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The Measurements of Light's Gravity Deflection of General Relativity were Invalid

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

There were two kinds of measurements of gravity deflection of light in general relativity. One was to measure the visible light's deflection of stars during solar eclipses, and another was to measure the radio wave deflection of quasars. This paper revealed that these measurements had not verified the deflection value 1.75"predicted by general relativity actually. The reasons are as below. 1. All these measurements had not actually took into account the effects of the refraction index of atmospheric matter and the corona of the solar surface on the deflected light. 2. The measurements of visible light's deflection were inaccurate and the obtained data had very large dispersion 3. The deviation caused by the fluctuation and refraction of the atmosphere on the earth's surface is not considered enough 4. The complex statistical methods such as the least square method and various parameters fitting were used to make the measured data consistent with the predictions of Einstein's theory, instead of directly observing the prediction values of Einstein's theory. 5. For the interference measurements of radio waves, the relative observation methods were used rather than the direct

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observation method, and interpretation of measurement results depended on theoretical models. In fact, astronomers tend to assume in advance that Einstein's theory was true, then by introducing a series of parameters to fit the measurements, so that the measurements always meet the Einstein's predictions. According to this method, a set of parameters can also be found to fit the measurement data so that the deflection of light can also satisfy the prediction of Newtonian gravity. The results are not unique. The conclusion of this paper is that the measurements of light's gravity deflection of general relativity were invalid. In fact, according to the authors' published paper, general relativity did not predict that light in the solar gravitational field would be deflated by twice as much as the prediction of the Newton's theory of gravity. How could the observations detect such deflection?

Keywords: General relativity; Newtonian theory of gravity; gravitational deflection of light; radio astronomy; solar atmosphere; corona; least square method.

1. INTRODUCTION

Recently, Mei Xiaochun published a paper to reveal that there were serious problems in the constant terms of the motion equations of planets and light of general relativity [1]. Strictly following the Schwarzschild metric and the geodesics of Riemann geometry, it was proved that the constant term in the time-dependent equation of planetary motion of general relativity must be equal to zero. Therefore, general relativity can only describe the parabolic orbit of celestial body (with a minor modification). It cannot describe the elliptic orbit and the hyperbolic orbit of celestial bodies. It becomes meaningless using general relativity to calculate the precession of Mercury's perihelion.

In contrast, a constant term is missing in the motion equation of light which results in serious mistake. When the high order correction term of general relativity does not exist, light travels in a straight line in a spherically symmetric gravitational field. This is completely impossible. The reason is that Einstein assumed that the motion of light satisfied $ds = 0$, which led to the absence of constant term and destroyed the uniqueness of geodesic.

If this constant term exists in the equation of light in general relativity, the deflection angle of light in the solar gravitational field cannot be $1.75''$. It can only be a small correction of the prediction value $0.875''$ of the Newton's theory of gravity with a magnitude order of 10^{-5}. At the same time, light is affected by the repulsive force in the solar gravitational field, and the direction of deflection is opposite to that predicted by general relativity and the Newtonian theory of gravity. When observing on the Earth, the wavelength of light emitted by the sun becomes purple shift, rather than red shift. This result is not true [1].

So general relativity had not predicted the deflection angle $1.75''$ of light in the solar gravitational field. Over the past century, however, more than a dozen measurements had been conducted on the gravitational deflection of light, all of them declared that the predictions of general relativity were verified. What's going on here? How could astronomers observe what did not actually exist?.

There were two main types of measurements on the gravitational deflection of light. One is the direct measurement during eclipses by telescopes, represented by the measurements of Eddington and Dyson in 1919 [2], and the measurements by Burton F. Jones et al. in the desert oasis of Ethiopian in 1973[3].

The another was the interferometric measurement of radar waves emitted by the quasar when the sun covered the quasars. This method was the indirect measurement. The typical ones were the measurements conducted by G.A. Seiestad, D. O. Muhleman and J. M. Hill in Cambridge, UK in 1972 [4], and the measurements conducted by A. B. Fomalont and R. A. Sramek in the American Radio Observatory from 1973 to 1975 [5].

This paper discusses the problems existing in these two types of measurements. It seems to show Einstein's saying that theory determines what we can see, especially for very small effects such as the corrections of general relativity. All these measurements needed to use the least square method in the final data processing, through parameter fitting, to make the measurement results consistent with the theoretical prediction. In fact, if a different set of parameters were chosen for fitting, the measurement results would also agree with the prediction value of the Newton's theory of gravity. It means that the results are unique.

By carefully analyzing the Eddington's paper published in 1920, the author finds that the errors in the Eddington's measurements were on the same order of magnitude as those predicted by general relativity. So it was useless to test general relativity with such precision measurements.

In addition, in the 35 photographs taken by two groups during the expedition, only nine were deemed usable and 24 were abandoned. Of the seven available photographs in the Eddington's paper, three showed the light bent in the opposite direction of gravity and four bent in the direction of gravity. Eddington had to use incorrect statistical method to erase the effects bent in the opposite direction of gravity. So Eddington's measurements were in fact fluctuations, and did not prove the predictions of general relativity at all.

The measurements provided in Eddington's paper had no margin of error, and the error magnitude of the measurements of the star’s coordinates was on the same order of magnitude of the gravitational effects of general relativity. Eddington did not take into account the influence of temperature on the thermal expansion and the cool contraction of photograph, did not considered the refraction of light caused by the presence of atmosphere on the solar surface, did not considered the effect of the abrupt drop of the temperature of the earth's atmosphere in the area of solar eclipse.

In view of the difficulty of using optical telescopes to observe gravitational deflection, radio telescopes had been used to make measurements since the 1970s. By using radio interference, this kind of measurement were relative observations, rather than direct observations. The interpretation of the measurement results depended on the theoretical model. Astronomers in fact tended to assume that Einstein's theory was true in advance, by introducing a series of parameters to fit the measurements to meet the Einstein's theoretical predictions. In fact, in this way, we can also find a set of parameters and make the measurement results consistent with the predictions of Newtonian gravity.

Therefore, the conclusion of this paper is that the measurements to verify general relativity on the gravity flection of light in the solar gravitational field is actually invalid.

The phenomenon of gravitational ring and gravitational lens observed in astronomy is actually only the result of the Newtonian gravity. We should use the Newtonian formula of gravity, rather than the formula of general relativity, to do calculations.

1.1 Eddington's Measurements during the Solar Eclipse in 1919

A total solar eclipse was predicted to be visible from some parts of the southern hemisphere on May 29, 1919. The British Astronomical Society sent two expeditions to observe. One team, led by C. Davidson, went to Sobral, off the northeast coast of Brazil, in South America. The other team, led by A. S. Eddington, set out to observe on the Principe Island in the Gulf of Guinea in western Africa.

Davidson’s expedition used two telescopes. One was astrocamera to have an eyepiece of Greenwich Space Telescope with a diameter of 33 cm (16 inches) and a focal length of 4.43 m. Another was a refraction telescope with a 10-centimeter (4-inch) eyepiece and a focal length of 19 feet and 4 inches. The small telescope had been used as a backup, but curiously, 19 pictures which were taken by astrocamera were deemed unusable, and only seven pictures that were taken with the four-inch telescope were used at last.

Eddington’s expedition used an astrocamera to have the eyepieces of Oxford telescope, with a diameter of 33 centimeters and a focal length of 4.43 meters. 16 photos were taken. Eddington decided that two of them were available, and the other fourteen were discarded. Using these two pictures for analyses, Eddington came up with a deflection angle of 1.61”, roughly consistent with the Einstein's prediction.

1.2 The Measurements in Sobral

Fig.1 was drawn from Eddington's paper, showed the positions of 11 stars near the sun during the eclipse [2]. The circle at the center represented the size of the sun. In the circle，P -- S line represented the direction that the moon sweep over the solar surface.

The square was the exposure plate of astrocamera with an area of 13 by 13 inches. The rectangle was the exposure plate of small astronomical telescope. Star 1 was thought to be too close to the sun to be seen, with its light obscured by the corona. The data from Stars 7, 8, 12 and 13 were considered unavailable, so only the data observed from Stars 2, 3, 4, 5, 6, 10 and 11 were used.

