

## Slowing Clock in Accelerated Motion is Necessity of Newton's Law

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[Abstract] According to the special relativity, clock will slow down due to its motion. So, someone took the clock into the flight capsule in the earth equator line, and measured the clock in the airplane slowing down, and then they got the conclusion "moving clock will slow down". This article will analyze this kind of physical phenomenon. Is Newton's law right or relativity right? This article obtains the result through theoretical arithmetic: clock in the equator line slowing down is necessity of Newton's law; it is caused by accelerated motion, not constant motion. Therefore, this article is challenging the relativity.

[Keywords] constant velocity, accelerated velocity, relativity, Newton's law, clock slows down

### 1 Introduction

Article 1 points out that time is absolute, if some event's elapsed time measured by reference frame  $S$  is  $\Delta t$ , and the same event's elapsed time measured by reference frame  $S'$  is  $\Delta t'$ , so there exists a relation  $\Delta t = \Delta t'$ . That means any event's elapsed time has no relation with the chosen reference frame. This conclusion is called time absoluteness. According to time absoluteness, if we set the moment when the event happens as timing origin of reference frame  $S$  and  $S'$ , time  $t$  in reference frame  $S$  and time  $t'$  in reference frame  $t'$  are the same, that is  $t = t'$ . This is basis of physics, and proved by daily experience and physical experiment. As for clock in the equator line slowing down, according to Newton's laws of mechanics, the pendulum

cycles of the earth two poles are  $T = 2\pi\sqrt{\frac{l}{g}}$ , and according to Newton law of inertia, the pendulum

cycle in earth equator line is  $T = 2\pi\sqrt{\frac{l}{g - a_{\text{离}}}}$ . Pendulum is placed in the elevator, when the elevator

risers at acceleration, the pendulum speeds up; when the elevator falls at acceleration, the pendulum slows down. All the clocks generated by object's motion (including particle's motion) will be influenced by acceleration. The clock's speed depends on acceleration, not the constant linear motion. Clock is man-made measure attribute; it depends on measure tool and environment. But time is not clock, time is nature attribute; it is absolute and one-dimension elapsed, and Galilean transformation principle has proved that time is absolute and one-dimension elapsed for a long time. This article answers the real reason of clock slowing down, through the practical calculation, we get the result that: clock in the equator line slowing down is necessity of Newton's law; it is caused by

accelerated motion, not constant motion. This article also proves the correctness of absolute space.

## 2 Clock in the Equator Line Slowing down is Necessity of Newton's Law

The clocks made at the beginning of last century were all mechanical clocks, and mainly famous for pendulum clocks. Now, we will discuss the cycle issues of pendulum clocks.

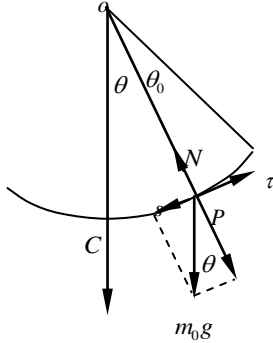


Figure 1 Pendulum clock

As shown in figure 1, when particle keeps moving in the vertical circumference through gravity, it is called single pendulum. Forces acting on the pendulum ball are gravity  $mg$  and binding force  $N$ . Because the freedom is 1, so take the deflection angle  $\theta$  as the parameter. It is positive when in right side of  $OC$ , and suppose the length of suspension line is  $l$ , according to Newton's laws of mechanics, the motion equation of natural system of coordinates is:

$$\begin{cases} m_0 \frac{dv}{dt} = -m_0 g \sin \theta \\ m_0 \frac{v^2}{l} = -m_0 g \sin \theta + N \end{cases} \quad (1)$$

Because the arc length  $s = l\theta$ ,  $v = \dot{s} = l\dot{\theta}$ , so put into the above formula and get the result:

$$\ddot{\theta} = -\frac{g}{l} \sin \theta \quad (2)$$

And then the motion regular  $\theta(t)$  is obtained. Use formula (1) to determine binding force  $N$ .

