55)$$

$$y_1 = -\left(\frac{1}{\alpha D^2}\right)^{1/3} \qquad u_1 = -\left(\frac{1}{\alpha D^2}\right)^{1/3} + \frac{1}{3\alpha} \approx -\left(\frac{1}{\alpha D^2}\right)^{1/3} < 0 \quad (56)$$

$$y_2 = \frac{1-i\sqrt{3}}{2}\left(\frac{1}{\alpha D^2}\right)^{1/3} \qquad y_2 = \frac{1+i\sqrt{3}}{2}\left(\frac{1}{\alpha D^2}\right)^{1/3} \quad (57)$$

In this case, the function $f(u)=0$ has one negative real root and two conjugated imaginary roots. The orbit is meaningless in physics. However, it is normal for light to star its motion in this position. We have to think that the motion equation (9) of general relativity can not correctly describe light's motion in the solar gravity field.

2. 3. 6 The deflection of light in the solar gravity field.

When light's initial position is located at $D = R = 6.69\times10^8$ m, the pole of orbit is located at the position $r_2 = 2.11\times10^4$ m. (3) becomes

$$\Delta\theta = \frac{4GM}{c^2 r_2} = \frac{4GM}{c^2 R}\frac{R}{r_2} = 1.75'' \times 3.3\times10^4 \quad (58)$$

It is about 33000 times more than the current result in general relativity, besides that the light would enter the sun inner so that we can not see them completely. The observation of light's deflection in the solar gravity field has not proved the validity of general relativity.

3. The problems of light's orbit equation of general relativity and solutions

3. 1 The problems of light's orbit equation of general relativity

According to common understanding, general relativity is the revision of Newtonian theory of gravity. The items αu^3 and $3\alpha u^2/2$ in (1) and (2) represent the revisions of general relativity. In weak field, they are small quantities. Omitting them, the motion equations of the Newtonian theory are obtained. However, (2) is completely different from the Newtonian theory, i.e., it is not the approximation of the

Newtonian equation of gravity actually.

For an object with mass moving in gravitational field, corresponding to (2), the orbit equation of the Newtonian theory of gravity is

$$\frac{d^2u}{d\theta^2}+u=\frac{GM}{L^2} \tag{59}$$

(59) describes conic curve. The item on the right side of equation is a constant. But the item $3\alpha u^2/2$ in (2) is not a constant. So (2) and (59) are not the same type of equations. The formula (2) describes neither the conic curve, no the Newtonian approximation of conic curve. Comparing (2) and (59), we have

$$\frac{GM}{L^2}\sim\frac{3GM}{c^2r^2} \tag{60}$$

It corresponds to let $L=Vr\sim cr$. In weak field, for the object with mass, we have $V<<c$. The item on the right side of (2) can be considered as small quantity. But for light's motion in weak field, we have $V\sim c$. The item $3\alpha u^2/2$ can not be considered as small quantity. When r is great, the item tends to zero. When r is small, the item will become great. However, the item on the right side of (59) is unchanged. So the formula (2) is not the Newtonian type motion equation. Using it to describe the light's motion in gravitational field, great mistake would be caused.

3. 2 The calculation of general relativity on the deflection of light's orbit.

According to the calculation of general relativity, when the item αu^2 does not exist, let $u=u_0$ in (7), we have

$$\frac{d^2u_0}{d\theta^2}+u_0=0 \tag{61}$$

The solution is

$$u_0=\frac{\sin\theta}{D} \qquad D=r_0\sin\theta \tag{62}$$

Substituting (62) in the right side of (1) and let $u=u_1$, we obtain an approximate equation [1]

$$\frac{d^2u_1}{d\theta^2}+u_1=\frac{3\alpha}{2}u_0^2=\frac{3\alpha}{2D^2}\sin^2\theta \tag{63}$$

The special solution of (63) is

$$u_1=\frac{\alpha}{2D^2}(1+\cos^2\theta) \tag{64}$$

Therefore, according to current general relativity, the solution of (2) is written as

$$u=u_0+u_1=\frac{\sin\theta}{D}+\frac{\alpha}{2D^2}(1+\cos^2\theta) \tag{65}$$

令$r\to\infty$， $u=1/r=0$，得：

$$\sin\varphi+\frac{\alpha}{2D}(1+\cos^2\theta)=0 \tag{66}$$

Let $\theta=\pi+\delta$, δ is a small quantity with $\sin\theta=-\sin\delta\approx-\delta$ and $\cos^2\theta\approx1$. Substituting them in (52), we get $\delta=\alpha/D$. When the light coming from a place far away passes through the solar surface with $D=R$, (3) is obtained.

