A No-Shape-Substance is the propagating medium of light

——The First Part of New Physics

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Abstract：Through analyzing a variety of physical phenomena, the author proposes that there exists a special kind of substance — No-Shape-Substance. The author believes that this matter is the medium through which light propagates and the foundation on which all laws of motion can be built. On the same foundation we can explain a great many physical experiments as well.

The No-Shape-Substance is an actual substance with mass in another state. The No-Shape-Substance is a more profound element in the nature, which can make people know the nature more thoroughly, as well as make the physics more objective, more natural and more logical.

Keywords: the No-Shape-Substance, the Shape-Substance, the No-Shape-Substance Space, the Mathematics Space, Vacuum

1. A Brief Introduction for a No-Shape-Substance

1.1 No-Shape-Substance

In the natural world, apart from all kinds of known substances, there exists largely a special kind of substance — a No-Shape-Substance. For the purpose of distinction, we call the matter that we have already known a Shape-Substance. A Shape-Substance is visible while a No-Shape-Substance is invisible. A Shape-Substance has its structure and is tangible, but the No-Shape-Substance is contrary. [1, 2]

For example, an atom or an electron is a Shape-Substance. If an electron is analogous to a big tree, a No-Shape-Substance is analogous to the air that flows at will among the branches of the tree. Different from the commonly known matter, a

No-Shape-Substance exists in another special state and is much tinier than the common matter.

The universe is a huge ocean full of No-Shape-Substance and all the Shape-Substance exist in the same ocean. Since the No-Shape-Substance exists on a dispersed state, it logically has density, which is usually denoted by S. (The SI unit for density is kg/m^3.)

Giving an example that is familiar to us. When pulling a small ball in the glycerin, the glycerin on the surface of the ball can be carried, while the glycerin attached closely to the surface of the ball can be carried completely.

If the small ball is displaced by a basketball or the earth, the influence on it will be different. The bigger the body is, the greater the influence is.

Since there is an attracting force between the Shape-Substance and the No-Shape-Substance, the movement of the Shape-Substance can also carry the No-Shape-Substance. The bigger the Shape-Substance is, the greater its influence on the No-Shape-Substance existing in the space is. The nearer to the body the No-Shape-Substance is, the greater the influence from the body on the No-Shape-Substance existing in the space is.

1.2 The No-Shape-Substance on the Earth

Well, let's consider the Earth at a macroscopic angle. The Earth is in an ocean of No-Shape-Substance. The movement of the Earth can carry the No-Shape-Substance near it. Moreover, the No-Shape-Substance is carried by the Earth on the Earth's surface while in the far distance from the Earth, the No-Shape-Substance can not be carried by the Earth at all.

As shown in figure 1.1. The velocity of the No-Shape-Substance relative to the earth increases from "zero" to 30 kilometers per second gradually as the increase in the distance from the earth.

The Earth is not likely to bring completely the No-Shape-Substance on the earth's surface, when the earth is translational movement. But when rotates, it is not easier to

bring completely No-Shape-Substance on the earth's surface. Because the speeds of all the points on the surface are completely different, even though that of a point is different at the different time, when the Earth rotates.

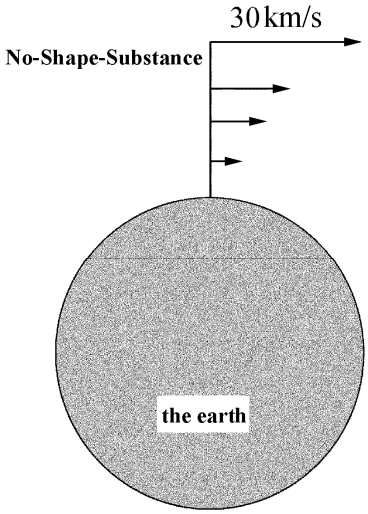

Fig. 1.1 the velocity distribution of the No-Shape-Substance relative to the earth

Are the densities of the No-Shape-Substance in the whole universe uniform? No. Because there is some attracting force between the Shape-Substance and the No-Shape-Substance, the density of the No-Shape-Substance is greater to some extent in the place where the Shape-Substance has more accumulation.