Because  $N$  does not work ( $N \perp v$ ), there should be energy integral. Indeed, after multiplying  $\dot{\theta} dt = d\theta$  and both sides of above formula, integrate them and get the result:

$$\frac{1}{2} \dot{\theta}^2 = \frac{g}{l} \cos \theta + h \quad (3)$$

Suppose the initial condition is  $\theta = \theta_0$ ,  $\dot{\theta} = 0$  (initial speed is zero), so the energy constant

$h = \frac{-g \cos \theta_0}{l}$ . The above formula should be:

$$\frac{1}{2}\dot{\theta}^2 = \frac{g}{l}(\cos\theta - \cos\theta_0) \quad (4)$$

Integrate this formula and get the motion regular.

Use energy integral to get binding force  $N$ . For this reason, use the above formula to obtain  $v^2 = l^2 \dot{\theta}^2$ , and then put formula (1) in, the result is:

$$N = m_0 g (3\cos\theta - 2\cos\theta_0) \quad (5)$$

The above formula indicates: when  $\theta = \cos^{-1}(2\cos\theta_0/3) \equiv \theta_M$ ,  $N=0$ ; when  $\theta > \theta_M$ ,  $N$  will be negative. From this, we can see: if single pendulum system uses light rod to hang or adapts the particle of vertical ring,  $\theta > \theta_M$ , and tension changes to pressure; if single pendulum system uses soft rope to hang, because the soft rope can't produce pressure,  $\theta > \theta_M$ , it becomes free motion. In order to integrate the energy equation, use  $\cos\theta = 1 - 2\sin^2\frac{\theta}{2}$  to change the right side of formula (4), and square and separate variables, the result is:

$$\frac{d(\theta/2)}{\sqrt{\sin^2\frac{\theta_0}{2} - \sin^2\frac{\theta}{2}}} = \sqrt{\frac{g}{l}} dt \quad (6)$$

In order to integrate above formula, we introduce new variables  $\varphi$  according to the following relation:

$$\sin\frac{\theta}{2} = \sin\frac{\theta_0}{2} \sin\varphi = k \sin\varphi \quad (7)$$

Where  $k \equiv \sin\frac{\theta_0}{2}$ , and  $\theta/2 = \sin^{-1}(k \sin\varphi)$ , so the result is:

$$d\frac{\theta}{2} = \frac{k \cos\varphi \cdot d\varphi}{\sqrt{1 - k^2 \sin^2\varphi}} \quad (8)$$

After the transformation of variables, formula (6) changes to:

$$\frac{d\varphi}{\sqrt{1 - k^2 \sin^2\varphi}} = \sqrt{\frac{g}{l}} dt \quad (9)$$

Integrate and get the result:

$$t = \sqrt{\frac{l}{g}} \int_0^\varphi \frac{d\varphi}{\sqrt{1 - k^2 \sin^2\varphi}} \quad (10)$$

Because the integral is very complicated, so we just calculate approximate result. That is:

$$t = \sqrt{\frac{l}{g}} \left[ \varphi + \frac{k^2}{4} (\varphi - \frac{1}{2} \sin 2\varphi) + \dots \right] \quad (11)$$

Through formula (6), we can see:  $\theta$  changes to  $\theta \rightarrow \theta_0$ , which equals that  $\varphi$  changes to  $0 \rightarrow \pi/2$ . But, the required time that  $\theta$  changes to  $\theta \rightarrow \theta_0$  is  $T/4$ , according to above formula, if  $\varphi = \pi/2$  and  $k = \theta_0/2$ ,  $T/4$ . So we can get two approximate results:

First approximation:

$$T = 2\pi\sqrt{\frac{l}{g}} \quad (12)$$

Second approximation:

$$T = 2\pi\sqrt{\frac{l}{g}\left(1 + \frac{\theta_0^2}{16}\right)} \quad (13)$$

But is worth to note that, above calculation does not consider other forcing, or does not consider the influence caused by other acceleration. But, if the acceleration of gravity  $g$  changes for some reason, the cycle will change too.