3. 3 The problem exists in the calculation of general relativity.

The geometrical picture of calculation above is unclear. Besides, the solution of equation has following serious problem.

1. As shown in Fig. 1, according to the definition, relation $y = r\sin\theta = D$ is always tenable for all points on the straight line. When light moves in gravitational field, for the points on the light's orbit, relation $y = r\sin\theta$ holds but relation $y = D$ does not hold (except initial point) . Let $u = 1/r$ in (65), we get

$$y = D - \frac{\alpha}{2D^2} r(1+\cos^2\theta) \tag{67}$$

（67）can be written as

$$r = \frac{D}{\sin\theta + \alpha(1+\cos^2\theta)/(2D^2)} = \frac{D}{\sin\theta} \tag{68}$$

The second equal sign of (68) is impossible unless $\alpha = 0$ or $M = 0$, which means that the sun does not exist. So the solution of (65) is meaningless.

2. In fact, as shown in Fig. 1, for the star located at infinite far place on the left side with $r \to \infty$ and $\theta = \pi$, according to (67), we have

$$y = \lim_{r\to\infty}\left(D - \frac{\alpha}{D^2} r \right) \to -\infty \tag{69}$$

For the observer located at infinite far place on the right side with $r \to \infty$ and $\theta = 0$, we have $y \to -\infty$. The total result is that the light omitted by the star located at position $(-\infty,\ -\infty)$ moves round the solar surface and reaches the observer located at position $(\infty,\ -\infty)$. The deflection angle is 180 degree, rather then 1.75". It indicates the absurdity of solution (65).

3. There are two reasons to cause this result.

I）As indicated before, the revised item of general relativity in (2) is not a small one. We can not take approximation calculation as we do in (63)

II）It can be proved that the solution of (2) can not be written as the form of (65). Let $u = u_0 + u_1$ and substitute it in (2), we get

$$\frac{d^2u_0}{d\theta^2} + u_0 + \frac{d^2u_1}{d\theta^2} + u_1 = \frac{3\alpha}{2}(u_0^2 + 2u_0u_1 + u_1^2) \tag{70}$$

By considering (61), we obtain

$$\frac{d^2u_1}{d\theta^2} + u_1 = \frac{3\alpha}{2}(u_0^2 + 2u_0u_1 + u_1^2) \tag{71}$$

By considering (73), we have $2u_0u_1 + u_1^2 = 0$ or $u_1 = -2u_0$. Therefore, we get

$$u = u_0 + u_1 = -u_0 \tag{72}$$

Substituting it in (2), we get

$$\frac{d^2u_0}{d\theta^2} + u_0 = -\frac{3\alpha}{2}u_0^2 \tag{73}$$

However, (73) contradicts with (61), unless $u_0 = 0$ and $u = 0$. That is to say, if the motion equation (2) has a solution with the form $u = u_0 + u_1$, and the solution also satisfies (61) simultaneously, the equation has no solution actually.

4. It is normal to use approximate method in physics. But the result should be exclusive without contradiction. The reason to cause contradiction in this problem is that the motion equation (2) is non-linear. But the solution (65) is the linear superposition of two special solutions. However, as we know in mathematics, the linear superposition of solutions is effective only for linear equation, invalid for non-linear equation. So (65) is not the solution of (2). The calculation of general relativity on the light's deflection in the solar gravity field is untenable. For this problem, general relativity hits the mark by a fluke.

There are other calculating methods for light's deflection in the solar gravity field [4] [5]. All of them put the poles of orbits on the solar surface, so all of them are invalid. We do not discuss them again here.