That is, the density of the No-Shape-Substance on the earth's surface is greater than that of far away from the earth.

The No-Shape-Substance can be superimposed. The total density of the No-Shape-Substance in space equals the algebraic sum of that of all objects.

The total density of the No-Shape-Substance in space is

$$S = S_1 + S_2 + S_3 + \ldots \tag{1.1}$$

Let's research the problem step by step.

We say that the No-Shape-Substance is carried completely by the earth. Well then, when a train passes by us, is the No-Shape-Substance driven obviously in the place where we are?

We know that the train is much smaller than the earth. Whether the train exists or not, it puts little influence on the state of the space where we are. The influence that the train exerts on the No-Shape-Substance in the space where we are can be neglected completely. It is the same in the carriage.

But it is a problem of another level to the inside of the matter, such as in water or in glass, since it's much nearer to the molecule or the atom. The density of the

No-Shape-Substance inside a body cannot be neglected.

Inside water, the total density of the No-Shape-Substance is the superposition of that of the vacuum in the earth's surface and that corresponding to the water. That is $S = S_E + \bar{S}_W$.

We know that it needs to establish a spatial reference system to discuss a physical question. The Shape-Substance has a velocity relative to a spatial reference system, and it is the same with respect to the No-Shape-Substance, too.

The velocity of the total No-Shape-Substance equals the full-weighted superposition of the velocity and the density of every object in space. That is

$$\vec{\upsilon} = \frac{S_1\vec{\upsilon}_1 + S_2\vec{\upsilon}_2 + S_3\vec{\upsilon}_3 + \ldots}{S_1 + S_2 + S_3 + \ldots} \tag{1.2}$$

Still we take the flow of water for example. Assumed that the water has a velocity of $\vec{\upsilon}_W$ relative to the spatial reference system on the earth's surface, we probe into the velocity of the No-Shape-Substance inside the water relative to the spatial reference system on the earth's surface.

The velocity of the No-Shape-Substance corresponding to the earth is zero relative to the earth's surface. The No-Shape-Substance corresponding to the flow of water moves together with the water, and its velocity relative to the earth's surface is $\vec{\upsilon}_W$. So the velocity of the total No-Shape-Substance relative to the earth's surface can be expressed as follows

$$\vec{\upsilon} = \frac{\bar{S}_W \cdot \vec{\upsilon}_W + S_E \cdot 0}{\bar{S}_W + S_E} = \frac{\bar{S}_W}{\bar{S}_W + S_E}\vec{\upsilon}_W$$

1.3 Vacuum

Now let's look at the case in a vacuum again. It has been thought for a long time that there was nothing in an ideal vacuum, but it is not the actual case. What the vacuum lacks is only the atmospheric molecules. In fact, there exists a large amount of No-Shape-Substance in the vacuum space. And the wall of a vacuum container will not block the move of the No-Shape-Substance.

If the vacuum is on the earth's surface, what permeates in it is the same No-Shape-Substance on the earth's surface; wherefore the density of the No-Shape-Substance in the vacuum is the same as that on the earth's surface. However, if the vacuum is in the cosmic space, what is dispersing in it is the No-Shape-Substance of its corresponding cosmic space; therefore the density of the No-Shape-Substance in the vacuum is the same as that in the relevant cosmic space.

1.4 Physical Laws

The No-Shape-Substance has very important physical properties.

The No-Shape-Substance is the medium through which light propagates. It is just because the No-Shape-Substance is the propagating medium of the light that the No-Shape-Substance is invisible.

The space in which the No-Shape-Substance exists is called the No-Shape-Substance Space or the Substance Space for short. Opposite to the No-Shape-Substance Space, we call the virtual and flat space the Mathematical Space.

All the motion laws of all bodies depend on the total No-Shape-Substance space where it exists instead of the absolutely mathematical space.

Here we consider the following case that a fish swims in a river and the water flows in relation to the bank. Well, to what is the force acting on the fish and its law of motion related? The force acting on the fish and its law of motion are closely related to the flow of water, but not to the mathematical reference system based on the bank.

