The Speed of Light in a Spherical Cavity and Non-uniqueness of The Speed of Light in Vacuum

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In a vacuum spherical cavity, the speed of vacuum light can be small or large. The speed of vacuum light is not unique. The speed of vacuum light and the speed can not be set upper limits.

Keywords: General Relativity; Schwarzchild Internal Solution; Spherical Shell's Internal Solution; Reissner-Nordström Solution; The Speed of Light In a Spherical Cavity; Non-uniqueness of The Speed of Light In Vacuum

I. INTRODUCTION

Is the speed of vacuum light always 300,000 kilometers per second in the vast universe?

In vacuum, the center of the uniform sphere is a vacuum, but the speed of light is smaller than the speed of light of the vacuum outside. So the speed of light in vacuum is not unique.

Einstein established the general relativistic equation.

$$G_{\mu\nu} + g_{\mu\nu}\wedge = R_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu} + g_{\mu\nu}\wedge = \kappa T_{\mu\nu}$$

Schwarzchild solves the Schwarzchild internal solution of static homogeneous sphere.

$$ds^2 = (\frac{3}{2}\sqrt{1-Ar_B^2} - \frac{1}{2}\sqrt{1-Ar^2})^2 c^2 dt^2 - \frac{1}{1-Ar^2}dr^2 - r^2(d\theta^2 + \sin^2\theta d\varphi^2)$$

In the formula, $A=1/3\kappa\mu c^2=8/3\pi G\mu c^{-2}$.

Reissner-Nordström solution:

$$ds^2 = (1 - \frac{2m}{r} + \frac{\kappa Q^2}{2r^2})c^2 dt^2 - \frac{1}{1 - \frac{2m}{r} + \frac{\kappa Q^2}{2r^2}}dr^2 - r^2(d\theta^2 + \sin^2\theta d\varphi^2)$$

II. ANALYSIS OF GRAVITATIONAL FIELD AT THE CENTER OF A SPHERE

1) Gravitational field at the center of a sphere

The center point r = 0 is substituted, and we obtain:

$$ds^2 = (\frac{3}{2}\sqrt{1-Ar_B^2} - \frac{1}{2})^2 c^2 dt^2 - dr^2 - r^2(d\theta^2 + \sin^2\theta d\varphi^2)$$

$$ds^2 = g_{00}c^2dt^2 - dr^2 - r^2(d\theta^2 + \sin^2\theta d\varphi^2)$$

$$= g_{00}c^2dt^2 - dl^2 = g_{00}c^2dt^2 - dx^2 - dy^2 - dz^2$$

$$g_{00} = (\frac{3}{2}\sqrt{1-Ar_B^2} - \frac{1}{2})^2 < 1$$

It can be seen that at the center point, the gravitation and gravitational acceleration are 0, and the light travels in a straight line, but the g_{00} is not 1, but less than 1.

2) The speed u_c of light at the center of the sphere

$ds^2=g_{00}c^2dt^2-dl^2=0$

$u_c=dl/dt=g_{00}^{1/2}c<c$

CONCLUSION: **The light speed u_c at the center of the sphere is less than the standard light speed c.**

3) Gravitational Field and Light Speed u_c near the Center Point of a Sphere

Because of the continuity, the above conclusion is still valid for the minimal space near the center point.

CONCLUSION: **The gravitation and gravitational acceleration near the center point is 0 and the light travels in a straight line, but the g_{00} is not 1, but less than 1, and the speed of light is less than the standard speed of light c.**

4) Gravitational Field and Light Speed u_c of a Small Round Hole At The Center Point

Dig a small round hole at the center point. Because the influence is so small, it can be ignored, and the above conclusions is still valid.

CONCLUSION: **The gravitation and gravitational acceleration in the small round hole at the center point are 0, and the light travels in a straight line, but g_{00} is not 1, but less than 1, and the speed of light is less than the standard speed of light c.**

III. ANALYSIS OF THE GRAVITATIONAL FIELD IN SPHERICAL SHELL

The central small hole model above is actually a thick spherical shell model. The above is the conclusion derived from the extreme thinking of Schwarzchild internal solution. The gravitational field of the general spherical shell is directly solved below.