As shown in figure 2, pendulum is in the equator line, and pendulum ball rotates with the earth, the inertial centrifugal force  $f = 3.39 \times 10^{-2}\text{m}$  (N), so the inertial centrifugal acceleration  $\alpha_{\text{cen}} = 3.39 \times 10^{-2}\text{m}$ . The direction of inertial centrifugal acceleration is opposite to that of acceleration of gravity, so put  $\alpha_{\text{cen}}$  into formula (12) and get the result:

$$T = 2\pi\sqrt{\frac{l}{g - a_{\text{离}}}} \quad (14)$$

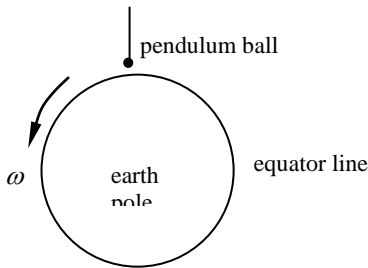


Figure 2 Pendulum in the equator line

So the clock cycle in the equator line increases, and clock slows down. But formula (12) is the clock in the earth pole, and formula (14) is the clock in the equator line. By contrast, the clock in the earth pole goes faster, and the clock in the equator line goes slower.

To sum up, when pendulum is in the equator line, pendulum ball will auto-rotate with the earth in the absolute space. Because inertia introduces centrifugal force, it makes ball's cycle longer, so the clock slows down. That is to say, according to Newton's laws of mechanics, the first approximation

of pendulum cycle in earth two poles is  $T = 2\pi\sqrt{\frac{l}{g}}$ , and the first approximation of pendulum cycle

in earth equator line is  $T = 2\pi\sqrt{\frac{l}{g - a_{\text{离}}}}$ . Pendulum is placed in the elevator, when the elevator rises

at accelerated speed, the pendulum speeds up; when the elevator falls at accelerated speed, the pendulum slows down. All the clocks generated by object's motion (including particle's motion) will be influenced by acceleration. The clock's speed depends on acceleration, not the constant linear motion. Clock is man-made measure attribute; it depends on measure tool and environment. But time is not clock, time is nature attribute; it is absolute and one-dimension elapsed, and Galilean

transformation principle has proved that time is absolute and one-dimension elapsed for a long time. We could not mistake that the acceleration makes clock slow down in the accelerated flight process is that motion makes it slow down. This is extremely wrong.

### 3 Inertia is the Representation of Absolute Space

According to Newton's law, inertia is linked with absolute space, and it is the representation of absolute space, so the inertia can be measured, and this is an inertia force experiment. Foucault pendulum is the earliest inertia force experiment.

#### 3.1 Foucault pendulum phenomenon

Since space is absolute and isotropic, the earth rotates in the absolute space, it should be non-inertia system, and we should do some force experiments to measure the earth's auto-rotation. In 1851, Foucault first made such an experiment.

1) Motion equation. As shown in figure 3, suppose suspension centre coordinate is  $A(0,0,l)$ , and pendulum suffers tension is  $N$  and gravity is  $mg$ , the motion equation is:

$$\begin{aligned} \frac{d^2x}{dt^2} &= -\frac{N}{m} \frac{x}{l} + 2\omega \frac{dy}{dt} \sin \theta \\ \frac{d^2y}{dt^2} &= -\frac{N}{m} \frac{y}{l} - 2\omega \frac{dx}{dt} \sin \theta - 2\omega \frac{dz}{dt} \cos \theta \\ \frac{d^2z}{dt^2} &= -\frac{l-z}{ml} N - g + 2\omega \frac{dy}{dt} \cos \theta \end{aligned} \quad (15)$$