A body is analogous to the fish while the No-Shape-Substance is analogous to the water. The motion laws of all bodies depend on the No-Shape-Substance Space where it exists but not directly on the Mathematical Space.

2. The Propagation Medium of light

Having learned what the No-Shape-Substance is, we are now in a better position to understand what light is, and some other basic physical laws about light. There is no essential distinction between the light wave and other waves. The light wave has all the

properties as the other waves do. And the No-Shape-Substance is the propagation medium of light.

2.1 The Propagation of Light

Before analyzing any physical laws, let's make our basic concepts clear first.

Newton has said, "The absolute space is essentially independent of any outside body and remains equivalent and motionless forever."

"The absolute, real or mathematical time, itself and to the extent of its nature, always lapses uniformly, having nothing to do with any outside body." [3]

……

Time and space are the standards and scales for people to learn the world, and meanwhile they are also the unshakable cornerstones of physics. My view of space-time is compatible with that of Newton's classical physics. Time exists objectively and it always lapses uniformly having nothing to do with any outside body.

The mathematical space is essentially independent of any outside body and remains equivalent and motionless forever. The speed follows the superposition principle of Galileo. Both mass (gravitational mass) and energy are conservative and can not be converted into each other.

But the unique viewpoint on which I don't agree with Newton's classical physics is what the laws of motion of a body depend on is not the absolute space but the total No-Shape-Substance Space in which the body exists.

As mentioned above, I have given an example about the fish swimming in water and the water flowing with reference to the bank.

A No-Shape-Substance is the propagation medium of light and the propagating velocity of light relative to the No-Shape-Substance is constant.

From the wave theory we can get the propagating velocity of a wave u is

$$u=\sqrt{\frac{G}{\rho}} \quad \text{or} \quad u=\sqrt{\frac{E}{\rho}} \quad \text{or} \quad u=\sqrt{\frac{K}{\rho}}$$

Where G and E are the shear modulus and the elastic modulus of a solid respectively, K is the volume modulus of a liquid or a gas while ρ is the density of

the medium.

In a word, no matter in a solid or in a liquid, the propagating velocity of a wave is always in direct proportion to the square root of the modulus of the medium and is inversely proportional to the square root of the density of the medium.

Because the No-Shape-Substance is the propagation medium of light, we can get the following relation between the speed of light C and the density of the No-Shape-Substance S :

$$c = \sqrt{\frac{W}{S}} \tag{2.1}$$

Wherein W and S are the modulus and density of the No-Shape-Substance respectively. The SI unit of modulus is Pa (viz. $\mathrm{N/m^2}$).

As we all know, the speed of light in other medium such as glass and water is lower than that in a vacuum.

Then how should we explain these physical facts?

If we look at it from the viewpoint of the No-Shape-Substance, it will become quite easy for us to understand.

In the vacuum near the earth's surface, the density of the No-Shape-Substance is that of the earth's surface S_E . Then the velocity of light in the vacuum near the earth's surface is:

$$c = \sqrt{\frac{W}{S_E}} \tag{2.2}$$

In the water, the total density of No-Shape-Substance is the sum of the density of the No-Shape-Substance in the vacuum near the earth's surface and the density of the No-Shape-Substance relating to the water. That is: $S = \bar{S}_W + S_E$

Then the speed of the light in the water is:

$$c_W = \sqrt{\frac{W}{\bar{S}_W + S_E}} \tag{2.3}$$

In such medium as the glass or the water, because the density of the No-Shape-Substance is larger than that in the vacuum, the speed of light is naturally

lower than that in the vacuum.

2.2 Explanation to Some Famous Physical Experiments Based on the New Physics

Since the classical physics was very natural and harmonic, why did the theory of relativity come into being? It's mainly because classical physics encountered some difficulties and contradictions, and even became irreconcilable to some experiments and phenomena.

These experiments and phenomena mainly include the binary star phenomenon, the aberration phenomenon, Fizeau's experiment, Ariy's experiment and Michelson-Morley Experiment. [3, 4, 5, 6]

In the following we will explain these experiments and phenomena from a completely new point of view.

2.2.1 Fizeau's Experiment

In 1851, Fizeau conducted a very sensitive experiment. It shows that water could slow down the motion of light. Light in water would move at a lower velocity.

