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Karami D

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Generalizing the physical time impact on the astronauts living on the international space station to the theory of relativity

Author(s): Danial Karami

Independent author - Contact: Danial.karami2004@gmail.com

SUMMARY

Traveling in the time has been an interesting topic almost for everyone in the world. The representatives of the community who are scientists worked on this project a lot. As time passed by, humanity information has developed more and more so by considering the obtained information throughout history, some scientists have succeeded in explaining some hypothesis that changed the mind of society about being not capable to travel in the time. Anyway in this research we will get familiar with the suggested paths that make us capable to travel in the time and find out how it is possible. Also, by analyzing and checking out some figures and available data about astronauts, it investigated that traveling in time is not a dream anymore and the rate of passing time can be changed by using nowadays technology.

INTRODUCTION

Traveling in the time has been a popular challenge from a long time ago. Many people has worked on it for instance, a lot of scientist announced new theories in order to improve human's knowledge about the methods that can be used for understanding the time better. For example, Albert Einstein proposed that wormhole can be a perfect choice for time travel because it curves the space so if instead of going from a point to a particular destination directly, someone goes into a wormhole; time travel won't be a dream anymore because wormholes can provide a shortcut way to the destination which are really shorter than the normal path (1). Surviving in wormholes is a hard challenge that seems to be impossible and its technology is not available currently, but maybe the future generations will be able to travel in the time by inventing a new approach to use this path as a result it will be dedicated to them.

anyway, there were a lot of scientists that worked on understanding the time better like Stephen Hawking, a famous physicist that in his final book expanded that time travel one day would be possible and proposed that time itself began at the big bang (2). On the other hand, there were some theories that rejected possibility of traveling in the time too like "Grandfather Paradox" that refuses traveling to the past (3). However, one of the most important hypotheses about traveling in the time gets back to 20th century when theory of relativity introduced. In fact, this theory contains two main part and they are special relativity and general relativity. Special relativity applies to all physical phenomena when there is no gravity; furthermore, General relativity explains the law of gravity and its relation with other forces in nature. By considering the theory of relativity, many results appear and one of them is time dilation which is a result of special relativity and this article moves forward based on it (4).

Totally time dilation expresses that time is relative and time slows down when the speed rises, more precisely, moving clocks run slower than stationary clocks. Time dilation is not a machine actually but it discusses that how the rate of passing time can be reduced relative to an observer. So, let's check it out more specifically. To understand time dilation better, some useful information has presented in the following which are vital for continuing this research.

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TIME DILATION

Time dilation was predicted by several authors in the beginning of the 20th century. Lorentz factor is the base of time dilation equation and several scientists like joseph Larmor or Emil Cohn had advanced on this theory but Albert Einstein introduced some unprecedented facts! According to the theory of relativity, as the speed of an object increases, time passes more slowly for that object. As we know, the speed of an object can be calculated from the following formula:

$$speed = \frac{distance}{time}$$

However, let's take a look at figure 1 while one object has imagined but once as a stationary object (A) and once, as a moving object (B):

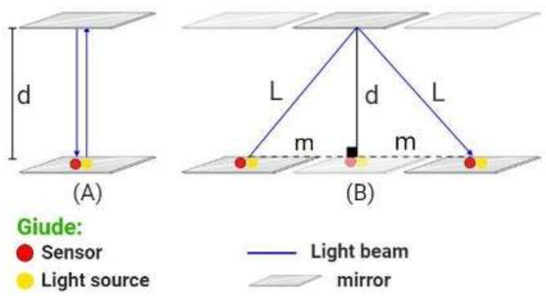

Figure 1. A simple experiment to demonstrate the theory of time dilution

At first' let's check some details about part (A), imagine that during $\boldsymbol{\Delta T}$, a light beam exits from the light source and after colliding with the top mirror, it gets back and arrives to the sensor so here: $\Delta T = \frac{2d}{c}$

On the other hand, there is an important tip about the second part which is (B); as it is clear, the considered object has moved from a place to another place, Consequently, while the light beam was continuing its journey to the mirror and getting back to the sensor at a time that is equal to the considered time in Experiment (A), the whole object has moved so a new path exists here between mirror and light source and also between mirror and the sensor. Relative to an observer, light beam is not continuing a same path compared to (A) this time, but we should know that the light beam relative to object is just going straight up and down as same as how it was in (A). Anyway, this time here for (B) we have: $\Delta T' = \frac{2L}{c}$

Let's pay attention; it is obvious that the speed of light is a same amount which is exactly $299\,792\,458\ m\,/\,s$, Also according to the Trigonometric rules $L^2 = d^2 + m^2$ consequently it is evident $2L > 2d$, so it must take the light longer to pass $2L$ compared to $2d$ relative to an observer but in this experiment the time was a constant amount which was $\boldsymbol{t}$! And here it was that time dilation was born. Although we considered a same time for part (A) and (B), the time length should be bigger in condition (B) because the distance that should be covered in experiment (B) for the observer is longer than the distance which should be covered in (A).