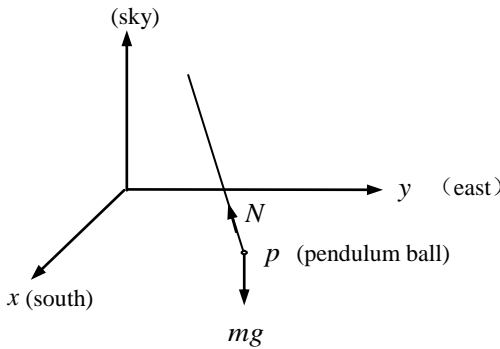


Figure3 Foucault pendulum force

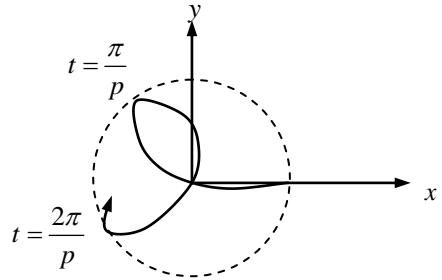


Figure 4 Foucault pendulum trail in the northern hemisphere

In the formula,  $\omega$  is angular velocity of the earth, and  $\theta$  is latitude of the earth. Solve the equation and get the result:

$$\begin{aligned} x &= x_0 \cos pt \cdot \cos(t\omega \sin \theta) \\ y &= -x_0 \cos pt \cdot \sin(t\omega \sin \theta) \end{aligned} \quad (16)$$

In the formula,  $x_0$  is pendulum ball's initial position,  $p = \sqrt{\frac{g}{l}}$ , and its cycle is  $T_0 = \frac{2\pi}{p}$ . The

trail of formula (15) is shown in figure 4.

In a word, according to theoretical mechanics, because inertia system and non- inertia system are in “unequal” status. If we give up the “priority” of inertia system, we can’t understand the universe correctly. In other words, Foucault pendulum proves the priority of inertia system and Galilean principle of relativity, so it proves inertia representing the absolute space. Coriolis found east declination phenomenon of free falling body, cyclonic air stream phenomenon and west declination phenomenon of north-south train and other physical phenomenon; they were all necessity of Newton’s law. They reflected the absolute space.

### 3.2 Coriolis force originates from Newton’s law

We use d’Alembert principle to derive the acceleration of a fixed point in the rigid body with uniform rotation  $a_b = a_0 + \omega \times (\omega \times r)$ ,  $r$  is the distance from some point to the fixed point,  $\omega$  is angle velocity. In a narrow rotating straight channel, Coriolis derived the acceleration of a moving point in the straight channel of rigid body  $a_b = a_0 + 2\omega \times u_r + a_r$ . Because  $a_b$  is called convected acceleration,  $a_r$  is relative acceleration (radial acceleration of rigid body),  $2\omega \times u_r$  is called Coriolis acceleration. This section points out: Coriolis acceleration is the representation of inertia in the rotational motion, Coriolis force comes from inertia, so it is inertia force.

Let’s start from the direct collision, suppose line of centers is in y axis, the formula is:

$$V_{1y} = \frac{m_1 u_{1y} + m_2 u_{2y}}{m_1 + m_2} - k \frac{m_2 (u_{1y} - u_{2y})}{m_1 + m_2} \quad (17)$$

In the formula,  $m_1$  and  $m_2$  are the mass of the two rigid balls,  $u_{1y}$  and  $u_{2y}$  are the speed before collision,  $V_{1y}$  is the speed of  $m_1$  after collision, and  $k$  is coefficient of restitution.

Two rigid bodies collide obliquely and  $\theta$  is the included angle, as shown in figure 5. Absolute speed of  $m_1$  is  $u_1$ , and absolute speed of  $m_2$  is  $u_2$ . So, after the momentum is converted into centering collision, its centering angle is:

$$\begin{cases} u_{1y} = u_1 \sin \theta \\ u_{2y} = u_2 \end{cases} \quad (18)$$

Put formula (18) in formula (17) and get the result:

$$V_{1y} = \frac{m_1 u_1 \sin \theta + m_2 u_2}{m_1 + m_2} - k \frac{m_2 (u_1 \sin \theta - u_2)}{m_1 + m_2} \quad (19)$$

Let’s talk the origin of Coriolis force.