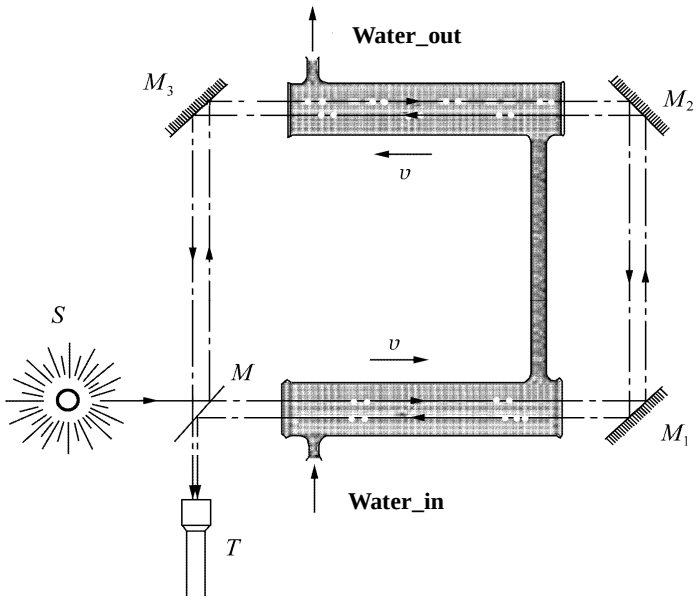

Fig. 2.1 Fizeau's Experiment

As shown in figure 2.1. The light emitted by the lamphouse S is divided into two beams of light when passing through M. One is reflected subsequently by M_3, M_2, M_1, and then is reflected again by M into T. Meanwhile, the other beam permeates M and then is

reflected subsequently by M_1, M_2 and M_3, and at last arrives at T permeating M. When traveling through the flowing water in the level tube, the former travels in the direction opposite to the direction of the flowing water, while the latter travels in the same direction as that of the flowing water. At last, the two beams of light interfere in T.

At the beginning of the experiment, we designate the speed of the flowing water in the level tube as zero. Because the two beams of light have the same traveling distance, the interference fringes are bright. Then when we increase the speed v of the flowing water in the level tube gradually, we will observe that the interference fringes change alternatively between bright fringes and dark ones, which shows that the speed of light in the flowing water changes when the light propagates in different direction from that of the flowing water. Furthermore, we can establish the velocity of the light propagating in the water relative to the earth.

Note that the velocity of the light propagating in the water relative to the earth in Fizeau's experiment is:

$$c' = \frac{c}{n} \pm f v_w \tag{2.4}$$

Where, n is the refractive index of water, the plus sign "+" applies the condition that light travels in the same direction as that of the flowing water in the tube, the subtraction sign "-" applies the condition that light travels in the opposite direction to that of the flowing water in the tube.

The dragging coefficient of water obtained from Fizeau's experiment is $f = 0.434 \pm 0.002$, with its value smaller than 1.

It shows that water can carry light but not completely.

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How to understand Fizeau's experiments? How can water slow down the motion of light?

It is the water that carries the No-Shape-Substance. So water can also carry light.

In the vacuum near the earth's surface, the total No-Shape-Substance has no motion relative to the earth reference system and its density, denoted by S_E, is uniform.

Because the distance between molecules inside water is quite small, the density of

the No-Shape-Substance in the flowing water can not be ignored. Thus the density of the total No-Shape-Substance equals the sum of the density of the No-Shape-Substance on the earth and that in the flowing water. That is $S = \bar{S}_W + S_E$

The velocity of the No-Shape-Substance on earth with reference to the earth's surface is zero, while the velocity of the No-Shape-Substance in the flowing water is υ_w relative to the earth's surface. Then we can get the velocity of the total No-Shape-Substance moving relative to the earth's surface from equation 1.2 as follows:

$$\upsilon = \frac{\bar{S}_W \cdot \upsilon_W + S_E \cdot 0}{\bar{S}_W + S_E} \qquad \text{If} \qquad f = \frac{\bar{S}_W}{\bar{S}_W + S_E}$$

$$\upsilon = f\upsilon_W \tag{2.5}$$

When light propagates in water, its velocity relative to the total No-Shape-Substance space is c/n, and its velocity relative to the earth is:

$$c' = \frac{c}{n} \pm \upsilon$$

$$c' = \frac{c}{n} \pm f\upsilon_W \tag{2.6}$$

It is water that carries the No-Shape-Substance .So water can also carry light. This perfectly reflects on Fizeau's experiment that showed, light was dragged by water.