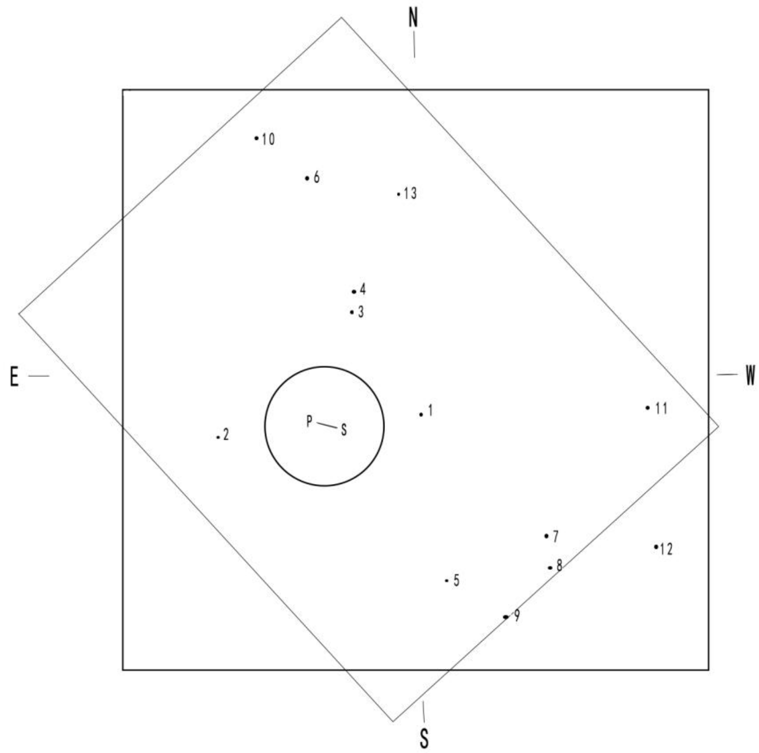

Fig. 1. The solar position in space during the eclipse in Eddington's measurements

Fig. 2 came from Table 1 of Eddington's original paper and showed the coordinates of seven stars in the telescope picture in a non-eclipse time. The origin of coordinate system was the solar center, and the coordinate unit of stars is 50 minutes. For Star 1, $x = +0.026$, $y = -0.200$. By times $50'$, they were $x = +1.3' = +78''$, $y = -10' = -600''$. The right hand sides were the prediction values of general relativity for the flection of light for each star with a unit of second along the x and y axes. Sobral column was the predicted values for the observation point at Sobral, and Principe column was the predicted values for the observation point at Principe.

For convenience, Fig. 2 took into account the ratio r/r_0 in the calculation, where r_0 was the radius of the sun, and r was the distance from the star to the solar center. It was equivalent to having converted all the stars to the solar surface for the deviation values predicted by general relativity.

Fig. 3 came from Table 2 of Eddington's original paper and showed the light's deviations of 13 stars observed in Sobral. I, II, III, IV, V, VII, VIII were the numbers of seven exposure plates. Dx and Dy were the angular deviations of light relative to the directions of x and y axes. The unite is second.

To do this, a set of data about the positions of stars during the solar eclipse were measured, called as the eclipse plate data. A few months after the solar eclipse, the team went back to the spot and took a set of data, called the comparison plate data. The data was photographed through glass during the solar eclipse, known as the scalar plate data. The values of the eclipse plate and the comparison plate were compared with the values of the scalar plate, the deviation values were obtained as shown in Fig.3 (Eddington did not provide the data of Star 1 in the paper).

The angle deviations of each star on each eclipse plate are discussed below. The data of Stars 2, 3, 4, and 5 in Fig.3 are rearranged and shown in Fig. 4 . The situations of Stars 6, 10 and 11 are basically the same [3], so they are not included in Fig. 4

No.	Names.	Photog Mag.	Co-ordinates Unit=50'		Gravitational displacement.			
					Sobral.		Principe.	
			x.	y.	x.	y.	x.	y.
		m.			"	"	"	"
1	B.D.,21°, 641	7.0	+0.026	-0.200	-1.31	+0.20	-1.04	+0.09
2	Piazzi, IV, 82	5.8	+1.079	-0.328	+0.85	-0.09	+1.02	-0.16
3	κ^2 Tauri	5.5	+0.348	+0.360	-0.12	+0.87	-0.28	+0.81
4	κ^1 Tauri	4.5	+0.334	+0.472	-0.10	+0.73	-0.21	+0.07
5	Piazzi, IV, 61	6.0	-0.160	-1.107	-0.31	-0.43	-0.31	-0.38
6	ν Tauri	4.5	+0.587	+1.099	+0.04	+0.40	+0.01	+0.41
7	B.D.,21°, 741	7.0	-0.707	-0.864	-0.38	-0.20	-0.35	-0.17
8	B.D.,21°, 740	7.0	-0.727	-1.040	-0.33	-0.22	-0.29	-0.20
9	Piazzi, IV, 53	7.0	-0.483	-1.303	-0.26	-0.30	-0.26	-0.27
10	72Tauri	5.5	+0.860	+1.321	+0.09	+0.32	+0.07	+0.34
11	66Tauri	5.5	-1.261	-0.160	-0.32	+0.02	-0.30	+0.01
12	53Tauri	5.5	-1.331	-0.918	-0.28	-0.10	-0.26	-0.09
13	B.D.,21°, 686	8.0	+0.089	+1.007	-0.17	-0.40	-0.14	+0.39

Fig. 2. The deviation angles between the stellar coordinates observed in Eddington's expedition and the theoretical values predicted by general relativity

No. of Star.	I.		II.		III.		IV.		V.		VII.		VIII.	
	Dx.	Dy.	Dx.	Dy.	Dx.	Dy.	Dx.	Dy.	Dx.	Dy.	Dx.	Dy.	Dx.	Dy.
	r	r	r	r	r	r	r	r	r	r	r	r	r	r
11	-1.411	-0.554	-1.416	-1.324	+0.592	+0.956	+0.563	+1.238	+0.406	+0.970	-1.456	+0.964	-1.285	-1.195
5	-1.048	-0.338	-1.221	-1.312	+0.756	+0.843	+0.683	+1.226	+0.468	+0.861	-1.267	+0.777	-1.152	-1.332
4	-1.216	+0.114	-1.054	-0.944	+0.979	+1.172	+0.849	+1.524	+0.721	+1.167	-1.028	+1.142	-0.927	-0.930
3	-1.237	+0.150	-1.079	-0.862	+0.958	+1.244	+0.861	+1.587	+0.733	+1.234	-1.010	+1.185	-0.897	-0.894
6	-1.342	+0.124	-1.012	-0.932	+1.052	+1.197	+0.894	+1.564	+0.789	+1.130	-0.888	+1.125	-0.838	-0.937
10	-1.289	+0.205	-0.999	-0.948	+1.157	+1.211	+0.934	+1.522	+0.864	+1.119	-1.820	+1.072	-0.768	-0.964
2	-0.789	+0.109	-0.733	-1.019	+1.256	+0.924	+1.177	+1.373	+0.995	+0.935	-0.768	+0.892	-0.585	-1.166

Fig. 3. The angular deviations of light from seven stars observed in Sobral

	$Dx(2)$	$Dy(2)$	$Dx(3)$	$Dy(3)$	$Dx(4)$	$Dy(4)$	$Dx(5)$	$Dy(5)$
I	-0.789	0.109	-1.237	0.150	-1.216	0.114	-1.048	-0.338
II	-0.733	-1.019	-1.079	-0.862	-1.054	-0.944	-1.221	-1.312
III	1.256	0.924	0.958	1.244	0.979	1.172	0.756	0.843
IV	1.177	1.373	0.861	1.587	0.849	1.154	0.683	1.226
V	0.995	0.935	0.733	1.234	0.721	1.167	0.486	0.861
VII	-0.768	0.892	-1.010	1.185	-1.028	1.142	-1.267	0.777
VIII	-0.585	-1.166	-0.897	-0.894	-0.929	-0.930	-1.152	-1.332

Fig. 4. The angle deviations of Stars 2, 3, 4, 5 on the different eclipse plates

Let's consider Star 2. On the four eclipse plates I, II, VII and VIII, the angle deviations $Dx(2)$ are negative values. But they are positive values on the three plates III, IV, and V. Since Star 2 was located on the left side of the Sun, $Dx(2)$ with a positive value indicating gravitational attractive force and a negative value indicating repulsive force, so theses seven measurement values are contradictory. Then we consider $Dy(2)$. They are positive values on the eclipse plates I, III, IV, V and VII, and negative values on the eclipse plates II and VIII. The results are also contradictory.