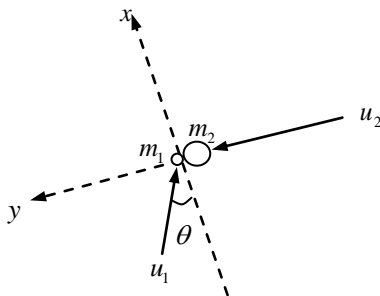


Figure 5 Oblique collision

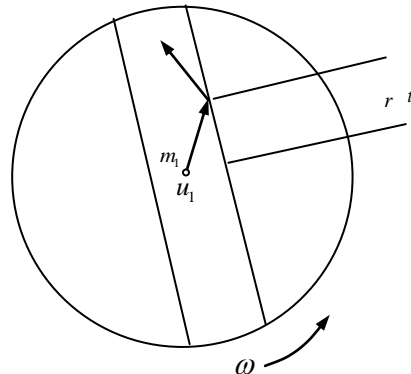


Figure 6 Collision in rotation

Now, suppose there is a smooth straight channel on the rotating rigid disk  $m_2$ , and the disk rotates anticlockwise, as shown in figure 6. Moving point  $m_1$  in the centre of rotating shaft is moving outwards constantly in the absolute speed  $u_1$ , and it collided with the smooth straight channel at time  $t$ , so the absolute distance  $m_1$  passed at time  $t$  is:

$$R = u_1 t \quad (20)$$

The length of channel wall relative to time  $t$  is:

$$r = R \cos \theta = (u_1 t) \cos \theta \quad (21)$$

Accordingly, tangential speed of channel wall in collision point is:

$$u_2 = \omega r = \omega (u_1 t) \cos \theta \quad (22)$$

Compare with figure 5, we can see that figure 6 is also oblique collision. So, put formula (22) in formula (19) and get the result:

$$V_{1y} = \frac{m_1 u_1 \sin \theta + m_2 \omega (u_1 t) \cos \theta}{m_1 + m_2} - k \frac{m_2 u_1 \sin \theta - m_2 \omega (u_1 t) \cos \theta}{m_1 + m_2} \quad (23)$$

This is transverse speed  $V_{1y}$  obtained by  $m_1$  when collision.

Considering the collision of rigid ball and smooth straight channel is elastic collision, so  $k = 1$ , and above formula becomes to:

$$V_{1y} = \frac{m_1 u_1 \sin \theta + m_2 u_1 \sin \theta + 2m_2 \omega (u_1 t) \cos \theta}{m_1 + m_2} \quad (24)$$

Furthermore, when the straight channel is too narrow,  $\theta \rightarrow 0$ , put  $\theta = 0$  in formula (24) and get the result:

$$V_{1y} = \frac{2m_2 \omega (u_1 t)}{m_1 + m_2} \quad (25)$$

Considering rotating disk  $m_2$  is much larger than moving point  $m_1$ , that is  $m_2 \gg m_1$ , so above formula becomes to:

$$V_{1y} = 2\omega (u_1 t) \quad (26)$$

So there is acceleration:

$$a_{1y} = \frac{dV_{1y}}{dt} = 2\omega u_1 \quad (27)$$

Considering radial speed  $u_r = u_1 \cos \theta$ , and  $\theta \rightarrow 0$  in narrow straight channel, so  $u_r = u_1$ .  $u_1$  is the radial speed  $u_r$  watched by observer on the disk, so formula (27) written as vector form is:

$$\mathbf{a}_{1y} = 2\boldsymbol{\omega} \times \mathbf{u}_r \quad (28)$$

This is the origin of Coriolis acceleration. Coriolis force is  $\mathbf{F}_c = 2m\boldsymbol{\omega} \times \mathbf{u}_r$ , which is familiar to every one. (Here  $m$  is not variable mass).

