**Article**

# Twin Paradox: A New Point of View

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**ABSTRACT**

In this article, we present a new analysis of the twin paradox and a thought-experiment with gravitational field. These hypotheses may explain dark energy.

**Keywords:** Special relativity, relative motion, twin paradox, dark energy.

## Introduction

In the twin paradox, two brothers are separated and one of them gets on a rocket, which runs at a speed close to that of light, while the other remains on earth. At the midpoint of the trip, rocket travel in the opposite direction (towards the earth). Which twin would be younger?

There are two solutions to the twin paradox:

A) The Space Twin will have aged slower, because he had to accelerate in order to get up to his great speed. However, there is no mechanism in Special Relativity for the past history of some state of motion to directly exert causal power on things now. There is nothing to remember if a system accelerated.

B) Another way of resolve twin paradox is the use of the relativistic Doppler Effect. Many authors (3, 6) in this case, use Lorenz equation of space. Space in earth is a rest frame. Therefore earth, in relativistic Doppler Effect, became a rest frame a priori; but all laws of nature are the same as measured by observers that are moving at constant velocity relative to each other. There is no reason to consider earth a special system.

Any solution gives rise to some doubt. We create an ideal experiment to clarify the problem.

## Gedanken Experiment

We build a rocket with a lift. Lift is only another frame and it is not near to any massive body (now).

Suppose three clocks:

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- one on earth
- one in a rocket
- one in lift on the rocket

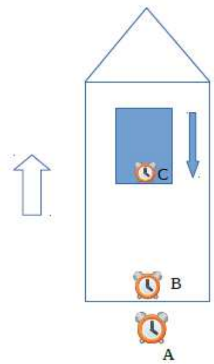


**Figure 1.** Three clocks: A on earth, B on rocket, C on lift

The lift with the clock C moves in the opposite direction but with same value of the rocket, therefore, the clock A and the clock C, for a short period, are located in the same reference system.

At the end of the journey comparing 3 watches:

B is slower of A and result is

$$A> B$$

But also considering C, we can think several hypotheses:

Since C is in motion for a period less than B someone can assume the following result:

$$A> C> B \qquad [1]$$

But in this case an astronaut on the rocket, and supportive to clock B, would see the clock C does not slow down but increase the flow of time. But lift accelerated in the rocket (fig.2 right)! Both reference frames (A and B)are equally good!.

This would cause a symmetry breaking directional. Experiments have shown that this does not happen (1, 2)

The result

$$A> B> C \quad [2]$$

Means that A and C are in different places ,but they are in the same frame (for a short time) and should sense a different flow of time (fig 2,left).If B>C than clock on lift and clock on earth measure a different time when they are in same frame. The result A>B>C is a new paradox if we see experiment from earth.

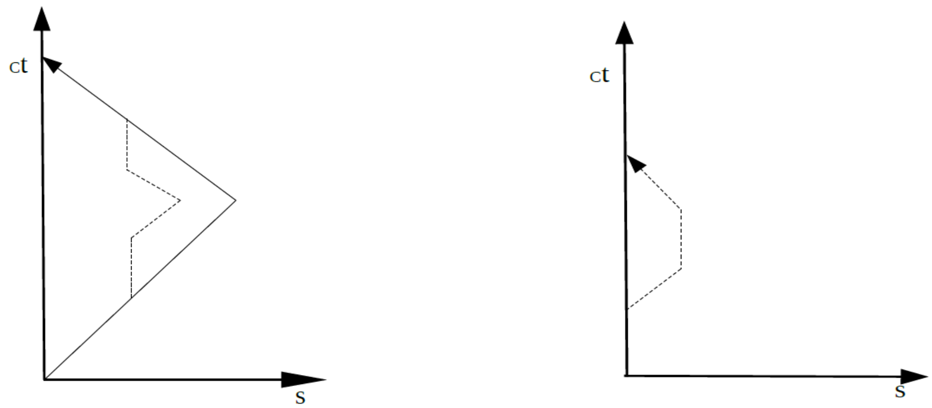


**Figure 2**. Minkowski 's graph: Dotted line show clock C from earth(left) and from rocket (right)

Some other solutions are described in appendix.

## Thought Experiment with Gravitational Field

One plausible result is that gravity decides which reference system to use. If you run the experiment on earth would the result [1], but if the rocket is in space would have the result [2].There is a different result because system changes its reference frame. However speed of light is a limit in each frame.

This implies that gravity, not only change the space-time, but it indicates reference frame. Now we wonder what will happen if we pass by an example [1] to the situation [2]. We must assume that the speed to be changed as provided by relativity, but assuming that momentum is constant.