The tensor equation is solved by using continuum and other boundary conditions.

The outer diameter is r_B and the inner diameter is r_0.

Remember $r_e^2 = (r^3 - r_0^3)/r$.

Remember $r_x^2 = (r_B^3 - r_0^3)/r_B$.

Remember $g\_00 = g_{00}^{1/2}$.

From $G^0{}_0 = \kappa T^0{}_0 = \kappa\mu = 3A$, we obtain $d(-r g_{11}^{-1}) = d(r - Ar^3)$.

$-r g_{11}^{-1} = r - Ar^3 + C1$

$-g_{11}^{-1} = 1 - Ar^2 + C1/r$

C1 is an integral constant.

The boundary conditions are considered below.

When $r = r_B$, it is consistent with the Schwarzchild external solution $-g_{11}^{-1} = 1 - A(r_B^3 - r_0^3)/r_B$.

We get $C1 = A r_0^3$.

It can also be solved continuously by $-g_{11} = 1$ at the inner boundary.

$-g_{11}^{-1} = 1 - A(r^3 - r_0^3)/r = 1 - A r_e^2$

For solid balls, C1=0.

As can be seen:

g_{11} depends on the average density inside the sphere surface.

From $G^1{}_1 = \kappa T^1{}_1$ and $G^2{}_2 = \kappa T^2{}_2$, the equation for g_{00} and g_00 is obtained.

$$d(g\_00(1-Ar^2+Ar_0^3 r^{-1})^{-1/2})/dr = 3/2\,(1 - A r_x^2)^{1/2}\, d((1-Ar^2+A r_0^3 r^{-1})^{-1/2})/dr - (3/4)(1-Ar_x^2)^{1/2} A r_0 (r_0/r)^2 (1-Ar^2+Ar_0^3 r^{-1})^{-3/2}$$

For the thick spherical shell of $r_0 r_B^{-1} \rightarrow 0$, the last item is ignored, and we get:

$$g\_00\,(1-Ar^2+Ar_0^3 r^{-1})^{-1/2} = 3/2(1-Ar_x^2)^{1/2}(1-Ar^2+Ar_0^3 r^{-1})^{-1/2} - C2$$

$$g\_00 = 3/2(1-Ar_x^2)^{1/2} - C2(1-Ar^2+Ar_0^3 r^{-1})^{1/2} = 3/2(1-Ar_x^2)^{1/2} - C2(1-Ar_e^2)^{1/2}$$

C2 is the integral constant. The latter term of g_00 of the internal solution depends on the average internal density of the spherical surface. The coefficient C2 depends on the boundary condition "continuity".

When $r = r_B$, it is consistent with the Schwarzchild external solution $g\_00 = (1 - A(r_B^3 - r_0^3)/r_B)^{1/2}$.

We get $C2 = 1/2$.

$$g\_00 = 3/2(1-Ar_x^2)^{1/2} - 1/2(1-Ar^2+Ar_0^3 r^{-1})^{1/2} = 3/2(1-Ar_x^2)^{1/2} - 1/2(1-Ar_e^2)^{1/2}$$

Get the inner solution:

$$ds^2 = g_{00}c^2dt^2 - (1-Ar_e^2)^{-1}dr^2 - r^2d\theta^2 - r^2\sin^2\theta d\varphi^2$$

$0 < g_{00} < 1$

The above conclusion is valid for the general static spherical shell.

When $r_0 = 0$, it degenerates into the Schwarzchild innernal solution.

The extremely thick spherical shell for $r_0 r_B^{-1} \rightarrow 0$ is the small hole dug in front:

$$g_{00}(r_0) = (3/2(1-Ar_x^2)^{1/2} - 1/2)^2 = (3/2(1-Ar_B^2)^{1/2} - 1/2)^2$$

IV. ANALYSIS OF THE GRAVITATIONAL FIELD OF SPHERICAL CAVITY

In Newtonian mechanics, we know that the gravitation and gravitational acceleration of the spherical cavity are 0. This is a fact that can be verified by experimental measurements. It has nothing to do with specific theory. Therefore, it is still valid in the general theory of relativity.