In order to clear the motion process, we will explode the motion process in the wide straight channel. Its motion trail is shown in figure 7. When oblique angle  $\theta \rightarrow 0$ , it is continuous collision, and its motion trail is a continual curve.

Why moving point in radial motion along the straight channel collides with the channel wall? The reason is inertia. Moving point in straight channel (for example: standing in the centre of rotating shaft, and shooting along the direction of the straight channel) moves in rectilinear direction due to inertia, but the channel wall applies acting force  $2m_1\omega \times \mathbf{u}_r$  to the moving point during rotation. The acting force and its direction are related with  $m_1$  and  $\mathbf{u}_r$  and their directions, just because of the inertia caused by  $m_1$  moving along the direction of  $\mathbf{u}_r$ .

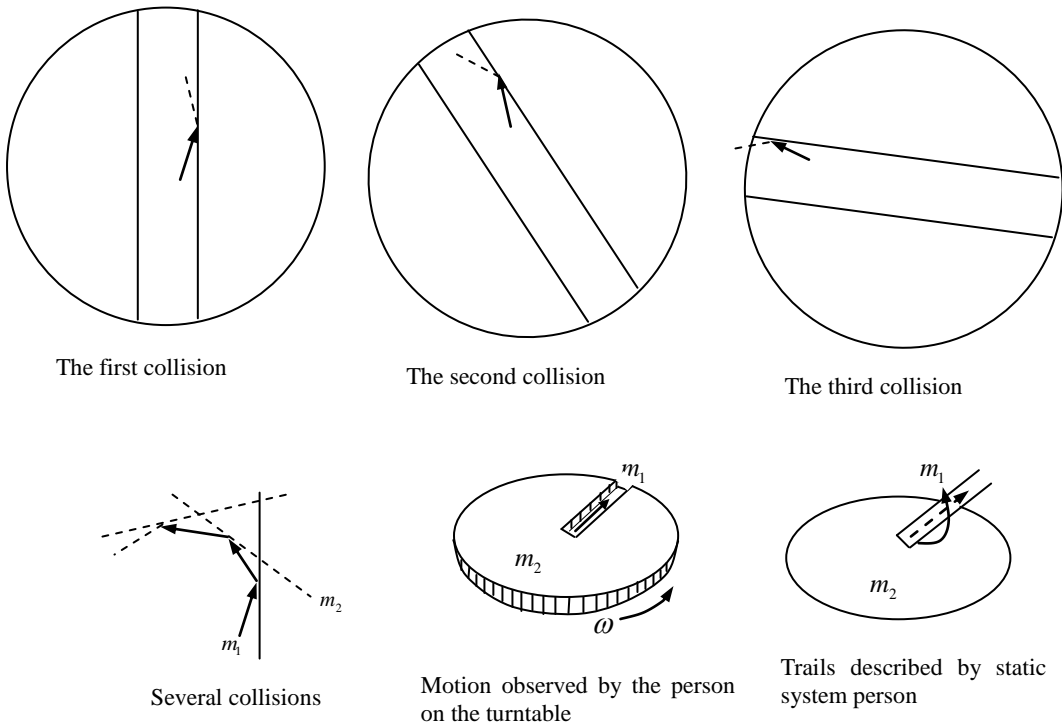


Figure 7 Exploded view of slant collision motion process

In the motion equation  $\mathbf{F}_a = \mathbf{F}_b + \mathbf{F}_c + \mathbf{F}_r$ , traction force  $\mathbf{F}_b$  is inertia force in the parallel motion, Coriolis force  $\mathbf{F}_c$  is inertia force in the rotational motion, they both come from inertia; relative force  $\mathbf{F}_r$  is additional force, it is derived by interaction of the objects. Inertia force runs through the motion equation, it can be felt and measured, it comes from absolute space and it is the representation of absolute space. We say that inertia force comes from absolute space, but we don't mean that absolute space can derive force; we mean that inertia force (primary or final) comes from original power supplied by non-inertia system, and original power (parallel or rotational) reflects inertia force through absolute space. Traction force and Coriolis force are the same. Falling object with east declination is the same, because initial tangential speed of the falling object is  $\omega(R + \Delta h)$ , and tangential speed of the ground surface is  $\omega R$ , inertia speed is supplied by momentum  $m_0\omega\Delta h$ . So we say it is true.

The ball tied on the rope is moving in cycles, when the rope is broken, the ball changes to tangential motion due to inertia. When losing control, although it moved in cycles before, no matter

what mass it is, the ball will change to tangential motion. This explains that inertia is reflected through “linear type” Euclidean space. In above figures, we can see clearly that: inertia is indeed reflected through “linear type” Euclidean space, and the curve trails is overlaid by several linear lines. This further explains: inertia reflected through space will not change with the motion state; it has its own build-in attribute. This also explains: space itself will not change with the motion state, it has its own build-in attribute, that is to say, object moves in absolute space, it will not change nature of the space; it will only represent some attribute of absolute space. Meanwhile, we can find that: inertia is the same in every direction, and it will not show the situation left-hand inertia larger than right-hand inertia. This proves that inertia caused by object’s motion in the space is isotropy, and space itself is also isotropy.