Below we will quantitatively calculate the dragging coefficient of the water.

As was said before, when the light travels in a certain vacuum near the earth's surface, its velocity in the vacuum can be expressed as

$$c = \sqrt{\frac{W}{S_E}} \tag{2.7}$$

When light travels in water, its speed is

$$c_W = \sqrt{\frac{W}{S_E + \bar{S}_W}} \tag{2.8}$$

We can easily get the following equation from equation (2.8) and equation (2.7),

$$\frac{c_W^2}{c^2} = \frac{S_E}{\bar{S}_W + S_E}$$

Since $f = \dfrac{\bar{S}_W}{S_E + \bar{S}_W}$

Again replacing c/n for c_W, it follows that

$$f = 1 - \frac{1}{n^2} \tag{2.9}$$

Since the refractive index of water is 1.33, we calculate the dragging coefficient theoretically as follows

$$f = 1 - \frac{1}{n^2} = 1 - \frac{1}{1.33^2} = 0.4347$$

The dragging coefficient of water obtained from Fizeau's experiment is $f = 0.434 \pm 0.002$. Apparently, the theoretical value perfectly agrees with the experimental value.

2.2.2 The Michelson-Morley Experiment

During the time between 1876 and 1887, Michelson and Morley conducted experiment in an effort to find the speed of the "ether –wind" using the Michelson Interferometer.

But the result showed that there was no so-called "ether-wind" on the earth's surface at all.

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How should we understand this experiment?

For the Michelson-Morley experiment, it would like to reveal the impact of global translation. The relationship of both the changes of the stripes number ΔN and speed of "Ether" (No-Shape-Substance) relative to the surface υ is described as,

$$\Delta N = \frac{2l}{\lambda}\frac{\upsilon^2}{c^2}$$

For the $\upsilon = 30000$ m/s, the moving stripes number $\Delta N = 0.37$ can observe.

Note: The change of number of stripes is proportional to v^2. When the speed is one sixth of that above, the change of stripes number is one thirty-sixth of that above. If the $v = 5000$ m/s, the moving stripes number $\Delta N = 0.01$ can observe.

Michelson and Morley draw the conclusion as follows:

Even if the relative velocity exists between the earth and Ether, the velocity would not exceed one-fourth of orbital velocity of the earth. The value of one-fourth of orbital velocity of the earth is about 7500m/s.

2.2.3 Millar experiment

From the year of 1902 to1904, Millar and Morley repeated the Michelson-Morley experiment with better instruments. The result of their experiment was closer to zero than what was got by Michelson and Morley in 1887.

Later on, Millar obtained different result when conducted the experiment rather than the space of the earth surface.

In 1921, Millar repeated this experiment on Mount Wilson by using the same methods as before. As a result, a positive effect of 10km/s *was found, which means light speed deviated by an amount of* 10km/s.

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We can say that Millar's experiment has undermined the theory of relativity. [7, 8, 9]

Well, how should we explain the experimental positive result?

Shown in Fig. 1.1, we have analyzed previously The Earth is not likely to bring completely the No-Shape-Substance on the earth's surface, when the earth is translational movement.

The Earth is also not likely to bring completely the No-Shape-Substance on the high mountain, when the earth is translational movement.

That means on the high mountain the No-Shape-Substance has higher speed relative to the earth. Therefore when we conducted the Michelson-Morley experiment there, the interference fringes would produce the speed deviation.

2.2.4 Light Aberration Phenomenon

When we observe a far-away star, we need change the direction of our telescope when seasons change, that is, we change the telescope's angle when earth changes its position on its orbital course round the sun.