Because there is no gravitation, the light travels in a straight line.

So, $g_{\mu\mu}$ are all constant.

$$ds^2 = g_{00}c^2dt^2 + g_{11}dx^2 + g_{22}dy^2 + g_{33}dz^2$$

Because xyz are symmetric, $g_{11}=g_{22}=g_{33}$.

$ds^2=g_{00}c^2dt^2+g_{11}(dx^2+dy^2+dz^2)=g_{00}c^2dt^2+g_{11}dl^2$
$=g_{00}c^2dt^2+g_{11}(dr^2+r^2d\theta^2+r^2sin^2\theta d\varphi^2)$

At the same time, the metric of static isotropic symmetry is:

$ds^2=g_{00}c^2dt^2+g_{11}dr^2-r^2d\theta^2-r^2sin^2\theta d\varphi^2$

Comparing the coefficients of the last two items, we get:

$-g_{11}=1$

In fact, it is already $-g_{11}=1$ before crossing the internal interface.

Therefore,

$ds^2=g_{00}c^2dt^2-dx^2-dy^2-dz^2=g_{00}c^2dt^2-dl^2$

We can see from the previous:

$0<g_{00}<1$

$ds^2=(w(k_t dt))^2-dr^2-r^2d\theta^2-r^2sin^2\theta d\varphi^2$

For a thick spherical shell of $r_0r_B^{-1}\rightarrow 0$, $g_{00}(r_0)=(3/2(1-Ar_x^2)-1/2)^2$

The speed u_c of light in the inner cavity:

$ds^2=g_{00}c^2dt^2-dl^2=0$

$u_c=dl/dt=g_{00}^{1/2}c<c$

The speed of light in the inner cavity is less than the standard speed of light c.

There is no gravitation and gravitational acceleration in the inner cavity of the spherical shell in vacuum, so it can be considered as a vacuum.

CONCLUSION: **In vacuum, the coefficients g_{00} of the static spherical cavity is reduced and the space-time is flat. The spherical shells do not affect the space-time flatness, have no gravitation or gravitational acceleration, and space in cavity is also vacuum. The speed of light is less than the standard speed of light *c***.

The inside space is also a vacuum, and the outside space in the distance is also a vacuum. But the speed of light at the two places are different. So there are:

Vacuum light speeds are not unique.

V. THOUGHT EXPERIMENTS ABOUT HEAVENLY DOME

The structure of spherical shells in the universe is called the **heavenly-dome**.

Suppose we have a spherical shell on the outside, that is, heavenly-dome.

Looking outside the spherical shell, the vacuum light speed c_{in} inside the spherical shell is smaller than the vacuum light speed c_{ex} outside the spherical shell.

And the speed of light inside is the standard speed of light c.

$cex>c_{in}=c$

For the outside observer, the actual measured vacuum speed $c_{ex}>c$, there is really no reason to ask him to think that the vacuum speed is another small c. So for outside observers, the vacuum speed is c_{ex} instead of c. When writing a metric, he can use the outside vacuum light speed c_{ex} instead of c.

The outside vacuum speed is $c_{ex}>c$, and the vacuum speed inside is c. Therefore, **the speeds of light in vacuum are not unique**.

The speed of light in the vacuum outside is $c_{ex}>c$. Therefore, **the speed of light in the vacuum can be greater than the standard speed of light (*c*).**

Since the amount of the outside material cannot be limited, the external vacuum light speed c_{ex} cannot be limited. Therefore, **the speed of vacuum light cannot be limited.**

Therefore, at present, **speed cannot be limited**.

VI. METRIC OF THE INNER CAVITY OF A RICHLY CHARGED SPHERICAL SHELL

The effect of charge is opposite to the mass. When charged, the charge plays a dominant role.