Compared with the theoretical prediction value in Fig. 2, and let the theoretical prediction values of deviations are $D'x(2)$ and $D'y(2)$. For Star 2, we have $D'x(2)=0.85$, $D'y(2)=-0.09$. It can be seen that half of the measurement values on the eclipse plate are in the wrong directions. Especially for $Dy(2)$ and $Dy'(2)$, the differences are very large. The absolute values $Dy(2)$ of six plates are around $\pm 1''$, ten times of $D'y(2)$. How can we say that the predictions of general relativity have been confirmed with such huge errors and wrong directions?.

Adding up the values Dx of seven eclipse plates and dividing it by 7, we get the arithmetic mean value $\overline{Dx}=0.079$. Adding up the values Dy of seven eclipse plates and dividing it by 7, you get the arithmetic mean value $\overline{Dy}=0.301$. It is impossible to get 0.85 and -0.09. For Star 2, Eddington's measurements were actually random fluctuations. It can not be either a gravitational deflection $1.75''$ of general relativity or a gravitational deflection $0.85''$ of Newtonian theory of gravity.

Looking at Star 5 again. Four Dx out of the seven eclipse plates are negative and three Dx are positive. Three Dy of them are negative, and four Dy are positive. They contradicts each other. In fact, for all 11 stars, that are always the case. The measurement results are contradictory and statistically insignificant. In fact, it does not even explain the qualitative problem of light's gravity deflection, much less quantitative problem.

So how did Eddington derive from these data and got the conclusion that the predictions of general relativity had been confirmed? He used a statistical method called the least square method, to adjust the parameters and turn the data into the evidence meting with general relativity. What Eddington did was, for each star, to set [3].

$$Dx=ax+by+c+\alpha E_x \quad Dy=dx+ey+f+\alpha E_y \qquad (1)$$

Where the values of Dx and Dy are shown in Fig.3, and a,b,c,d,e,f are the undetermined parameters, which are related to the properties of the glass scale plate added to the astronomical telescope, the refractive index of the glass plate, the aberration and direction angle. α is defined as the angular deviation caused by the effect of general relativity, E_x and E_y represent the directions of $x-$ axis and $y-$ axis, αE_x and αE_y represent the angular deviations predicted by general relativity in the direction of $x-$axis and $y-$axis.

Based on Eq.(1), Eddington choose the parameters a,b,c,d,e,f without any rational explanation, and used the least square method to do calculations and obtained the result that the deflection angle of the star's light passing through the sun's surface is $\alpha=1.98''\pm 0.12''$. Obviously this is not the result of actual measurement of each star. It is fitted out by using random fluctuation data and the least square method and is actually meaningless.

The essence of this calculation is presuming that Einstein's prediction is correct and looking for a set of parameters that make Eq. (1) true for each star, thus producing a uniform set of data. As for whether the values of parameters are really consistent with the nature of scale glass plates, it is not considered. In fact, following this method, as long as taking other proper values for the parameters a,b,c,d,e,f , we can match any deflection angle, including the result $\alpha=0.87''$ of the Newtonian theory of gravity and use it to deny general relativity.

1.3 The Measurements on Principe Island

Eddington's measurements on Principe is land were a virtual failure. Of the 16 eclipse photos taken, only two were considered usable, called the X and W plates. A few months before that time, Eddington had also taken several pictures of the eclipse area at the Oxford Observatory, called Check Plates, showing the pictures of the stars in the region far away from the sun, and used them to compare with the pictures of the eclipse. According to the Eddington paper, the reason was that on Princeton island, where the eclipse took place in the afternoon, it would take many months to photograph the eclipse field in the same position before dawn.

Eddington's data was processed using a different metric. In Fig.5 and Fig.6, the first column was the number of stars. In the measurements, only five of the stars were considered valid. The unit of x and y was 5 millimeters, corresponding to about 5' . The unit of Δx and Δy is $0.003''$. The converted Δx and Δy were placed in the parentheses. The comparison results between X plate and Oxford plates G1 and H1 were shown in Fig.5 and Fig.6 [3].

Obviously, the deflections of all stellar light in the X plate were negative compared with the Oxford G1 plate, but they were all positive compared with the Oxford G2 platen, which was contradictory to each other, so the measurement results were meaningless. In addition, most Δx and Δy were much larger than 1.75 ", even more than 10 times. This might explain why Eddington had to use a different standard for the same paper to describe the deflections, and multiplied by a factor of 0.003 to obscure the results.

The comparison results of W plate with Oxford plate were the same as shown in Fig. 7 and Fig.8. The comparing with Oxford plate D1, all Δy rare positive, but compared with Oxford plate I2 , all Δy were negative. The results contradicted each other too. And the deflections in all directions were much more than 1.75 ", even more than 10 times.

No.	x	y	Δ x	Δ y
3	17.48	17.60	-2924 ($-8.77''$)	4236 ($12.71''$)
4	17.34	18.72	-2869 ($-8.61''$)	4512 ($13.54''$)
5	12.40	2.93	-5518 ($-16.55''$)	4121 ($12.36''$)
6	19.87	24.99	-1568 ($-4.70''$)	4148 ($12.44''$)
11	1.39	12.40	-3916 ($-1.75''$)	6398 ($19.19''$)

Fig.5 The comparison of X plate with Oxford plate G1

No.	x	y	Δ x	Δ y
3	17.48	17.60	7320 ($21.96''$)	1785 ($5.36''$)
4	17.34	18.72	7126 ($21.38''$)	1881 ($5.65''$)
5	12.40	2.93	6751 ($20.25''$)	858 ($2.57''$)
6	19.87	24.99	7429 ($22.29''$)	1909 ($5.73''$)
11	1.39	12.40	7290 ($21.87''$)	1586 ($4.98''$)

Fig. 6. The comparison of X plate with Oxford plate H1

No.	x	y	Δx	Δy
3	17.48	17.76	3834 ($11.50''$)	5911 ($17.73''$)
4	17.34	18.72	3948 ($11.84''$)	5745 ($17.24''$)
5	12.40	2.93	2450 ($7.35''$)	5320 ($15.96''$)
6	19.87	24.99	4525 ($13.58''$)	5628 ($16.89''$)
10	1.39	12.40	5199 ($15.60''$)	5616 ($16.85''$)

Fig. 7. Comparison of W plate with Oxford plate D1

No.	x	y	Δx	Δy
3	17.48	17.60	4622 $(13.87'')$	-5609 $(-17.73'')$
4	17.34	18.72	4732 $(14.20'')$	-5751 $(-17.25'')$
5	12.40	2.93	5050 $(11.15'')$	-6824 $(-20.47'')$
6	19.87	24.99	4635 $(13.91'')$	-5425 $(-16.28'')$
10	22.60	27.21	4764 $(14.29'')$	-5109 $(-15.32'')$

Fig. 8. Comparison of W plate with Oxford plate I2

Evidently, Eddington's measurements on Princeton island deviated far from the predictions of general relativity, even larger than measurements in Sobral. In order to make the measurements on Princeton island meaningful, Eddington also applied the least square method, by using Equation (1) to do calculation and by selecting parameters a, b, c, d, e, f , resulted in the angle $1.61'' \pm 0.30''$ for the deflection of starlight on the sun's surface. Eddington's measurements on Princeton island were therefore meaningless and could not be used to prove general relativity.

1.4 The other Problems in Eddington's Measurements

1.4.1 Refraction of gas and corona on the surface of the sun

The refraction of gas on the surface of the sun has a great influence on the deflection of light, which is an important cause to cause the error in Eddington's measurements. As we all know, the sun is a ball of plasma gas with intense nuclear reactions inside, constantly emitting light and plasma gas. This is completely different from the earth. The earth does not emit matter into outer space; the gas on its surface is balanced by gravitational constraints. The sun, on the other hand, is a dynamic system, with frequent large eruptions and a corona that can extend several solar radii beyond. The so-called solar wind can even affect the earth as far as 500 million kilometers away, causing disruption to the earth's communications systems.

The sun has a radius of 6.96×10^5 kilometers. Mercury is about 554.60×10^5 kilometers away from the sun, which is about 80 times the radius of the sun, and Earth is about 240 times the radius of the sun. From Mercury's extreme environment, we can imagine how badly it would be affected by material emitted from the sun's surface. The pressure and density of gas on the solar surface are poorly understood. While there are theoretical models, there are no actual measurements. We can't compare the gas on the surface of the earth to the gas on the surface of the sun.

