A New Approach Towards Relativity and Time Dilation

Vipin choudhary

Abstract: Time Dilation is the difference in the amount of time two clocks measure in the same inertial frame. Many studies have explored the relativity of time dilation using various approaches. However, the scientific and mathematical explanation of time dilation of moving things and light pulse clocks still has limited research. Therefore, this article examines relativity by utilizing scientific and mathematical approaches, the experience of moving things and light pulse clock ticks have been examined. The study revealed that the time elapsed for the same process is different for the different observers. Here, it showed that the time can be expressed in the form of a wave. In addition, the relative distance changes between the observers, and the observing subject time flows differently for the observer relative to the observing subject.

Keywords: *Einstein's Special Theory of Relativity, Reference Frame, Time Dilation, Length Contraction, Lorentz transformation.*

1. INTRODUCTION

During the period of 1905, Albert Einstein proposed a special theory of relativity. This special theory of relativity is mostly valid for slow-moving objects having inertia, as well as for the motion of light. Through his theory of relativity, related to time with space as a fourth dimension, time dilation has been introduced [1, 2, and 3]. The term 'time dilation' is borrowed from physics and the time dilation phenomenon was predicted by Einstein and it was a consequence of the Lorentz Transformation (LT) [4, 5]. Under some circumstances, all activities are slowed down, which results in Time Dilation since Time is measured by the pace at which the activities happen [6, 7]. However, the psychological time dilation does not measure an interval of clock time in seconds, minutes, and so on.

2. Thought experiment: Doppler effect of time

Imagine three atomic clocks, namely A, B, and C are considered. Here, A is located 10 light minutes straight away from B and C. Next, clocks B and C are synchronized with respect to A; then, the time observed in clock A is 11:00 PM, but the time observed from B is 10:50 PM (due to the time taken by light to travel to a distance of 10 light minutes between A and B) after 20 minutes of moving. With half the speed of the light observer reached A, during this journey, the observer that clock A had passed 30 minutes from 10:50 PM to 11:20 PM. Also, clock C had passed only 20 minutes from 10:50 PM to 11:10 PM observer observed a 30-minute clock movement at A in 20 minutes from C as the speed of light is constant for every observer at any reference frame then the observer noticed time at C is moving slower as compared to A, If there is any change in the speed then still there is a time dilation of 10 minutes by increasing the speed only the rate of time dilation increases.

Also, one more observer is considered in the ship who observes clock B during the journey. Both C and B are synchronized to 10:50 PM after 20 minutes of moving. With half the speed of the light observer reached A, the other observer's observed time in clock B from A is 11:00 PM (due to the time taken by light to cover 10 light minutes), Also, clock B had passed only 10 minutes from 10:50 PM to 11:00 PM within the journey of 20 minutes, then other observer noticed time at C is moving faster as compared to B. Here, the observer noticed that time had moved slowly and the other observer said that it had moved fast for clock C while both were in the same frame of reference. Time is relative to the direction and the position of the observer, and the observing subject also the total time dilation for a given path covering in a specific way is constant. Therefore, Figure 1 represents the experiment movement of clock C from clock B to A.

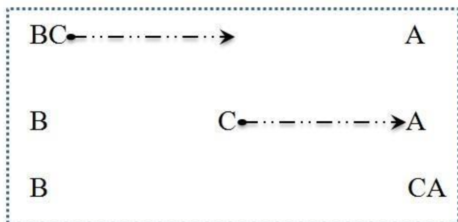


Figure 1: Movement of clock C from clock B to A

2.1. Time dilation: How moving light pulse clocks tick differently

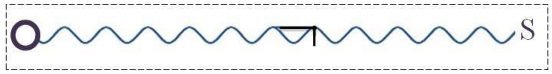
Let the light pulse be representee time clock not light there will be no light shift and relativistic doppler effect

Suppose a spaceship is traveling with a light pulse clock and the path of light pulse in a spaceship is moving up and down at the interval of a fixed period behaving like a clock.