At this time, we can know that $g_{00}>1$ by Reissner-Nordström solution.

The charge is concentrated on the outer surface of the metal. Considering a thin spherical shell, the thickness is negligible. Because of the continuity of g_{00}, the value of g_{00} of external solution is maintained in the inner cavity. $g_{00}>1$.

Based on the same analysis above, the inner cavity space is vacuum and the inner cavity metric is:

$$ds^2=g_{00}c^2dt^2-dx^2-dy^2-dz^2=g_{00}c^2dt^2-dl^2$$

$g_{00}>1$

The above conclusions are valid for the general static rich charge spherical shell.

The speed u_c of light in the inner cavity:

$ds^2=g_{00}c^2dt^2-dl^2=0$

$u_c=dl/dt=g_{00}^{1/2}c=(1-2m/r_B+kQ^2/r_B^2)^{1/2}c>c$

The vacuum speed of the inner cavity is greater than the standard speed of light c.

CONCLUSION: **The coefficient g_{00} of the inner cavity of the rich charge in the vacuum increases, the space-time is flat, the spherical shell does not affect the space-time flatness, there is no gravitation or gravitational acceleration, the inner cavity space is also vacuum, and the speed of light is greater than the standard speed of light c.**

In addition, outside the spherical shell, the speed of light near the outer surface is faster.

$ds^2=(1-2m/r+kQ^2/r^2)c^2dt^2-(1-2m/r+kQ^2/r^2)^{-1}dr^2=0$

$u_r=dr/dt=(1-2m/r_B+kQ^2/r_B^2)c>u_c>c$

In addition, outside the spherical shell, near the outer casing, the speed of light along the spherical surface is as fast as the interior.

$ds^2=g_{00}c^2dt^2-dl_s^2=0$

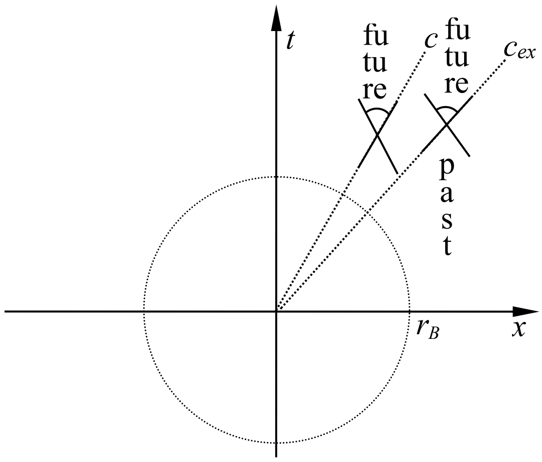
$u_s=dl_s/dt=g_{00}^{1/2}c=(1-2m/r_B+kQ^2/r_B^2)^{1/2}c=u_c>c$

VII. HOW TO UNDERSTAND DIFFERENT VACUUM LIGHT SPEEDS?

The theoretical vacuum speed of light is actually, in pure mathematics, when r^{-1} approaches zero, the asymptotic slope of space-time graph of a piece of logic, and the asymptotic slope is the limit slope of the cone. It's not really infinite. We have not actually gone to infinity, just to deduct from mathematics.

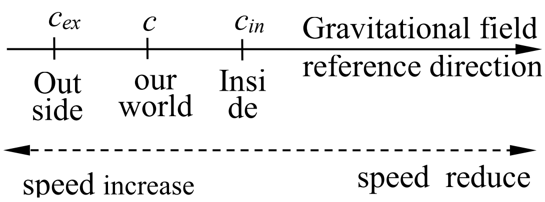
There are different asymptotes in the spherical shell and outside the spherical shell. The speed at which the asymptote corresponds to the cone of light is the vacuum speed. The slope of the asymptote to the t-axis is the speed of vacuum light. Outside the spherical shell, there is a larger limit cone and a larger vacuum speed.

From the perspective of differential equations, general relativistic differential equations must be solved in sections. Each segment has its own asymptote and limit cone.