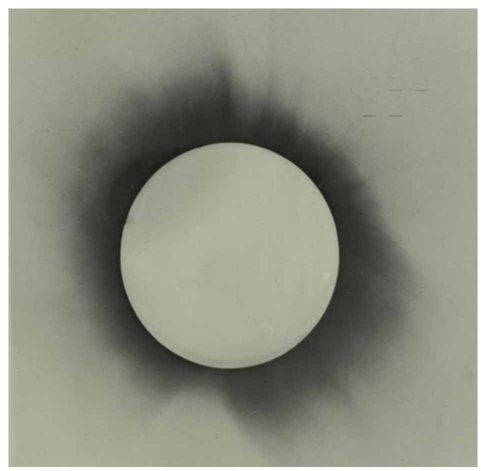

Fig. 9 The photograph of corona taken by Eddington

Eddington was clearly aware of the influence of the refraction of gas on the solar surface to the deflection of light, but he completely ignored this effect in his paper. He said [3]:

In order to produce the observed effect by refraction, the sun must be surrounded by material of refractive index $1 + 0.00000414/r$, where r is the distance from the centre in terms of the sun’s radius. At a height of one radius above the surface the necessary refractive index $1 + 0.00000212$ corresponds to that of air at $1/140$ atmosphere, hydrogen at $1/60$ atmosphere, or helium at $1/20$ atmospheric pressure. Clearly a density of this order is out of the question.We know that the index of refraction of vacuum is 1.The index of refraction of the atmosphere on the surface of the earth is 1.00029 at a standard state with the temperature of zero and one atmosphere pressure. According to the distribution formula of atmospheric pressure with height, atmospheric pressure is equivalent to the height of 40000 meters on the earth's surface, which is very thin. The problem is that the atmosphere on the surface of the sun is not in equilibrium. The sun constantly emits light and particle streams all the time, so it is impossible to describe the density distribution of the solar atmosphere with the theory of equilibrium state on the earth's surface.

Fig. 9 was the picture of corona taken by Eddington. The corona was a burst of material from the sun, made up of fast-moving electrons, protons and plasma. It was still very intense in a place beyond several solar radii. In fact, the corona can reach even a dozen solar radii, and its influence can reach the earth in a broad sense.

As shown in Fig.1, Stars 2, 3, and 4 were all within 2 solar radii. Because the corona was too strong, Star 1 could not be observed. In addition to the coronal mass, there was a large amount of gas on the surface of the sun whose density was basically stable, and whose pressure should reach or exceed the $1/140$ pressure of the earth's surface atmosphere. According to current observations, the temperature of corona can reach millions of degrees.

According to the formula $\mathrm{pV} = \mathrm{nRT}$ of ideal gas formula, pressure is proportional to temperature, and the atmospheric pressure on the solar surface can be very high. Under such high temperature conditions, the material moves very fast, and the collision probability increases greatly. The influence of gas on the refractive index of light is unknown. So Eddington's estimate of the pressure on the solar surface was wishful thinking, and we could not rule out the refraction of light by the gas on the solar surface.

1.4.2 The continuous refraction of gases with different densities on the earth's surface

As the atmosphere on the surface of the earth is fairly well understood, we can make some quantitative calculations about the influence of atmospheric refraction on Eddington's experiment. We can consider the earth as a uniform ball of medium composed of air. The refractive index of air against visible light is 1.00029. As shown in Fig. 10, light is emitted from a distance star in parallel. The refraction of light caused by the sphere near the optical axis is calculated by the following formula [6]

$$\frac{n'}{s'} - \frac{n}{s} = \frac{n'-n}{R} \tag{3}$$

Where s' is the image distance, n' is the refractive index of the sphere, s is the object distance, n is the refractive index of the vacuum. Assume that the light rays radiates parallel to the sphere with $s = \infty$, $n = 1$, $n' = 1.00029$. The radius of the earth is $R = 6.378 \times 10^6$ meters, so that:

$$\frac{R}{s'} = \frac{n'-n}{n'} \tag{4}$$

The refraction angle is

$$\sin\alpha \approx \alpha = \mathrm{R/s'} = 2.899 \times 10^{-4}\, arc = 59.83'' \approx 1' \tag{5}$$

The angle of refraction is about 1 minute, which is 35 times the gravitational deflection of general relativity. So in the morning, when the sun is still below ground level, people on the surface of the earth can see the sun 0.067 minutes earlier because the atmosphere refracts the light. But this is based on that the atmosphere is uniformly dense, so light is refracted only once at the interface between the sphere and the vacuum.

However, the actual situation is that the density of the atmosphere is different at different altitudes. The sunlight in the atmosphere is continuously refracted by the interface of different density layers as shown in Fig. 10. In this case，the calculation of refraction becomes very complicated. The actual observed result is that on the Earth's equator, the refractive angle of sunlight in the morning is about 0.5 ~ 0.8 degrees, The sun will be seen about 2 ~ 3 minutes earlier. This angle is 1028 ~1645 times of the gravitational deflection angle of general relativity.

Therefore, the refractive index of the atmosphere on the earth's surface as a uniform distribution of density is much smaller than the actual refractive index with different density. This result also applies to the refraction of the atmosphere on the sun's surface, since the density of gas on the solar surface is also uneven, the result may cause astronomers to seriously underestimate the refraction angle of light.

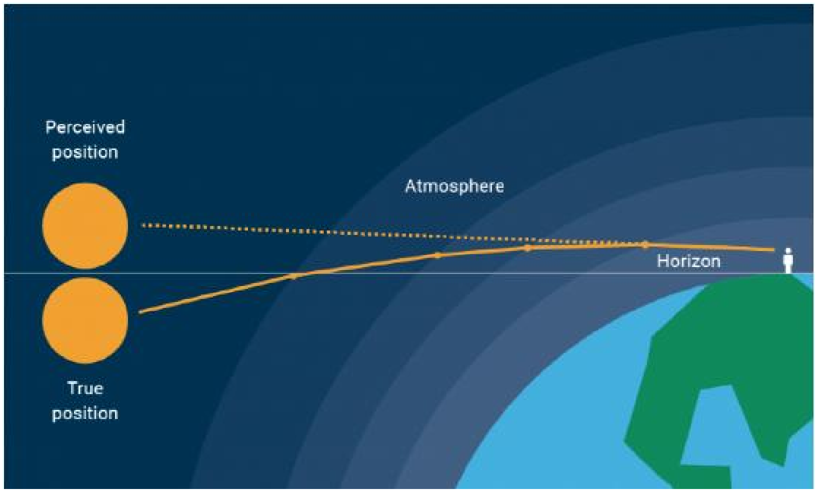

Fig. 10 Continuous refraction of light by the density change of the earth's atmosphere

When the sun is overhead at noon, the angle of refraction of the atmosphere is zero. Assuming that the sun rises at 6:00 a.m. To 12:00 noon, a total of 6 hours, the average refraction angle changes by 5 to 8 seconds per minute. So taking pictures at different times of the day, and at different times on different days, the earth's atmosphere has a different refractive index. This led to systematic errors that were far greater than the gravitational deflection predicted by general relativity. This is a problem that neither Eddington nor subsequent measurements had considered.

Besides, Eddington's measurements had not considered the changes in refractive index caused by changes in density due to atmospheric movement at different times, as well as the changes in refractive index caused by the movement of air currents and the changes in the density caused by the cooling of the atmosphere during an eclipse when the moon hides the sun. These effects, though small, could be on the order of seconds, enough to affect the gravitational refraction value of light.

1.4.3 The errors caused by film thermal expansion and cold shrinkage

In Eddington's measurements, the eclipse plates and the comparison plates were photographed at different times. In Sobral in late May, for example, the average temperature was around 90 Fahrenheit degrees. But when the team returned to Sobral in mid-July to rephotograph the positions of stars in the same sky in the absence of the sun , the average temperature was about 70 Fahrenheit degrees, there was a difference of 20 Fahrenheit degrees. Due to the phenomenon of hot expansion and cold contraction of the film, it lead to the movement of star' position, so that the measurement results appeared deviation. The following calculations show that the deviation is on the same order of magnitude as the gravitational deflection.