Situation 1

The observer standing at some relative rest position observes that the spaceship is going straight away from the observer. Then the light flash keeps on moving up and down; also, the observer will notice the flash following a diagonal path and make it look like a wave to the observer. The frequency of the light clock decreases when it starts to move away, and then the wavelength increases. As a result, the observer takes more than a second to notice seconds in the light clock. It is concluded that the time for spaceships moves slower as compared to observers when both are traveling away from each other. Thus, Figure 2 represents the position of light with respect to stationery and motion.

(a)

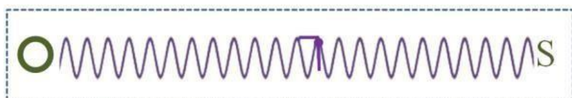


(b)

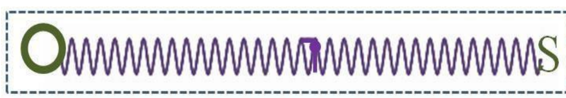
Figure 2: (a) Source at rest **(b)** Source at motion

Situation 2

The ship is imagined to move straight towards the observer. The light pulse as a wave when it starts to move towards the observer, the wave shows that frequency increases as the observer observes that his clock is moving slower as compared to that of the light clock. Every second passes faster as compared to the observer, so the observer concludes that for ships, time moves faster as both move toward each other. Thus, Figure 3 represents the position of light with respect to its stationary as well as motion.



(a)



(b)

Figure 3: (a) Source at rest **(b)** Source at motion

3. SCIENTIFIC AND MATHEMATICAL CALCULATION OF TIME DILATION

By simplifying the situation when a light pulse generator as a source, a scientific and mathematical calculation of time dilation is evaluated. The observer has a source emitting light pulse at exactly an interval of 1 second, thus acting as a clock for the observer. When both the observer and source emitting a light pulse are at rest, the observer does not observe any difference in the clocks. Here, the source emits the light pulse at the same rate at an interval of 1 second by a stationary source.

Case 1

Now, by considering a stationary source Y with an observer X moving away from the source with a constant velocity v at time t=0, the source sends a light pulse indicated in black. The light wave moves with constant speed c and the position of the light pulse at intervals of period Ts. After one pulse, the observer has moved to dx or v.Ts, and when the observer notices the second pulse, it moves out at the speed of light c. Observer A is moving at a constant speed v away from source Y, where the source emits a light pulse after a constant interval of 1 second as the speed of the light pulse is c. Further, when the observer starts to move away from the source, every second of source Y for the observer is greater than a second as compared to other sources. The observer considers time for Y to be moving slowly as compared to observers. The equation of the distance is,

$$do = ds + dx = ds + v.Ts \tag{8}$$

Where,

To = times at observer observe in source

Ts = actual time of source

ds =relative distance between source and observer when both are at rest

v= relative velocity between source and observer

c=velocity of light

do =relative distance between source and observer in motion

dx=distance covered after motion relative to rest position

From the above observation, the applied mathematical physics to the related situation is,

$$ds = do - dx$$

Here, $(do = c.To, ds = c.Ts, dx = v.Ts)$

$$c.Ts = c.To - v.To$$

$$c.Ts = To(c - v)$$

Here, $Ts = To[(c-v)/c]$ and $To = Ts/(1-v/c)$

Thus, Figure 4 represents the case 1 experiment. Here, the solid line represents the position of the light pulse after the period from the initial time. The dotted lines show the position of the light pulse if both are at rest.