The maximum angle α *is about* 10^{-4} *radian in the practical observation.*

Physicists used to explain the light aberration phenomenon with the theory of ether. They said that the earth moves relative to ether at a speed of 30km/s. *That is to say that there is a "ether wind" moving at that speed on the earth's surface.*

But such an explanation is completely contradictory to the zero result of Michelson-Morley experiment conducted at the earth's surface.

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Now we can explain the light aberration phenomenon naturally.

As shown in figure 2.2, we suppose that the light from a star is vertically incident upon the orbit-plane of the earth at the speed of c and the earth has a velocity of υ relative to the cosmic space.

When light propagates in the cosmic space far from the earth, the influence on the total No-Shape-Substance in the far distance caused by the motion of the earth is so little that it can be ignored. The light from the star will still be vertically incident upon the orbit plane of the earth at the speed of c in the cosmic. Because the earth moves at a speed of υ with reference to the cosmic space, if observed from the earth, the light is incident onto the orbit-plane of the earth at an angle of α (to the original propagation).

We can learn from the above figure that the tangent value of angle α which is the observed direction and the original propagation direction is

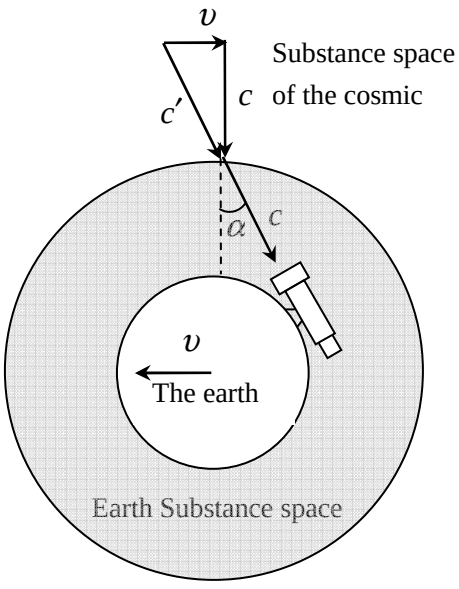

Fig. 2.2 light aberration phenomenon

$$\tan\alpha = \frac{\upsilon}{c}$$

In this equation, if we replace υ and c respectively with the value of the earth's orbit-speed and the value of light speed, we will follow the maximum of angle α is about 10^{-4} radian.

The above explanation of mine perfectly accords with the result of observation.

2.2.5 Airy's Experiment

We know that the water can carry light in the Fizeau's experiment.

People deduced that if the telescope were filled with water, there would be an aberration phenomenon different from the one when there is no water.

In 1871, Sir George Airytried just that, but he still observed the same aberration phenomenon as the case that the telescope was not filled with water.

It's contradictory with the result of light aberration phenomenon and Fizeau's experiment in the frame of ether.

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Now we can understand Airy's experiment naturally.

As shown in figure 2.2, in this experiment we filled the telescope with water. Note that the water in the telescope has no relative motion to the earth, comparable to the absence of water, and that the water in the telescope just increases the density of the total No-Shape-Substance in the telescope, and that the total No-Shape-Substance in the telescope is still immobile relative to the earth.

After light has come into the No-Shape-Substance space near the earth surface, the water there will not affect light's propagating direction. Therefore we can still observe the same aberration phenomenon as the case that there was no water in the telescope.

2.2.6 Binary Star Phenomenon

From the observation of the remote binary star system, people can tell whether the speed of light would be affected by the light source. People have found that the observed binary star system is always quite natural. People have never observed the phenomenon

of ghost stars. So people have concluded that the speed of light will not be affected by the motion of the light source.

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We say that the No-Shape-Substance is the propagating medium of light. The speed of light is independent from the motion of the light source.

Here let's analyze the binary star phenomenon.

As shown in figure 2.3. The total No-Shape-Substance around a celestial body will be influenced by the motion of the celestial body. Thus the two beams of light originating from point a and point b respectively have different velocities relative to the cosmic space, but the propagation time of light near celestial body is very short. However, in the remote cosmic space, the total No-Shape-Substance wouldn't be influenced by the motion of the celestial body. When light travels in the broad cosmic space, the two beams of light originating from point a and point b respectively have the same speed of propagation. Therefore the binary stars that we observed are a normal system.