We don't know what the coefficient of thermal expansion of Eddington's film was, but suppose that we could substitute it for the coefficient of thermal expansion of optical glass. Given that the coefficient of thermal expansion of glass is 1.1×10^{-5} meters per degree, let the side length of the film be 0.1 meters. The change in side length caused by the temperature change of 20 centigrade degrees is $1.10\times10^{-5}\times0.2\times10=2.2\times10^{-5}$ meters or 0.022 millimeters. So a picture taken at a high temperature will shrink toward the center at a low temperature. The star's position shifts toward the center compared to a cold image, would give the illusion of gravitational deflection.

Fig.11 shown the New York Times report on the Eddington's measurements in 1919. The arrows represented the gravitational displacement of starlight. For the middle Stars 3 and 4, the displacement was about 6 millimeters, and the figure shown that the actual displacement is one 600th of this figure. That was to say, for Stars 3 and 4, the observed gravitational displacement was 0.01 millimeters. Therefore it possible to assume that the gravitational deflection of light measured by Eddington was caused by the thermal expansion and cold contraction of the film.

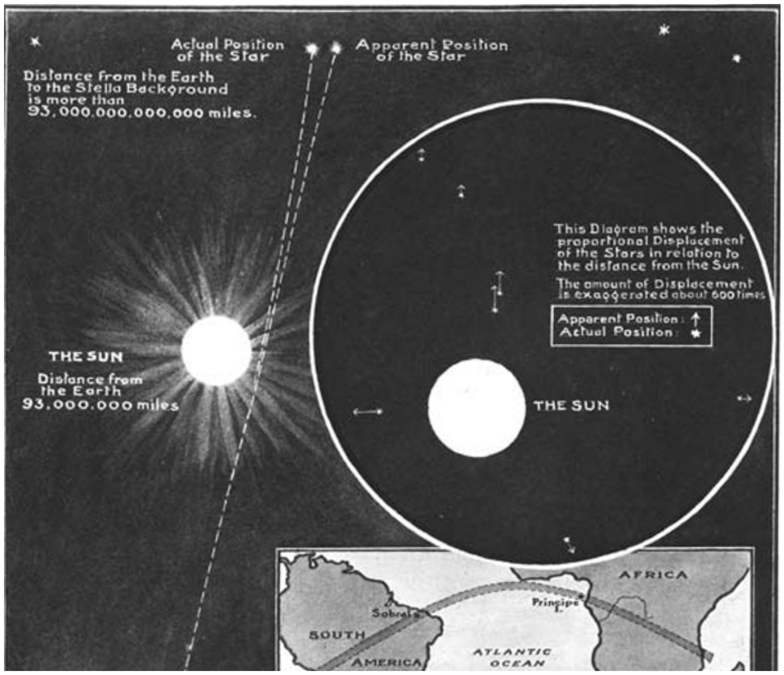

Fig 11. The illustration of New York Times report on Eddington's measurements in 1919

So Eddington's measurements of the deflection of light in the gravitational field of the sun could not tell whether it was an effect of the Newtonian gravity or an effect of general relativistic effect, or even whether the deflection were a gravitational effect.

1.4.4 The time differences between the standard plate and the comparison plate

According to standard method, to determine the deflections of star's lights, the photographs taken during the period of eclipse need to be compared with the picture of the sky when the sun is far from the region. A comparative plates of the starlight should be taken at the same place after six months of the eclipse when the earth moves to other side of its orbit around the sun. But Eddington did not do so. The Sobral's comparative plates was taken between July 12 and 17, 1919, less than two months later than the eclipse plates were taken. The temperatures were different for two measurements.

The Principe's comparative plates had not been taken on the same place. It was taken when Eddington returned to England and used a telescope on the Oxford University Observatory to do it. It indicated the Principe team took the images from different locations, at different temperatures, and in different latitudes. The resulting error is of the same order of magnitude as the correction of general relativity to the Newtonian theory of gravity.

2. THE OBSERVATION IN SOUTH AUSTRALIA IN 1922

On September 21, 1922, G. F. Dodwell and C. R. Davidson made a measurement of the deflection of light during a total solar eclipse in South Australia [7]. Four photographs were taken. The plates I and II contained both the stars in the eclipse field, and the stars in the distance from the sun, that were used for locating the stars in the eclipse field.

The plate IV showed too few stars to produce results. The scale of plate III was different from that of plate I and II, and there were no stars on this plate that can not be used for comparison, so the final result relied only on plates I and II. Three months after the eclipse, the team went back to take five plates of the eclipse area. The scale of comparison plate was determined on these five plates.

There were 14 stars on plates I and II, based on them, Dodwell and Davidson might give the deflection of light from each star on each plate. But they did not provide such detailed data. The data shown in Fig. 12 was taken from the paper published by Dodwell and Davidson [7], the last column of which shown a statistical average of each star in both plates, with the more detailed deviations erased. Why did not Dodwell and Davidson give the deviation of each star in each plate? Could it be as the Eddington expedition's measurements, once providing detailed data for each star in each photograph, would lead to contradictory results?

Dodwell and Davidson also used the least square method to process the data in order to get the results from the measurements to support general relativity. By considering Eq.(1) and adjusting the parameters a,b,c,d,e,f , the deflection angle of $1.77''$ was deduced. For the same reason, the results of Dodwell and Davidson's measurements were dubious.

2.1 The Measurements in the oasis of Chinguetti desert, Mauritania in 1973

Since Davidson and Dodwell, several groups had made the observations of light's deflections at the eclipses [8]. They were Freudlich (May 9, 1929), А. Л. МихайловMў (on July 19, 1936), Biesbroek (May 20, 1947), Biesbroek (February 25, 1952), and Burton, F. Jones (on May 30, 1973). Some of the measurements deviated significantly from the Einstein's predictions, while others deviated less. One of the most accurate observations was made by Burton F. Jones of the University of Texas in the Oasis of Chinguetti Desert in Mauritania at the total solar eclipse of 30 June 1973[9]. Let's talk about this expedition.

Burton F. Jones measured 150 stars in the eclipse field and 60 stars in the comparison field photographed in three plates. Five months after the eclipse, three plates were photographed in the same location . By comparing the six plates and through a series of complex calculations, the observation results were represented by the points shown in Fig.13. Some of the stars considered unqualified had been excluded. The horizontal axis was the distance of the star's light from the center of the sun, and the vertical axis was the angle at which the star's light is deflected.

When processing the observed data, the Burton F. Jones still used the least square method, in which nonlinear equations and multiple iterations were involved, including introducing different weights to various parameters, to obtain the deflection value of each star. So Fig.13 was still not a direct measurement, but a product of complex calculations. These included the correction of annual and diurnal aberrations, as well as the correction of instrumental-induced deviations and refraction of the light system. Changes in temperature, pressure and humidity were also calculated, and there were many conditions that could cause errors did not taken into account.

Stars in the Eclipse Field.

Centre R.A. $11^h\ 50^m\ 40^s$. Dec. $+1°\ 0'$.

Serial No.	B.D. No.	Mag.	Co-ordinates. x. Int.	y. Int.	Gravitational Factor. Ex.	Ey.	Displacement. x.	y.
Sun	°		0·00	0·00			″	″
1	0 2831	7·6	− 13·72	− 6·16	− ·061	− ·027	− ·16	− ·07
2	0 2843	6·5	− 8·00	− 5·04	− ·089	− ·056	− ·23	− ·15
3	3 2560	7·7	− 6·95	+ 9·49	− ·050	+ ·069	− ·13	+ ·18
4	β Virg.	3·7	− 5·77	+ 6.87	− ·072	+ ·085	− ·19	+ ·22
5	− 0 2510	8·0	+ 0·27	− 11·45	+ ·002	− ·087	+ ·01	− ·23
6	4 2544	8·0	+ 0·65	+ 15·12	+ ·003	+ ·066	+ ·01	+ ·17
7	1 2628	8·0	+ 1·05	+ 3·02	+ ·103	+ ·297	+ ·26	+ ·75
8	1 2633	7·7	+ 5·06	+ 1·74	+ ·177	+ ·061	+ ·47	+ ·16
9	1 2636	6·8	+ 6·26	− 0·20	+ ·160	− ·005	+ ·42	− ·01
10	2 2499	7·1	+ 6·74	+ 7·19	+ ·069	+ ·074	+ ·18	+ ·20
11	− 1 2600	7·7	+ 6·99	− 14·15	+ ·028	− ·056	+ ·07	− ·15
12	− 0 2520	6·8	+ 9·07	− 13·29	+ ·035	− ·051	+ ·09	− ·13
13	0 2881	8·3	+ 10·38	− 2·64	+ ·090	− ·023	+ ·24	− ·06
14	2 2509	8·3	+ 13·62	+ 5·12	+ ·064	+ ·024	+ ·17	+ ·06