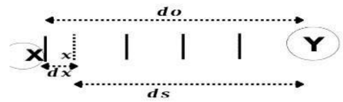


Figure 4: Analysis of Case 1

The source emitting light pulse and observer is considered to move towards the source Y at a

constant velocity v. Then, the distance is equal to the time in the velocity of light. When the observer moves towards source Y, the relative time per second decreases for the observer as compared to source Y. This is because the observer starts to move towards the source time, and the light pulse to reach the observer decreases. From the findings, the observer noticed that the time is moving slowly for the observer relative to source X as compared to when both are at rest relative to each other.

$$ds = do + dx$$

Here, $(do{=}c.To, ds{=}c.Ts, dx{=}v.Ts)$

$$c.Ts = c.To + v.To$$

$$c.Ts = To(c + v)$$

Here, $Ts = To[(c + v)/c]$ and $To = Ts/(1 + v/c)$

Thus, the diagrammatic representation of the position of the light pulse for case 2 is shown in Figure 5,

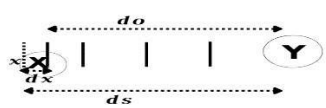


Figure 5: Position of light pulse

Case 3

Now, the observer measures the time interval by source when the observer is traveling perpendicularly toward the direction of the source. Therefore, the equation can be expressed as, $do^2 = ds^2 - dx^2$

$$(c.To)^2 = (c.Ts)^2 - (v.Ts)^2$$
$$(c.To)^2 = Ts^2(c^2 - v^2)$$

$$To^2 = Ts^2(1 - v^2/c^2)$$
$$Ts^2 = To^2/(1 - v^2/c^2)$$

From the findings, the result indicated that by observing light pulses, they were different from each other. So, the time dilation is also affected by the relative position of observers. Thus, Figure 6 represents the scenario of case 3 of the relative position of observers.

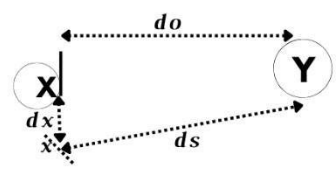


Figure 6: Analysis of case 3

4. CONCLUSION

The presented research investigated other forms of time dilation other than Einstein's special theory of relativity. Further, this article explored how moving things and moving light pulse clocks experience time dilation. The relativistic mechanism and the physical observational consequences are examined through scientific and experimental methods. The findings of the study showed that relative distance decreases between the observer, and the observing subject time flows differently for the observer relative to the observing subject no matter who is moving. Total time dilation is constant for a given distance, and the rate of time dilation depends on the relative speed between two comparing bodies. The theory of relativity must be balanced in nature, it must not tell us only one side by explaining time moving slower and length contraction, but it must also be capable of explaining the whole mechanism of relativity of time moving faster and expansion of length to have balanced theory. In the future, the study will consider other transformation approaches and express a more scientific formulation of time dilation.

5. RELATED LITERATURE REVIEW

Robert J. Buenker [8] examined the time dilation derivation by using two different Lorentz-type transformations. Einstein's special theory of relativity (STR) of Lorentz transformation (LT) helps to identify the length contraction and time dilation of moving rest frames. The study concluded that the global positioning transformation (GPS-LT) was similar to the LT but differs in a significant way, where the GPS-LT does not lead to the characteristics of space-time mixing with the LT.

Tupac Bravo *et al.* [9] investigated the case of light clocks in Schwarzschild spacetime towards the fully relativistic description of extended quantum clocks. By applying quantum metrology techniques, the precision of quantum light clocks could be estimated. The findings of a study proved that compared with horizontal light clocks, the vertical light clock was more precise when the center of the central object of the Schwarzchild spacetime was further away from the vertical light clock.

D. V. Peregoudov [10] identified the relativistic length contraction and time dilation as dynamical phenomena. For examining the exact analytical solutions for a number of problems, a simple relativistic model has been utilized. Further, by applying the Lorentz-contraction formula, the approximate gentle acceleration has been identified. The result of dynamical consideration revealed that both the proper time formula and Lorentz-contraction formula were appropriate and became exact in the case of the specific way of acceleration, perfect elastic rod, and an infinitely small clock.

Dirk J. Pons *et al.* [11] aimed to explore the effect of matter distribution on relativistic time dilation. In this study, a non-local hidden-variable (NLHV) approach was applied based on the specific particle structures of the Cordus theory. The study found that the Lorentz and relativistic Doppler formulations were derived from a particle perspective of NLHV. However, the situational theory of relativity interprets gravitational interactions at the galactic scale.