A mass state A (with speed Va and distance from the center of gravity Ra) became state B (with speed Vb and Rb distance from the center of gravity M).

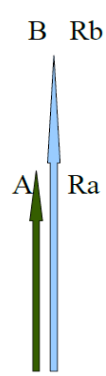


**Figure 3**. Mass in a rocket with gravitational field from A to B

We can use the Schwarzschild vacuum solution of Einstein's gravity equations:

$$\frac{1}{\sqrt{1-\frac{2MG/r}{c^2}}} = y \qquad [3]$$

relativistic momentum in A and B are:

$$m*V*y_a = P_a \qquad [4]$$

$$m*V*y_b = P_b \qquad [5]$$

as a rocket become a rest frame, momentum result

$$m*V_a = P_a \qquad [6]$$

$$m*V_b = P_b \qquad [7]$$

momentum don't change than we can write:

$$m*V*y_a = m*V_a \qquad [8]$$

$$m*V*y_b = m*V_b \qquad [9]$$

and

$$\frac{y_a}{y_b} = \frac{V_a}{V_b} \qquad [10]$$

substitute [3] in [10]

$$\frac{\sqrt{\frac{1}{1-\frac{2MG}{C^2 r_b}}}}{\sqrt{\frac{1}{1-\frac{2MG}{C^2 r_a}}}} * V_a = V_b \qquad [11]$$

$$\frac{C^2 r_b * r_a - 2MGr_b}{C^2 r_b * r_a - 2MGr_a} V_a^2 = V_b^2 \quad [12]$$

assuming

$$r_b = r_a + x \quad [13]$$

this becomes

$$V_b = V_a \sqrt{\frac{C^2 (r_a + x) * r_a - 2MG(r_a + x)}{C^2 (r_a + x) * r_a - 2MGr_a}} \quad [14]$$

since

$$a = \frac{dV}{dt} = \frac{\frac{dV}{dt} * dX}{dX} = V * \left(\frac{dV}{dx}\right) \quad [15]$$

$$a = f(x) \frac{df(x)}{dx} \quad [16]$$

than

$$a = V_a \sqrt{\frac{C^2 (r_a + x) * r_a - 2MG(r_a + x)}{C^2 (r_a + x) * r_a - 2MGr_a}} \frac{\delta}{\delta x} V_a \sqrt{\frac{C^2 (r_a + x) * r_a - 2MG(r_a + x)}{C^2 (r_a + x) * r_a - 2MGr_a}} \quad [17]$$

which, rearranged, becomes

$$a = V_a \sqrt{\frac{C^2 (r_a + x) * r_a - 2MG(r_a + x)}{C^2 (r_a + x) * r_a - 2MGr_a}} * V \left( \frac{-2MG(rC^2 - 2GM)}{2r((r + x)C^2 - 2GM)^2 \sqrt{\left(\frac{C^2 (r_a + x) * r_a - 2MG(r_a + x)}{C^2 (r_a + x) * r_a - 2MGr_a}\right)}} \right) \quad [18]$$

$$a = V^2\left(\frac{-2MG\left(rC^2 - 2GM\right)}{2r\left(\left(r+x\right)C^2 - 2GM\right)^2}\right) \qquad [19]$$

as x nears 0 then [19] became:

$$a = \lim V^2\left(\frac{-2MG\left(rC^2 - 2GM\right)}{2r\left(\left(r+x\right)C^2 - 2GM\right)^2}\right) = V^2\left(\frac{-2MG}{r\left(C^2 r - 2MG\right)}\right) \qquad [20]$$

add gravitational acceleration:

$$a_{ist} = V^2\left(\frac{-2MG}{2r\left(rC^2 - 2GM\right)}\right) - \frac{MG}{r^2} = \frac{MG\left(rC^2 + rV^2 - 2MG\right)}{r^2\left(2MG - rC^2\right)} \qquad [21]$$