We say that inertia is the representation of absolute space. In my opinion, it is clearest to Einstein. In the first article of relativity, Einstein first emphasized that “Discussing absolute space is meaningless, because the different in mechanics caused by earth rotation is tiny. According to Maxwell electrodynamics ... Since then, space should not be symmetric”. Why Einstein said this by contrast, because he was clever, he has realized that inertia in earth rotation was the representation of absolute space. So, he asked others to omit the inertia representing absolute space, and he asked others to take a notice of asymmetric space caused by Maxwell asymmetric equation. So far as his ways, I have to admire his intelligence and wisdom.

## 4 Conclusion

For the question clock slowing down in the equator line, according to Newton’s law, the pendulum cycle of the earth’s two poles is  $T = 2\pi\sqrt{\frac{l}{g}}$ , and according to Newton law of inertia, the

pendulum cycle in earth equator line is  $T = 2\pi\sqrt{\frac{l}{g - a_{离}}}$ . Pendulum is placed in the elevator, when

the elevator rises at acceleration, the pendulum speeds up; when the elevator falls at acceleration, the pendulum slows down. All the clocks generated by object’s motion (including particle’s motion) will be influenced by acceleration. The clock’s speed depends on acceleration, not the constant linear motion. Clock is man-made measure attribute; it depends on measure tool and environment. But time is not clock, time is nature attribute; it is absolute and one-dimension elapsed, and Galilean transformation principle has proved that time is absolute and one-dimension elapsed for a long time. This article discussed absolute space based on Newton's laws of mechanics. The reason I choose mechanics to discuss rather than electromagnetics and optics is because the mass of electric field, magnetic field and optical field is zero, and they do not have inertia or occupy absolute space, so electromagnetics and optics can not distinguish the existence of absolute space (except the deviation caused by observing remote stars). As for the space of relativity, it is mathematic space varied by Lorenz assumption according to wrong curl equation sets, so it is not physical space.

This article mainly supports the space view of Newton – Galilean, and adopts Newton’s law to explain why clock slows down in the equator line. We can say that Newton is the greatest scientist in our universe; he revealed the universal mystery scrupulously and devoted his life for our human. It is a pity that his life is limited, his time can’t dilate or move backward, so he did not reveal the

First Cause, and he never thought light velocity would be restricted. What is most valuable, Newton didn't imagine, suspect or have a chimera, or played mathematic games. Otherwise, we will be misled in science research.

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