Fig. 12. The flection data of light during the solar eclipse from Australia in 1922

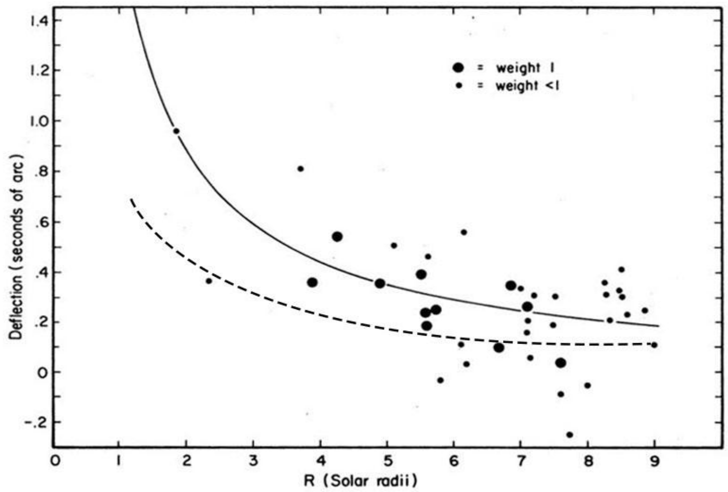

Fig. 13. The measurement results of the group of University of Texas in the oasis of Chinguetti desert, Mauritania in 1973

Based on Fig.13, Burton F. Jones's experimental group finally obtained a deflection angle of 1.75 (0.95 ±0.11) seconds, suggesting that Einstein's prediction was confirmed. The solid line was what Einstein's theory predicted, and the dotted line was what Newtonian gravity predicted. It can be seen from Fig. 13, even if such a complex calculation method was adopted and so many parameter modifications were introduced, the obtained points were still very diffuse with large deviation from the predicted values of general relativity.

And more importantly, the measurement still did not take into account the refraction of light by the atmosphere and corona on the solar surface. If these factors were taken into account, the gravitational deflections of all points would shift down, more consistent with the Newton's theory of gravity. In fact, if we use the different fitting parameters and the least square method, we can also get the result of Newton's gravitational prediction. So Burton F. Jones's measurements did not distinguish between the Newton's theory of gravity and the Einstein's theory of gravity too, and did not confirm the prediction of the Einstein's theory of gravity.

2.2 The Radio wave Deflection Experiments of Light's Deflections

2.2.1 The principles of radio interferometry

Unlike direct observations made by telescopes at visible wavelengths, radio wave measurements observed the radiations of stars at invisible radio wavelengths. By two or more radio telescopes at different locations, the interference waveform generated by the radio waves emitted by celestial bodies can be measured to infer the positions of celestial bodies in space. So it belongs to indirect measurement, which was related to theory modes. That was to say, the positions of radio wave emitter were not directly observed, but calculated theoretically.

The principle of a radio telescope is shown in Fig.14 [5]. Assume that two radio telescopes on the Earth's surface are located at the two ends of the baseline $\overline{B}$ and that the object being observed is located in the direction of $\vec{\sigma}$. the angle between $\overline{B}$ and $\vec{\sigma}$ is θ . Two radio telescopes are connected by conduction wires and the radio signals they receive are transmitted to a data-processing device. Because the radio waves from the celestial bodies don't take the same time to reach the two telescopes, the interference occurs.By analyzing the interference pattern, the position of celestial bodies in space can be inferred.

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The resolution of radio telescope is calculated by the formula $\delta = \lambda / L$, λ is the wavelength of the radio wave, and L is the distance between two radio telescopes. Although the wavelengths of radio waves are much larger than that of visible light, the resolution of a radio telescope can be small because the distance between two telescopes can be very large. The calculation formula of radio astrometry measurement is as follows [5] :

$$R(t) = A\cos\left(\frac{2\pi}{\lambda}\vec{B}\cdot\vec{\sigma} + \varphi(\vec{\sigma},t)\right) \qquad (6)$$

Where, $R(t)$ is called the response caused by the time difference between two radio waves, $\vec{B}$ is the baseline vector, and $\varphi(\vec{\sigma},t)$ is the phase caused by various interference factors. Since the earth is rotating, each physical quantity on the right side of Eq. (6) actually varies with time, and $R(t)$ accordingly varies with time.

Since what is actually measured is the interference response of two radio waves, it involves very complex mathematical calculations to deduce the spatial position of the celestial body from the above formula. The biggest uncertainty of Eq.(6) is the phase generated by various interference factors. How correctly to estimate the phase is the key problem.

2.2.2 The radio wave deflection experiment at Cambridge, England in 1972

The measurements of radio telescope of the gravitational deflection of light do not need to be taken during a solar eclipse, but it needs to look for suitable radio emitting bodies and make observations during the period when the sun is close to and covers the radio emitting bodies. Since the earth is constantly rotating and moving around the sun, the whole measurement process is in a dynamic state, so the determinations of the initial positions of the radio emitting bodies is very important. It is necessary to find two or more radio emitting objects, one is farther away from the sun as a reference for measurement. The other was close to the sun during the measurement, covered by the sun, and then came out of the sun's cover (due to the relative motion of the earth). By comparing the two sets of measurement data, the deflection of radio wave in the solar gravitational field is determined. Since the radio emitting bodies used as the reference was also moving with respect to the earth during this period, such measurement values are relative ones rather than absolutes. The obtained gravitational deflections are also relative values.

In the early 1970s, G.A. Seiestad, D. O. Muhleman and J. M. Hill et al. used radio interference astronomical telescopes to observe the radio sources 3 C 273 and C 279 before and after solar occultation, in an attempt to measure the deflection angle generated by the gravitational field of the sun. Radio source 3 C 273 was far from the sun and was used for calibration. What was actually measured was the deflection of C 279 radio waves. The results showed that the irregular phase deviation caused by the fluctuation of water vapor content in the troposphere limited the accuracy of this method [9].

In Cambridge University in 1972, F. Mriley measured the radio waves of radio source C 279 before and after solar occultation with two radio telescopes 5 kilometers apart. He believed that the phase stability of the instrument was better than 5 degrees per day, and there was no evidence of phase deviation on a short time scale. The errors were small compared to those introduced by the troposphere, and it was therefore not considered necessary to conduct a quick check of the collimation error of the instrument by observing 3C 273. The measured deflection of radio waves caused by the gravitational field of the sun was 1.04 ± 0.08 times as large as predicted by the general theory of relativity, thus it was considered to confirm the general theory of relativity. The experimental results are shown in Fig. 15 [10].

2.2.3 The abscissa is time in days, and the ordinate is deflection angle in seconds

Because radio waves entered the vicinity of the sun and was obscured by the sun, there were no data on Days 7, 8 and 9. One great problem with this measurement was that it also did not take into account the refraction of radio waves by the gas on the sun's surface. In fact, the measurements on 3.5, 4.5, and 10.5 were in the anti-gravitational deflection direction compared to the measurement in other times. This might be caused by the violent fluctuations in the density of the air currents on the sun's surface.