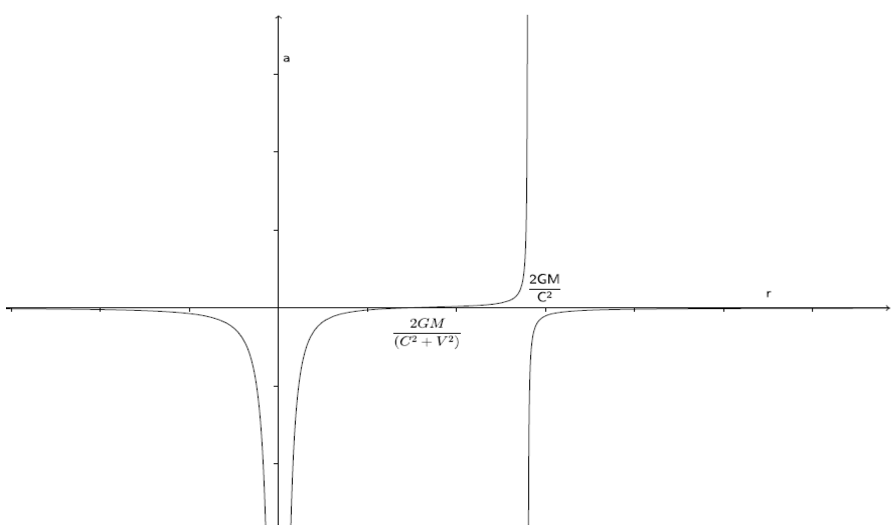


**Figure 4**. Acceleration versus distance (r)

Function [21] assumes a value of 0 for

$$r = \frac{2GM}{C^2 + V^2} \qquad [22]$$

For potential energy we have

$$E = -\int m * \left( \frac{MG\left(rC^2 + rV^2 - 2MG\right)}{r^2\left(2MG - rC^2\right)} \right) = m * V^2 \ln\left( \sqrt{\left| \frac{r}{2rC^2 - 4GM} \right|} \right) - \frac{GmM}{r} \qquad [23]$$

There is a new energy:

$$E = m * V^2 \ln\left( \sqrt{\left| \frac{r}{2rC^2 - 4GM} \right|} \right) \qquad [24]$$

## Numerical Calculations

If we can suppose relative average speed in universe is about V=C/2 and M is visible mass of universe, than we can calculate when universe modified its direction of acceleration with equation [22]. This value is about $18{,}2 * 10^9$ light years.

We can also calculate value of this new energy with equation [24] $E=4*10^{-30}$ g/cm$^3$ $=3.61*10^{-10}$J/m$^3$ in good agreement with the experimental value. Experimental value of dark energy density is (7) $6.3*10^{-10}$J/m$^3$.

## Conclusion

In this article we analyze twin paradox but any solutions cannot describe completely this gedanken experiment. So we create a new thought experiment and show that the twin paradox maybe incomplete.

In Michelson-Morley experiment light speed is a constant but Consoli et al. (4) describe “a non-zero observable Earth's velocity”.
We can suppose that gravity can change rest frame (but momentum remains constant). This solution creates a new type of energy. The new energy is equivalent to the dark energy. In this conjecture everything go to Schwarzschild's limit.

## Appendix

A) One can also assume that the relativity of space (by shortening the length of the lift) affect the calculation of the time in C. The rocket, however, is shorter by a factor γ and therefore for the measured time A will be reduced by the same factor, then B and C will measure the same value.

But then it is deduced that the time measured in B and C must be the same.

B) Someone can suppose that Twin on earth measure a different speed of lift, we can use the equations of Lorenz.

We calculate the speed of the lift U

$$dx = \gamma * (dx' - Vdt') \qquad [I]$$

$$dt = \gamma * \left(dt' - \frac{Vdx'}{c^2}\right) \qquad [II]$$

[I] and [II] together

$$U = \frac{dx}{dt} = \frac{\gamma * (dx' - Vdt')}{\gamma * \left(dt' - \frac{Vdx'}{c^2}\right)} = \frac{\frac{dx'}{dt'} - v}{1 - \frac{Vdx'}{c^2 dt'}} = \frac{u - v}{1 - \frac{vu}{c^2}} \qquad [III]$$

being u = v is shown that the elevator is stationary to earth.

## Reference

1. Robert Blum, Lorentz Symmetry Breaking, Physic World, 17, n3, pp.41-46, March 2004 http: //physicsweb.org/article/world/17/3/7
2. Pospelov Maxim Michael Romalis, Lorentz invariance on trial, Physics Today vol 57, No 7, pp40-46,2004
3. Ronald C. Lasky, "How does relativity theory resolve the Twin Paradox?",Scientific American;(2003), http://www.scientificamerican.com/article/how-does-relativity-theor/
4. M. Consoli E. Costanzo,"The motion of the Solar System and the Michelson-Morley experiment",(2003), http://cds.cern.ch/record/686813/files/0311576.pdf
5. Tamara M. Davis, Charles H. Lineweaver,"Expanding Confusion: common misconceptions of cosmological horizons and the superluminal expansion of the Universe" (2003), http://arxiv.org/abs/astro-ph/0310808v2
6. G. G. Nyambuya,"A Solution to the Twin Paradox from Within the STR without Invoking Accelerations" (Unpublished)
7. Martin L. Perl,"Exploring the possibility of detecting dark energy in a terrestrial experiment using atom interferometry" arXiv:1001.4061v1 [physics.ins-det] 22 Jan 2010