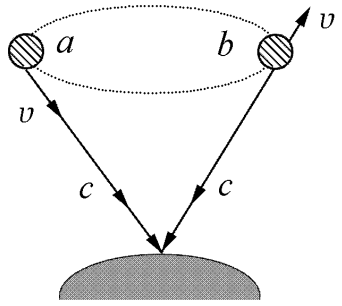

Fig. 2.3 the binary star phenomenon

2.2.7 The Sagnac Effect

In 1911, Sagnac invented a ring interferometer as shown in figure 2.4. A beam of light is split into two beams by beam splitter, and the beams of light are made to follow a trajectory in opposite directions. To act as a ring the trajectory must enclose an area .On return to the point of entry, the light is allowed to exit the apparatus in such a way that the interference fringes are obtained on the viewing screen.

The amount of displacement of the interference fringes in the Sagnac effect is proportional to the product of the angular velocity of the interferometer and the area enclosed by the trajectory.

As shown in figure 2.5. Now, let's explain it as follows. To simplify the question,

we suppose the trajectory is a circular loop of radius R and the interferometer is moving in the clockwise rotating direction around a fixed axle with an angular velocity of ω. Because the motion of the interferometer has no effect on the total No-Shape-Substance on the earth's surface, the total No-Shape-Substance is motionless relative to the earth's surface. Then the speeds of the two beams of light are both c in the earth's surface reference frame.

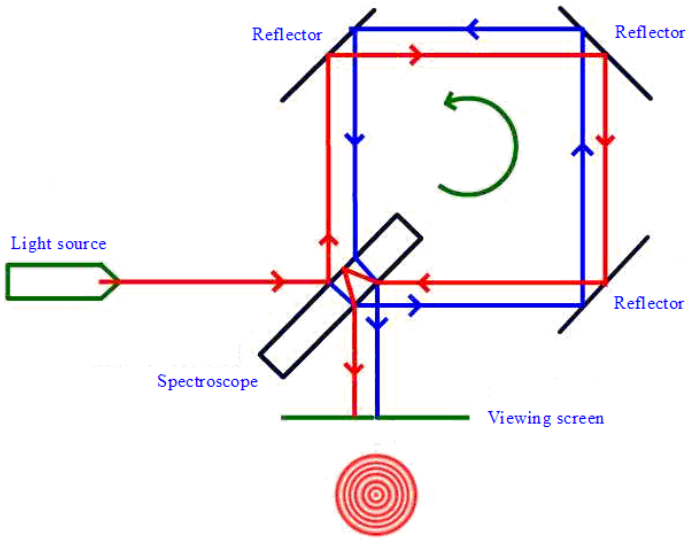

Fig. 2.4 Sagnac Effect

The circumferential tangent speed of the loop is ωR. Based on the superposition principle of speed of Galileo, we get the light speeds in the clockwise rotating direction and the counterclockwise rotating direction respectively in the reference system where the loop is as follows

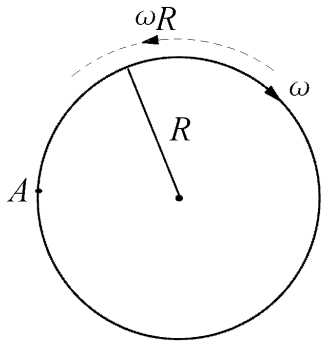

Fig. 2.5

$$\upsilon_{co} = c - \omega R$$

$$\upsilon_{counter} = c + \omega R$$

The travel times of the two beams in the loop are

$$t_{co} = \frac{L}{\upsilon_{co}} = \frac{2\pi R}{c - \omega R}$$

$$t_{counter} = \frac{2\pi R}{\upsilon_{counter}} = \frac{2\pi R}{c + \omega R}$$

Where $L = 2\pi R$ is the perimeter of the loop.