Actually, what time dilation expresses is that moving clocks run slower compared to stationary clocks. There is no such thing as absolute time it is what Einstein said exactly (5). The time is personal to us, time passed in (B) at a different rate but the reason that why no one can notice and feel this in everyday life is that the amount by which time slows down for a moving object is miniscule. The speed of light is much bigger than the common speeds that we can observe in everyday life on the earth so the normal speed that everyone can experience, won't reveal a visible time impact on them and as it mentioned, the reason is that the common speed that can be experienced by almost all of the people is really tiny compared to the speed of light. Certainly, these facts can be determined as a formula hence in the following by doing some mathematical operations we are going to achieve an equation for this theory, this proof moves forward based on Lorentz term or Lorentz factor, a quantity which describes while an object is moving, how much the measurements of time, length, and other physical properties changes. The evaluation of time dilation formula can be discussed as (6):

$$m = \frac{v\Delta T'}{2} \quad and \quad L = \sqrt{d^2 + m^2}$$

$$\xRightarrow{m = \frac{v\Delta T'}{2}} L = \sqrt{d^2 + \left(\frac{v\Delta T'}{2}\right)^2}$$

By replacing L into the expression for the time interval $\Delta T'$ will produce:

$$\Delta T' = \frac{2l}{c} = \frac{2\sqrt{d^2 + \left(\frac{v\Delta T'}{2}\right)^2}}{c}$$

And by squaring two side of the equation:

$$(\Delta T')^2 = \frac{4\left(d^2 + \frac{v^2 \Delta T'^2}{4}\right)}{c^2} = \frac{4d^2}{c^2} + \frac{v^2}{c^2}(\Delta T')^2$$

Hold the obtained equation till now and now let's square the first one which was $\Delta T = \frac{2d}{c}$ so by doing this mathematical operation $(\Delta T)^2 = \frac{4d^2}{c^2}$ will be achieved, and as it is obvious this term appeared in the last equation so:

$$(\Delta T')^2 \left(1 - \frac{v^2}{c^2}\right) = (\Delta T)^2 \Rightarrow (\Delta T')^2 = \frac{(\Delta T)^2}{\left(1 - \frac{v^2}{c^2}\right)}$$

And finally let's remove the power of variables in the above formula, hence, the formula for calculating the time dilation by eliminating variables d and L from these equations can be resulted in:

$$\Delta T' = \frac{\Delta T}{\sqrt{1 - \frac{v^2}{c^2}}}$$

Here $\Delta T'$ is the observer time, ΔT is the proper time, v is the velocity (m/s), and c is the speed of light which is approximately (3.0 x 108 m/s).

What can be concluded here is that when the speed increases, the effect of time dilation can appear perfectly. Anyway, the above information that has been stated, are necessary to continue this research. In the coming section, the results of the author's research have expanded and the main question of this article answered clearly.

RESULTS

According to the Lorentz term which discussed previously, in order to feel the impact of time dilation on physical time, we need to consider a situation which provides an object, traveling at a fast speed. But it is obvious that because of the earth conditions such as atmosphere, nothing can be very fast on the earth compared to speed of light. Even the fastest man-made object on the earth was NASA's X-43 aircraft with approximate speed of 7,000 mph which is obviously tiny compared to speed of light. As a result, outside of this planet, a perfect situation exists to move very fast like many orbiters in space such as satellites and spaceships. Anyway, when a man goes into space, certainly, a new world would be felt by him, a world that is completely different from his home planet. These differences should appear some consequences for sure also based on the researches including those that NASA had done, space has a lot of effects on the astronauts, for example, in space they will be taller than the height that they had on the earth, their bone and muscles will deteriorate or even they will be influenced by psychological effects of space situation (7). Furthermore, after completing this research, a new effect will be added to the list of space influences on astronauts and that is time travel. Even currently that you are on the earth and you are reading this research, there are some astronauts in space station and their time is passing at a different rate. But how and based on what logical reasons, the author of this article claims that and how time passes for them? So, lets analyze some information to find the answer.