4. The problem in the calculation of radar wave's delay

4. 1 The correct calculation of radar wave's delay

In the calculation of general relativity on the radar wave's delay between the earth and Mercury, the orbit pole of light was assumed on the surface of the sun. But this is impossible as discussed above. Suppose that radar wave propagates between the earth and Mercury, the distance between the sun and the earth is $r_e = 1.50\times10^{11}$ m, the distance between the sun and Mercury is $r_p = 5.55\times10^{10}$ m. According to (32), the pole of orbit would be located at the point $r_2 = 2.11\times10^4$ m. Substituting r_2 for R in (5), we get [1]

$$\Delta t \approx \frac{4GM}{c^3}\left(\ln\frac{4r_e r_p}{r_2^2}+1\right) = 6.21\times10^{-4}\,\text{s} \qquad (73)$$

(73) is 2.58 times more than (5). More important is that the radar waves would enter the sun inner and can not be dedicated practically.

4. 2 The inconsistence between two motion equations of general relativity

There are two equations for light's motion in gravity field. One is unrelated to time

$$\frac{d^2u}{d\theta^2} + u = \frac{3}{2}\alpha u^2 \qquad (74)$$

Another is related to time as shown in (4)

$$\frac{1}{2}m_0\left[\left(\frac{dr}{dt}\right)^2 + r^2\left(\frac{d\theta}{dt}\right)^2\right] + \frac{2GMm_0}{r}\left[1-\frac{\alpha}{r}-\frac{L^2}{2K^2c^2r^2}\left(1-\frac{\alpha}{r}\right)^2\right] = \frac{1}{2}m_0c^2 \qquad (75)$$

Comparing with the energy conservation formula of Newtonian theory of gravity, (75) describes the motion equation of hyperbolic curve. The differences are that photon is acted by repulsive force and the gravity mass is represent by following formula

$$m_g = m_0\left[1-\frac{\alpha}{r}-\frac{L^2}{2K^2c^2r^2}\left(1-\frac{\alpha}{r}\right)^2\right] \qquad (76)$$

In the weak field of the solar system, we have $\alpha / r << 1$. When light passes through the solar surface, nearby the pole of orbit, we take $L = VR$, $V \approx c$, $r \approx R$ and $K^2 = 1$. From (76), we get $m_g \approx m_0 / 2$. (75) becomes (only nearby the pole)

$$\frac{1}{2} m_0 \left[\left(\frac{dr}{dt} \right)^2 + r^2 \left(\frac{d\theta}{dt} \right)^2 \right] + \frac{GMm_0}{r} = \frac{1}{2} m_0 c^2 \tag{77}$$

The formula becomes the same as that in the Newtonian theory of gravity, except that light is acted by repulsive force. So (75) can be considered as the high order approximation of the Newtonian theory.

However, as discussed before, (74) is completely different from the Newtonian theory of gravity. It is not the high order approximation of the Newtonian theory. This point can be seen clearly in the calculation of radar wave's delay based on general relativity.

As shown in Fig. 5, suppose that there are two detectors of radar waves located at points r_1 and r_2 nearing the solar surface. If the sun does not exist, the radar wave will move along the transverse line. When the sun exists, according to (77), radar wave moves along the approximate hyperbolic curve L_1 which is very close to the transverse line.

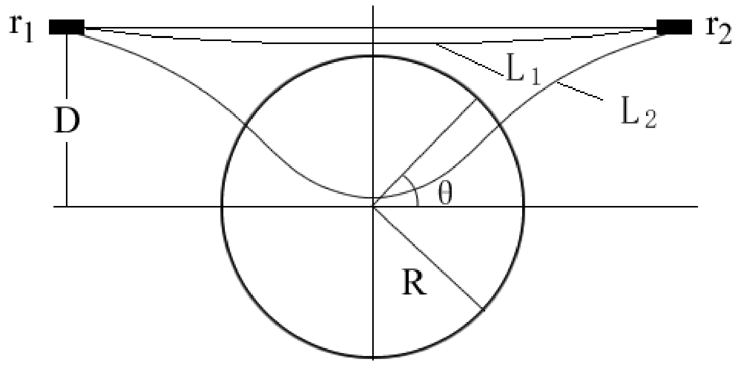

Fig. 5 the delay of radar wave in the solar system

If using (74) to do calculation, the result is shown in curve L_2. Light would enter the solar center. The orbit is not hyperbolic curve again. Motion equations (75) and (76) are completely inconsistent. Let's analyses the reason below.