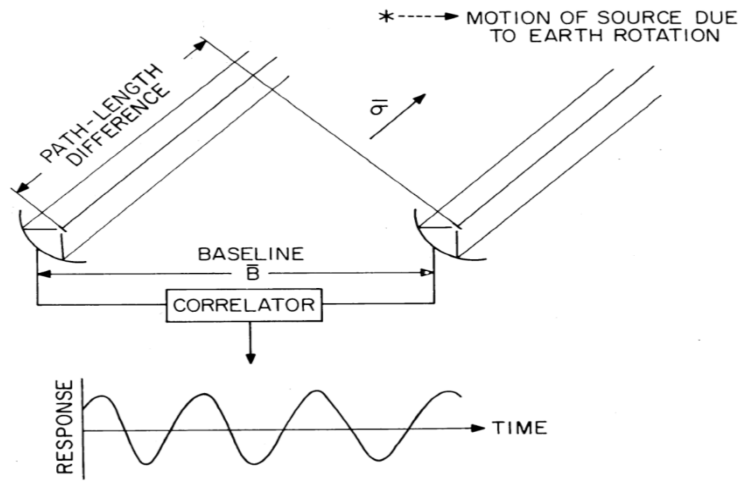

Fig. 14. The schematic diagram of radio astrometry measurement

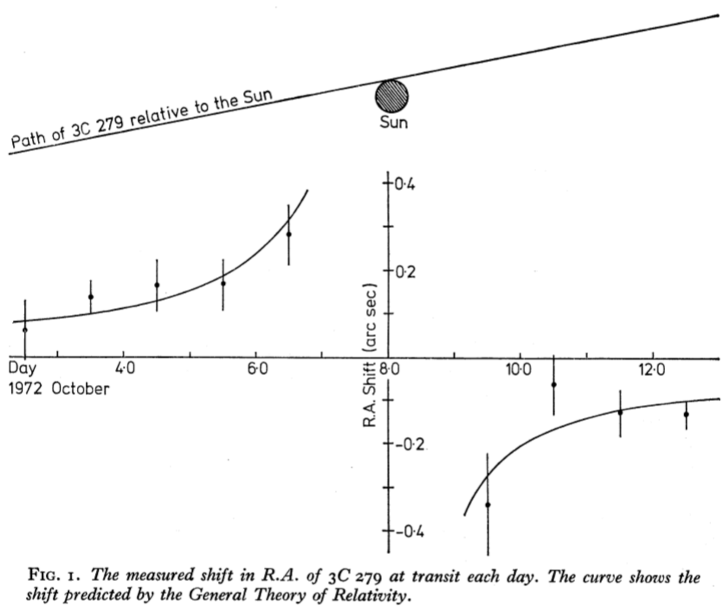

Fig. 15. Interferometer measurements by the Cambridge Radio Telescope, UK, 1972

Besides, the accuracy of the experiment was questionable. The measured radio wavelength was 6 centimeters, and the distance between the two radio telescopes was 76240.6 wavelengths (4574.436 meters). According to the resolution formula of telescope, we have

$$\Delta\theta = \frac{\lambda}{D} = \frac{1}{76240.6} = 1.3116\times10^{-5} = 2.76'' \quad (7)$$

In other words, if we measure two stars in an image with this device, they are indistinguishable from each other when their center point is less than $2.76''$. However, we can see from Fig.15 that the changes of the center position of the radio source are less than $0.1''$ between the abscissa 3.5 and 4.5, 4.5 and 5.5, as well as 11.5 and 12.5,. The error range of measurement each day is also nearby $0.1''$. For a radio telescope with resolution $2.76''$, it is generally impossible to distinguish such a small displacement. When the measurement value and the measurement error are in the same order of magnitude, the measured data has no statistical significance.

2.2.4 The radar wave deflection measurements at the American radio observatory in 1975

The radar wave deflection measurements at the American Radio Observatory in 1975 was not so much an attempt to test the Einstein's theory of gravitational deflection as an attempt to distinguish between the Einstein's theory of gravity and the Brans-Dick's theory of gravity. According to Brans-Dick's scalar tensor theory of gravity, when the light of a star from outer space passes through the edge of the sun, the gravitational deflection was [5]:

$$\Delta\theta = 1.75\left(\frac{1+\gamma}{2}\right)'' \tag{8}$$

The parameter $\gamma = 1$ was the result of Einstein's theory. When $\gamma = (1+\omega)\ /\ (2+\omega) \neq 1$ (ω is a scalar coupling constant) , it is the result of Brans-Dick's theory. The essence of this experiment is to presume in advance that the deflection angle 1.75" predicted by general relativity is basically correct, and then to determine the unknown parameter γ through fitting by using the least square method.

A. B. Fomalont and R. A. Sramek measured three quasars numbered 3C0116 + 08, 3C0119 + 11 and 3C0111+02. From the point of view on the earth, three quasars were almost in a straight line. 3C0119 + 11 and 3C0111+02 were far from the sun and were used as background reference. 3C0116 + 08 passed the edge of the sun and was covered by the sun on April 11, 1974, and reappeared through the edge of the sun on April 12, as shown in Fig. 16 [5].

2.2.5 The x-axis is the radius of the sun, and the y-axis is the phase angle (degrees)

The experiment consisted of two antennas, one telescope with a radius of 85 feet (26 meters) and another telescope with a radius of 45 feet (14 meters). The lengths of three baselines were 33.1, 33.8, and 35.3 kilometers respectively. The observed quasar radio wavelengths were 2695MHz and 8085 MHz. According to Eq.(6), the change of the deflection angle of 3C0116 + 08 with time was deduced through the measurement of correspond value $R(t)$ and the complex calculation. This change was relative to the change of the other two quasars. Because the light of the other two quasars also passed near the sun to reach the earth, and therefore they also were affected by the sun's gravitational field.

The key is how to to determine the phase angle generated by other interference factors in Eq.(8). In the published paper of A. B. Fomalont and R. A. Sramek, they defined [5]:

$$\varphi_x^j(t) = C^j(t) + D^j(t) + B_x^j(t) + \psi_x^j(t) \tag{9}$$

$$\varphi_s^j(t) = C^j(t) + \frac{1}{3}D^j(t) + B_s^j(t) + \psi_s^j(t) \tag{10}$$

Indicators j and s described different baselines and radio sources. $C^j(t)$ represented the phase effects of the sun's corona. $B_x^j(t)$ and $B_s^j(t)$ described the standard position error of the radio source and phase changes caused by the presence of the source's internal structure. $\psi_x^j(t)$ and $\psi_s^j(t)$ and described the phase changes caused by instruments.

The paper had not provided the specific forms of the above quantities. No physical measurements were made to determine their values. Similarly, the least square method was used with the weight to adjust the relationship between each parameter. Taking into account the actual measured response value $R(t)$ and through a very complex algorithm, the deflection angle of the radar wave caused by gravity was deduced from Eq. (9) and (10), and obtained the value of parameter γ at last . So this is not so much a measurement as a theoretical deduction.

The final gravitational deflection given in the A. B. Fomalont and R. A. Sramek paper was shown in Fig.17-20. The conclusion was that the parameter $\gamma \approx 1$ in Eq.(8) which was considered more consistent with the Einstein's prediction [5].

The paper of A. B. Fomalont and R. A. Sramek only gave the measurement results at 5, 6, 10, and 14 solar radii. Why don't they give the measurement results at the distance between 1 and 4 solar radii closer to the Sun? We don't know, but a reasonable guess was that the error of gravitational deflection was so large in these fields, so that it's impossible to find a self-consistent set of parameters that would make all the measurements and calculations consistent enough to satisfy Einstein's theory.

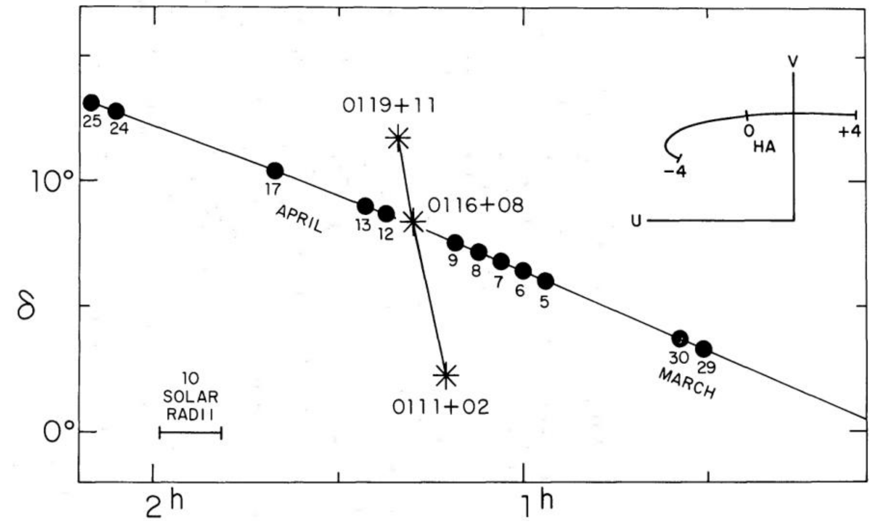

Fig. 16 The Graph of interference measurements at the United States Radio Telescope, 1974