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DISCUSSION

In fact, it is preferable to prepare a new way that a lot of information is accessible about it todays. Additionally, a method involving a person must be considered because the effect of "time dilation" is going to be studied on an astronaut, hence, unmanned satellites or orbiters are not appropriate for continuing the process. Consequently, let's consider international space station (ISS) because despite other missions like Apollo, astronauts are capable to stay in space much more.

INTERNATIONAL SPACE STATION

The core of this space station launched in November 20, 1998 and as time passed by, Subsequent parts were launched into space, and the space station gradually became more complete. The ISS travels at an approximate speed of 27,600km/h around the earth, and it has average distance of 400 km from the earth surface. It takes international space station 92.68 minutes to rotate around the earth once and it completes 15.54 orbits per a day (8). Let's take a look at figure 2 where some of this important information presented as an illustration.

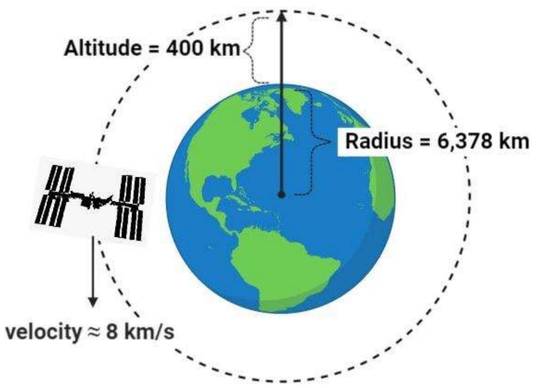

Figure 2. Some details regarding to the international space station at earth orbit

As it can be seen in figure 2, ISS is not a stationary object and it is moving around the earth in order to maintain its orbit. So, can we allow ourselves to say time passes slower for all astronauts that have lived in the international space station? Like always, there exist several ways to go through a research, However, based on the reasons that discussed in beginning of the Discussion part, the author of this article pointed out that ISS is the best choice to assess, in next section, by calculating some equations and some logical basis, it will be indicated that according to the time dilation theory, does time passes at a different rate for astronauts and how it is possible?

METHODS

The process will move forward like the experiment of time dilation that covered previously. The author of this research suggests continuing the study by considering the time as 24 hours (one day). So now let's check two things about them. At first, as it is clear, the orbit distance is greater that the circumference of earth because the distance of the space station from the center of the earth is 400 km more than the radius of the earth. Also as it mentioned before, international space station completes 15.54 orbits per a day. Now let's calculate the distance that an astronaut covers during a day while he or she is staying in the international space station. The speed of ISS is 27600 km/h and the distance that it covers during 24 hours can be achieved as:

$$s = \frac{d}{t} \rightarrow distance = speed \times time$$

$$d = 27600 \frac{km}{h} \times 24\ h \rightarrow d = 662400\ km$$

So, let's Hold the obtained result here and then calculate the distance that a person who lives on earth covers during one day. To simplify the proposition, we consider the circumference of Earth at the equator which is 40,075 kilometers (9). As we know, each day earth just rotates one time around its axis. So that man, who lives on Earth equator, covers 40,075 km during a day. Finally, the big result happens here; the astronaut has moved around 662,400 km and the man on earth equator has moved just 40,075 km. So it takes light longer to cover 662,400 km compared to 40,075 km, but the paradox appears here because the considered time was 24 hour for both of them which is a same amount! So here it is obvious that time passed at a different rate for the astronaut compared to that man on the earth! 24 hours for that astronaut passed slower! But again, the effect of time dilation is not too much; the reason is that, the astronaut just covered 622,325 km more than that person on the earth in 24 hours but the speed of light is much bigger that these amounts which is 1,079,252,848.7999 km/h. So, it is obvious that these little amounts won't show a big consequence to us but at least it is clarified that nowadays ISS is a window to time travel. But let's consider an astronaut for this research that stays for a year at ISS. So, this 622,325 km repeats for a year which is 365.25 days. And after putting the data in Lorentz factor, the result will illustrate that during one year, how time dilation can appear better. Anyway, by considering the results of this research and generalizing them to other astronauts, it concluded that astronauts are time travelers! As an astronaut stays more at ISS, time dilation appears better, because ISS will cover more distance compared to a human on the earth constantly. In order to travel more in the time at a particular time, definitely the speed should be increased. Although in the past traveling in the time seemed to be impossible, but even nowadays somehow humans are changing the rate of passing of time, besides that, technology is developing more and more so finally in the near future humanity will probably achieve its old wish of traveling at time by using a new approach.

Acknowledgement

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