From the gravitational field influence trend, the gravitational field can slow down the speed of light infinitely. Then, in reverse, it can be said that the speed of light can increase infinitely. And we have already known through measurement that the speed of light at a certain node of the universe is the standard speed of light c, then there may be a speed of light c_{ex} greater than the standard speed of light c. In other words, the standard speed c of light we get may actually be the low speed of light that is reduced by the gravitational field outside.

The key point is that the spherical shell has no effect on the g_{11}, gravitational and gravitational acceleration of the lumen, but has a cumulative effect on g_{00}. At then same time, spherical shell causes segmentation of the equation.



3 metrics from outside to inside:

outside : $ds^2=(1-2m/r)c_{ex}^2dt^2-(1-2m/r)^{-1}dr^2-r^2d\theta^2-r^2sin^2\theta d\varphi^2=((1-2m/r)c_{ex}^2/c^2)c^2dt^2-(1-2m/r)^{-1}dr^2-r^2d\theta^2-r^2sin^2\theta d\varphi^2$

we: $ds^2=(1-2m/r)c^2dt^2-(1-2m/r)^{-1}dr^2-r^2d\theta^2-r^2sin^2\theta d\varphi^2$

inside: $ds^2=(1-2m/r)c_{in}^2dt^2-(1-2m/r)^{-1}dr^2-r^2d\theta^2-r^2sin^2\theta d\varphi^2=((1-2m/r)c_{in}^2/c^2)c^2dt^2-(1-2m/r)^{-1}dr^2-r^2d\theta^2-r^2sin^2\theta d\varphi^2$

From the perspective of the formula, the formula can be unified into the form of the standard speed of light c. Accordingly, g_{00} needs to be multiplied by a constant. Therefore, the Einstein gravitational equation can be applied. They all satisfy the Einstein gravitational equation. The Einstein gravitational equation itself supports higher vacuum speeds of light and different vacuum speeds of light. The standard speed of light c in Einstein's gravitational equation is only a reference standard for vacuum speed of light, similar to the melting point of ice as a reference for temperature.

Mach's principle is the starting point of general relativity. Einstein praised it early.

But in the later period, he found that the Mach principle and the final general theory of relativity were not compatible at all. He abandon the principle of Mach completely.

Mach's principle, from the starting point, becomes the final abandonment.

The general relativistic equation can deduce that the velocity of vacuum light is not unique.

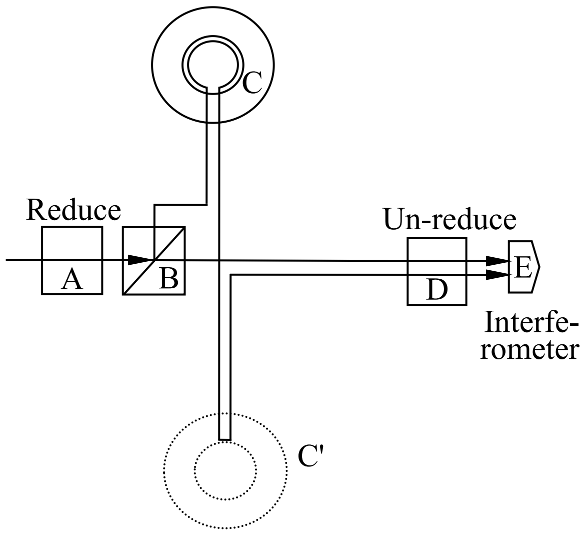
It is understandable that, the uniqueness of the speed of vacuum light becomes the final abandonment from the starting point. And after abandoning it, general relativity becomes greater.

VIII. INFLUENCE

First, there is no upper limit on speed. Human life has become more meaningful.

Second, cosmology needs to be adjusted. Previous cosmological model designs did not take into account different vacuum light velocities, and larger vacuum light velocities.