Shishir Khandelwal *et al.* [12] intended to analyze universal quantum modifications to the general relativistic time dilation in delocalized clocks. Furthermore, this study identified the consequence of the unavoidable entanglement between the clock time and its center-of-mass degrees of freedom. Based on applying a theory of relativity, a low-velocity limit, weak-field, and quantum clock experience time dilation and its state of motion were examined. However, the unavoidable consequence of quantum theory was not perfectly accurate.

Hakan Karsilar *et al.* [13] focused on exploring the time dilation and constriction of subjective time based on observed walking speed. For testing experiment 1, a total of 34 participants were selected and for experiment 2, a total of 32 participants were selected. Based on qualitative and quantitative research methods, study results have been analyzed. The study concluded that the walking speed in experiment 1 and experiment 2 observed a parametric effect of walking speed on perceived time.

A. J. Paige *et al.* [14] explored the classical and nonclassical time dilation for quantum clocks. By using velocity boosts, the ideal behaviors in both cases of classical and nonclassical time dilation were examined. The study concluded that the expected classical behavior was recovered by velocity boosters and demonstrated the significance of translation operators in distinguishing the observer being set in motion or cases of the clock.

REFERENCES

1. Devinder Kumar Dhiman, “A study of redundancy of time dilation in theory of relativity”, Indian Journal of Science and Technology, vol. 10, no. 43, pp. 1-19, 2017.

2. Jianzhong Zhao, “Lorentz transformation derived from relativity of time”, Journal of Modern Physics, vol. 13, pp. 851-857, 2022.

3. Roman Szostek, “Explanation of what time in kinematics is and dispelling myths allegedly stemming from the special theory of relativity”, Applied Sciences, vol. 12, no. 12, pp. 119, 2022.

4. Robert J Buenker, “The universal time-dilation law: Objective variant of the lorentz transformation”, Relativity and Gravity Publications: Preprints, vol. 31, pp. 1-28, 2017.

5. Robert J Buenker, “Relativity theory based on the uniform scaling of physical properties”, Thesis, Bergische Universitat Wuppertal, 2022.

6. Kiran Malleshappa, “Time Dilation”, International Journal of Scientific and Research Publications, vol. 4, no. 9, pp. 1-5, 2014.

7. Robert J Buenker, “Simultaneity, time dilation and the lorentz transformation”, International Journal of Applied Mathematics & Statistical Sciences, vol. 10, no. 1, pp. 2128, 2021.

8. Robert J Buenker, “Derivations of time dilation using two different lorentz-type transformations”, Journal of Physics & Optics Sciences, vol. 3, no. 1, pp. 1-3, 2021.

9. Tupac Bravo, Dennis Ratzel and Ivette Fuentes, “Gravitational time dilation in extended quantum systems: the case of light clocks in Schwarzschild spacetime”, AVS Quantum Science, vol. 5, no. 1, pp. 1-10, 2022.

10. Peregoudov D. V, “Relativistic length contraction and time dilation as dynamical phenomena”, European Journal of Physics, vol. 41, no. 1, pp. 1-12, 2019.

11. Dirk J Pons, Arion D Pons, Aiden J Pons, “Effect of matter distribution on relativistic time dilation”, Journal of Modern Physics, vol. 9, pp. 500-523, 2018.

12. Shishir Khandelwal, Maximilian P. E Lock and Mischa P Woods, “Universal quantum modifications to general relativistic time dilation in delocalised clocks”, Quantum, vol. 4, pp. 1-17, 2020.

13. Hakan Karsilar, Yagmur Deniz Kisa and Fuat Balci, "Dilation and Constriction of Subjective Time Based on Observed Walking Speed", Frontiers in psychology, vol. 9, pp. 1-14, 2018.

14. Paige A. J, Plato A. D. K and Kim M. S, "Classical and Nonclassical Time Dilation for Quantum Clocks", Physical Review Letters, vol. 124, no. 16, pp. 1-5, 2020.