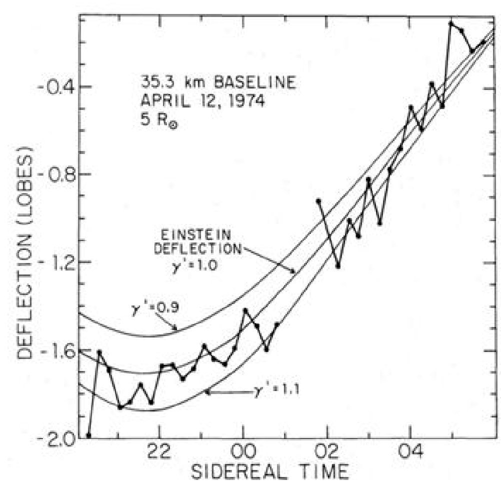

Fig. 17. Measurement data at 3 solar radii

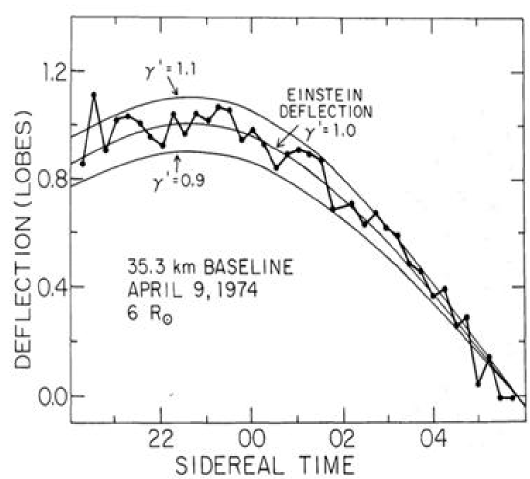

Fig. 18. Measurement data at 6 solar radii

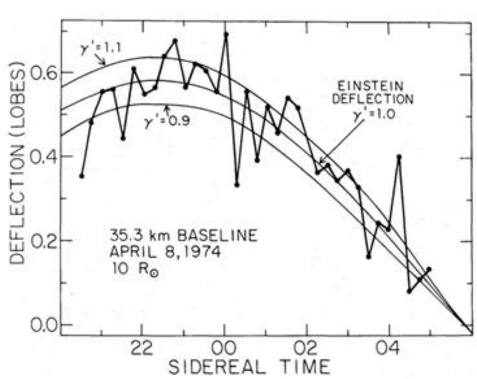

Fig. 19. Measurement data at 10 solar radii

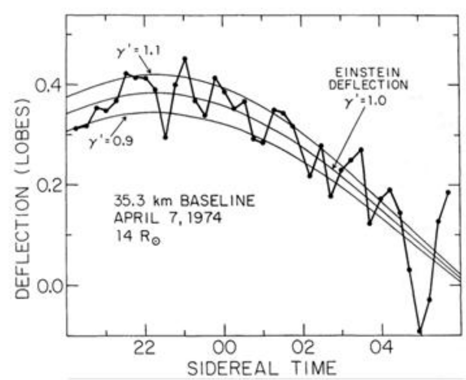

Fig. 20. Measurement data at 16 solar radii

It should be emphasized again that the measurements of Fomalont and Sramek, actually assumed in advance the basic value of gravity deflection was 1.75”, then to determine what the value should be taken for parameter γ for the radar wave gravitational deflection formula (6). So these measurements were only try to distinguish the Einstein’s theory from the Brans-Dick's theory of gravity, not tests to see if the Einstein's theory was correct.

In fact, if we assume in advance that the deflection of radar wave is the value predicted by the Newtonian gravity, a set of self-consistent parameters can be obtained according to this data processing method, so that Eq.(6) can be satisfied, and it is proved that the deviation of radar wave satisfies the Newtonian gravity formula.

2.2.6 More observations of light's gravitational deflection and gravitational lens

Following the work of A. B. Fomalont and R. A. Sramek, astronomers made some measurements of gravitational deflection of radar waves [10]. These measurements were similar to those taken by A. B. Fomalont and R. A. Sramek, assuming that Einstein's prediction of 1.75” was correct and then fine tune it. Because the least square method was used for parameter fitting, neither of them can be used to prove general relativity.

Some theories adopted the post-Newtonian approximation of general relativity, introducing more tunable parameters, for example $\gamma, \ \beta, \ \varepsilon$, to calculate the gravitational deflection of light [11,12, 13]. The corresponding gravitational deflection experiment was not so much to prove Einstein's prediction as to find some consistency parameters for the post-Newtonian approximation.

While studying the phenomenon of gravitational deflection of light, physicists also proposed the problem of gravitational lens [14,15]. When light from a distant object in the deep universe reaches the earth, if it encounters a massive object, the light will be bent, as if it were passing through an optical lens. To an observer on the earth, therefore, a celestial body may produce multiple images, even forming a circular virtual image known as the Einstein ring.

However, the phenomenon of gravitational lens can also be explained by the Newtonian theory of gravity. Unlike general relativity, Newtonian gravity requires twice as much center mass as general relativity for the same light deflection. Since the predictions of general relativity do not hold, we should use Newtonian gravity (it is better to plus a modification of magneto-like gravity) to calculate gravitational lens, which will have an impact on the mass judgment of gravity lens matter.

3. CONCLUSIONS

There are four basic experiments to verify general relativity. One is the gravitational redshift of light which is related to the equivalence principle, independent of the Einstein's equation of gravitational field. Another three are related to the equation of gravitational field. They are the perihelion precession of Mercury, the deflection of light and the radar wave delay in the gravitational field of the sun. Among them, the gravitational deflection of light is the most famous and sensational.

According to the Einstein's theory of gravity, light coming from a distant star passes through the solar surface, a deflection angle of $1.75''$ can be observed on the earth. According to the Newtonian theory of gravity, the deflection angle is $0.875''$. The deflection predicted by Einstein's theory is twice that of Newton's theory. This effect is considered an important experimental criterion to determine which of the two theories is correct.

Before the measurements of Eddington, Einstein's gravity theory of curved space-time was so discredited that no one took it seriously. It was due to the measurements of light’s gravity deflection, the scientific world paid attention to general theory and made Einstein famous.

It has been proved that in the deduction of the time-independent equation of light’s motion of general relativity, a constant term is missing. If this constant term exists, the deflection angle of light calculated by using general relativity is only a slight correction of the value $0.875''$ predicted by the Newton's theory of gravity with the magnitude order of 10^{-5}. In other words, general relativity has not predicted that the deflection angle of light in the solar gravitational field is $1.75''$.

For a century, all observations on the gravitational deflection of light have been considered to confirm the prediction of general relativity. How could physicists possibly observe something that theory has not predicted and does not exist in reality? In this paper, the problems in these experiments are revealed.

There are two types of gravitational deflection experiments for general relativity light. One was to measure the deflection of visible light emitted by stars in out space during the solar eclipses. Another was to measure the deflection of radio waves emitted by quasars. Most observers were preconceived, hoping to confirm the predictions of the Einstein's general theory of relativity, not the other way around.

The measurement by visible light was inaccurate due to the small gravitational deflection of light, the great interference of the atmospheric material on the sun's surface to the motion of light, the fluctuation and refraction of the atmosphere on the earth's surface, and the deviation of measuring instruments. In the process of data processing, the least square method and other complex statistical methods should be used to make the measurement data of each star to be consistent, instead of directly observing the deflection of light. The measurements needs to be fitted for obtaining the parameters to agree with the prediction of the Einstein's theory.

For the interference measurement of radio waves, the relative observation method was adopted, rather than the direct observation, and the measurement results were more dependent on the theoretical model.

Astronomers in fact prefer to assume that the Einstein's prediction is self-consistent, introducing a set of parameters to fit the measurements to meet Einstein's theoretical predictions. In fact, in this way, if we presuppose that the deflection of light satisfies the predictions of Newtonian gravity, we can also find a set of parameters, fit them to the experimental measurements, and conclude that the predictions of the Newtonian gravity are confirmed.

So the truth of the matter may be, as Einstein said, that theory determines what we observe. This is especially true for very small effects, such as those predicted by general relativity. Glashaw, an American physicist, once claimed that he could fit out an elephant by giving him four free parameters, and that the elephant's trunk could swing by giving him five free parameters. Physicists should take note of this thing, which appears in the experiment of gravitational deflection of light in general relativity.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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