The difference between the travel times is

$$\Delta t = t_{co} - t_{counter} = 2\pi R(\frac{1}{c-\omega R} - \frac{1}{c+\omega R})$$

$$\Delta t = \frac{4\pi R^2 \omega}{c^2(1-\frac{\omega^2 R^2}{c^2})}$$

Ignore the secondary lesser time, we get $\Delta t = \frac{4\pi R^2 \omega}{c^2}$, Substitute the *S* for πR^2 which indicates the area enclosed by the loop, the equation will be

$$\Delta t = \frac{4S\omega}{c^2} \tag{2.10}$$

The optical path difference is $\Delta = c\Delta t = \frac{4S\omega}{c}$

So the amount of displacement of the interference fringes corresponding to the optical path difference is

$$\Delta N = \frac{\Delta}{\lambda} = \frac{4S\omega}{c\lambda}$$

This equation applies to any enclosed loop, not necessarily circular.

We have explained the Sagnac effect well.

The Segnac effect has been employed in many practical ways. For example, a fiber gyroscope has been successfully utilized in the field of aviation and space flight. It was one of the highly developed gyroscopes in the last 20 years.

For the fiber gyroscope, when light propagates in the medium, its speed is relevant to both the refractive rate and the tangent speed of the medium. Then how should we understand the Sagnac effect and get the equation (2.10) conforming to the fact?

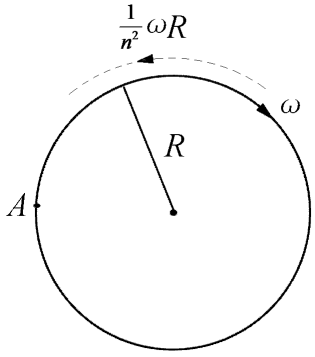

Fig. 2.6

As shown in figure 2.6. The radius of the fiber coil is R. Both the light source and the detector are at point A. The device is moving in the clockwise-rotating direction with an angular speed of ω, so the tangent

speed of the coil is ωR .

The total No-Shape-Substance inside the fiber will also move in the clockwise-rotating direction because of the carrying ability of the fiber. From the equation discussed in Fizeau's experiment, we get the tangent speed of the total No-Shape-Substance relative to the earth's surface as follows:

$$\upsilon = f\,\omega R = (1-\frac{1}{n^2})\omega R$$

But the total No-Shape-Substance is moving in the counterclockwise-rotating direction relative to the rotating reference system where the interferometer is, so its tangent speed relative to the rotating reference system is:

$$\upsilon' = \omega R - \upsilon = \frac{1}{n^2}\omega R$$

When the light propagates in the clockwise and counterclockwise direction, its tangent speeds relative to the interferometer are υ_1 and υ_2 respectively.

$$\upsilon_1 = \frac{c}{n} - \frac{1}{n^2}\omega R$$
$$\upsilon_2 = \frac{c}{n} + \frac{1}{n^2}\omega R$$

The time difference is

$$\Delta t = \frac{2\pi R}{\upsilon_1} - \frac{2\pi R}{\upsilon_2} = \frac{4\pi R^2\omega}{c^2\left(1-\dfrac{\omega^2R^2}{n^2c^2}\right)}$$

Ignoring the secondary lesser time, we get $\Delta t = \dfrac{4\pi R^2\omega}{c^2}$, and doing the same substitution as before, we get the equation as follows

$$\Delta t = \frac{4\mathrm{S}\omega}{c^2} \tag{2.11}$$

It has the same form as the equation (2.10) in vacuum.

The corresponding phase difference is:

$$\Delta\phi = 2\pi\frac{\Delta t c_n}{\lambda_n} = 2\pi\frac{\Delta t c}{\lambda} = \frac{8\pi S\omega}{\lambda c}$$

Where, λ is the wavelength of laser in vacuum, λ_n and c_n are the wavelength and the speed of laser light in the medium respectively.

If the fiber coil has N circles, its phase shift is:

$$\Delta\phi = \frac{8\pi SN\omega}{\lambda c}$$

After measuring the value of $\Delta\phi$ according to the phenomenon of interferometer of light, we can calculate the value of the angular speed ω.

So far we have explained the Sagnac effect in the fiber gyroscope well.

Dear friends. If only we rethink about the physical laws carefully, basing on objectivity, nature and reality, all the experiments will become natural, concordant and harmonic.

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