4. 3 The reason that two motion equations are inconsistent.

General relativity uses the concept of curved space-time to represent gravity and the geodesic equation to describe the particle's motion in gravitational field. The geodesic between two points in curved space is unique, having nothing to do with what particle moves along it. That is to say, no matter what particle's masses are, they always move along the same geodesic.

In general relativity, the Schwarzschild metric is used to describe the solar gravity field. By solving the Einstein's equation of gravity, the geodesic equations are obtained. By eliminating arbitrary variation parameter in the set of geodesic equations, following two equations are obtained strictly [2].

$$\frac{d^2u}{d\varphi^2} + u = \frac{GME}{L^2} + \frac{3\alpha}{2} u^2 \tag{78}$$

$$\left(\frac{dr}{dt}\right)^2+r^2\left(\frac{d\varphi}{dt}\right)^2=c^2\left(1-\frac{E}{K^2}\right)+\left(\frac{3E}{K^2}-2\right)\frac{2GM}{r}$$

$$+c^2\left(1-\frac{3E}{K^2}\right)\frac{\alpha^2}{r^2}+\frac{\alpha c^2 J^2}{K^2 r^3}\left(1-\frac{\alpha}{r}\right)^2-\frac{E}{K^2}\frac{\alpha^3}{r^3} \qquad (79)$$

Comparing (79) with the energy conservation formula of Newtonian theory, we know that the parameter in the front of potential energy item $2GM/r$ should be 1, i.e., $3E/K^2-2=1$, or $E/K^2=1$. By comparing (78) with the Newtonian formula (59), we have $E=1$ and $K^2=1$. So (121) and (122) become

$$\frac{d^2u}{d\varphi^2}+u=\frac{GM}{L^2}+\frac{3\alpha}{2}u^2 \qquad (80)$$

$$\left(\frac{dr}{dt}\right)^2+r^2\left(\frac{d\varphi}{dt}\right)^2=\frac{2GM}{r}+\frac{2c\alpha^2}{r^2}+\frac{\alpha L^2}{r^3}\left(1-\frac{\alpha}{r}\right)^2 \qquad (81)$$

There is no constant item on the right side of (81), so it only describes the orbit of parabola (approximate one), rather then ellipse or hyperbole. Because (80) can also describe parabola, (80) and (81) are consistent in physics and mathematics. For the particle with mass, or the planet in the solar system, the problem of general relativity is that (81) can only describe parabola, can not describe ellipse and hyperbola.

According to Riemann geometry, the geodesic equation has nothing to do with whether or not practical has mass when it moves along the geodesic. So the geodesic of light should also be represented by (80) and (81). However, general relativity did not obey this principle. General relativity takes $E=0$ (rather than $E=1$) in (78) and (79) , to get (74) and (75) for the motion of light. In this way, (74) is not the high order revision of hyperbola but (75) is still the high order revision of hyperbola. The contradiction is caused to lead to the great difference between two curves L_1 and L_2 in Fig. 5.

Strictly obeying Riemann geometry and general relativity, light's motion in the solar gravity field should also be described by (80) and (81). However, (81) describe the orbit of parabola. Based on it, we can neither obtain the deflection formula (3) nor the formula of time (5). Therefore, general relativity has not explain the light's motion in the solar gravity field really.

Reference

1. Hong Baoling, Liu Xuecheng，Liu Mingcheng, General Relativity, Jilin Science and Technology Publishing House, 1995，p. 112.
2. Mei Xiaochun, Yuping, The Strict Proof that General Relativity can not Describe the Ellipse Orbits of Planets in the Solar System, Prontier Science, 2016, 2, p. 75 ~ 79.
3. Mei Xiaochun, The strict proof that general relativity can not correctly describe the light's motion in the solar system, Prontier Science, 2016, 4, p. 69 ~ 87.