IX. VERIFICATION EXPERIMENT OF LIGHT SPEED REDUCTION IN SPHERICAL CAVITY



As shown in the figure, the interfering laser passes through the speed reducer A to greatly reduce the traveling speed. After half-silvered mirror B, it is divided into two strands and enters two channels of fiber. One fiber enters the large-mass or richly charged spherical shell C, and the optical path in C is very long. The other fiber is away from C. After the un-reducer D the laser returns to normal. Then enter the interferometer E.

First move C to the symmetrical position C' (can not move if the requirements are not high), to ensure that the influence of the optical path outside the shell always the same, adjust the optical path, and ensure that the interference fringe is in the center. Then, C is moved back, and the optical path passes through C, and the number of stripes movement Δn (including the direction) is measured. Verify that the speed of light u_c in C is slow.

It is also possible to use a well-designed optical path without using an optical fiber, and to ensure sufficient travel within C.

Do it on earth first. Conditionally re-do it in space vacuum. In the initial test, it can be tested on the outer surface of C.

Calculation of the number of moving stripes:

The optical path length of the inner portion of the spherical shell is L.

Normal running time is $t=L/c_1$, and number of cycles is $n_1=tv_1=L/\lambda_1$.

When running in the inner cavity of the spherical shell, the number of cycles is $n_2=tv_2=(L/\lambda_1)g_{00}^{1/2}$.

The number of moving fringes is $\Delta n=n_1-n_2=(L/\lambda_1)(1-g_{00}^{1/2})$.

X. MOONLIGHT BOX

The moonlight box is a device that increases the light path.

A pair of parallel mirrors are laser-engraved into N rows, each row having M pairs of small round mirrors. Light is reflected first in the first row in turn, and then reflected to the second row. Then reflected in the second row in turn, and so on, until the last small mirror is reflected.

XI. RELATED CONCLUSIONS

1.1) The metric of Schwarzchild internal solution of center of vacuum sphere is:

$$ds^2 = g_{00}c^2dt^2 - dr^2 - r^2(d\theta^2 + \sin^2\theta d\varphi^2) = g_{00}c^2dt^2 - dl^2$$

$$g_{00} = (\frac{3}{2}\sqrt{1-Ar_B{}^2} - \frac{1}{2})^2 < 1$$

1.2) The gravitational and gravitational accelerations at the center of the vacuum ball are both 0.

1.3) The center of the vacuum ball is a vacuum.

1.4) The light speed in the center of the vacuum sphere is $u_c=dl/dt=g_{00}^{1/2}c<c$.

1.5) The vacuum light speed in the center of the vacuum sphere is $u_c=dl/dt=g_{00}^{1/2}c<c$.

1.6) The gravitational force and acceleration of the small hole in the center of the vacuum sphere are both 0.

1.7) The small hole in the center of the vacuum ball is vacuum.

1.8) The light speed of the small hole in the center of the vacuum sphere is $u_c=dl/dt=g_{00}^{1/2}c<c$.

1.9) The vacuum light speed of the small hole in the center of the vacuum sphere is $u_c=dl/dt=g_{00}^{1/2}c<c$.

2.1) The metric of the vacuum spherical cavity is $ds^2=g_{00}c^2dt^2-dx^2-dy^2-dz^2=g_{00}c^2dt^2-dl^2$, $0<g_{00}<1$.

2.1) The gravitational force and acceleration of the vacuum spherical cavity are both 0.

2.2) The inner cavity of the vacuum spherical shell is a vacuum.

2.3) The speed of light in the vacuum spherical cavity is $u_c=dl/dt=g_{00}^{1/2}c<c$.

2.4) The vacuum light speed of the vacuum sphere cavity is $u_c=dl/dt=g_{00}^{1/2}c<c$.

2.5) Vacuum light speeds are not unique.

3.1) If there is a heavenly-dome outside us, the vacuum light speed c_{ex} outside it is larger than the standard vacuum speed c inside, $c_{ex}>c$.

3.2) The vacuum light speed can be greater than the standard vacuum speed c.

3.3) We cannot give an upper limit to the speed of vacuum light.

3.4) We cannot give an upper limit to the speed.