International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2020): 7.803

Oscillating Light Clocks Reveal the Possibility of Time Conservation in Moving Frames

Tao Jia

Department of Thermal Engineering, Taiyuan University of Technology, China, 030024
tjcoch[at]outlook.com

Abstract: ***Oscillating light clock is invented and its behavior is investigated. Time conservation is found in oscillating light clock; it means that time is neither dilated nor contracted in the oscillating frame if the angular velocity takes some quantized values. The curved trajectories of the light rays (light bending) 'seen' by the mirrors in the oscillating frames are plotted.***

Keywords: oscillating light clock; time conservation; angular velocity; quantized values; light bending

1. Introduction

Light clock [1 - 2] is a conceptual light clock usually used in physics books on Einstein's relativity to illustrate time dilation in moving frames. Recent inventions of spinning and rotational light clocks [3 - 4] show the ergodicity of the behavior of time. Time contraction is shown based on spinning light clocks [3], and time contraction is shown by some rotational light cocks [4] in which the angular velocities take some quantized values. Mathematically, a light clock can be abstracted as an object that is composed of two points (representing the two mirrors) and a line segment (representing the trajectory the light ray bounces between the two mirrors). In this paper, a novel light clock called oscillating light clock is invented, and it is demonstrated that the time is not dilated and is not contracted in the oscillating frame if the angular velocity of the oscillation takes some quantized values.

2. Oscillating Light Clock

An oscillating light clock is composed of two parallel mirrors and one light ray that travels between the two mirrors. And the velocity of the two parallel mirrors is represented as the following:

$$V = A \cdot \sin(\omega \cdot t) \qquad (1)$$

where V is the translational velocity of the mirror, A is a constant and it represents the maximum velocity, ω is the angular velocity, and t is time. The distance between the two mirrors is denoted as L, and the distance between the photon and the bottom mirror is denoted as H.

In fig.1, it shows that the mirrors conduct an oscillation motion, and the photon initially is at the bottom mirror, and then it hit the top mirror, and then it goes back to the bottom mirror again; this corresponds to one tick of the oscillating light clock.

$$\int_0^{\Delta t} A \cdot \sin(\omega \cdot t)\, dt = 0 \qquad (2)$$

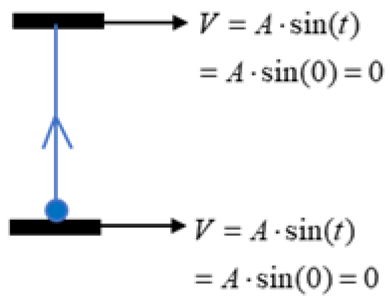
$$\cos(\omega \cdot \Delta t) = 1 \qquad (3)$$

$$\omega \cdot \Delta t = 2n\pi \quad (n = 1, 2, 3 \cdots) \qquad (4)$$

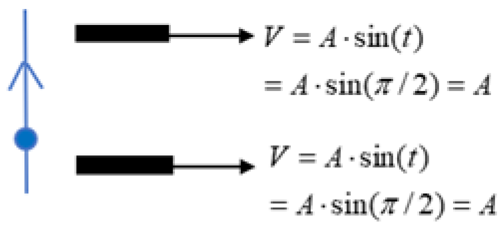
$$\omega = \frac{2n\pi}{\Delta t} \quad (n = 1, 2, 3 \cdots) \qquad (5)$$

From (5) we can see that if the angular velocity is equal to quantized values, the time will be conserved in the oscillating frame; it is same as that in the stationary frame.

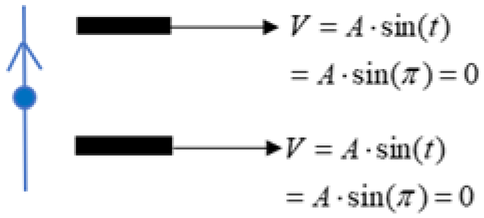
In fig.1 and fig.2, the blue disk represents the photon, and the curved blue line represents the trajectory of the photon, and the two black rectangles represent the two mirrors.



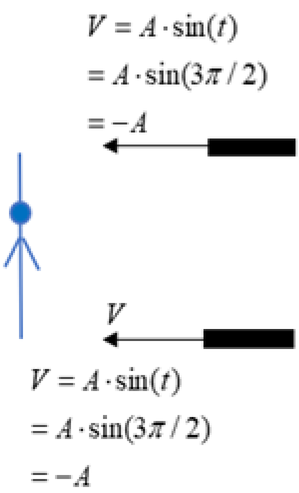
(a) t = 0; H = 0



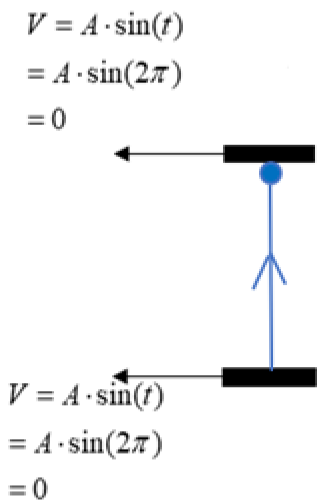
(b) t = π / 2;   H = L/4



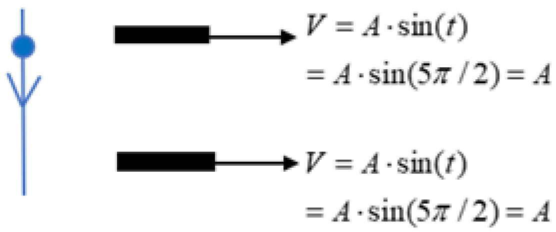
(c) t = π ; H = L/2



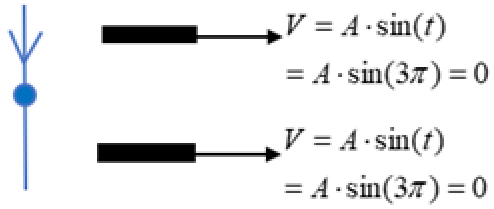
(d) t = 3π/2 ; H = 3/4L



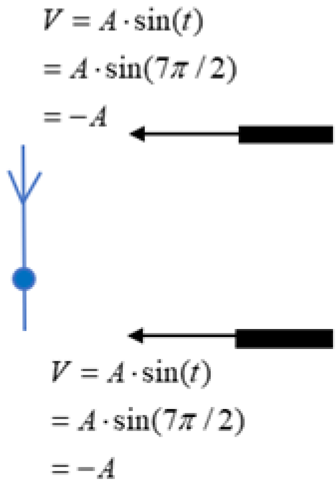
(e) t = 2π ; H = L



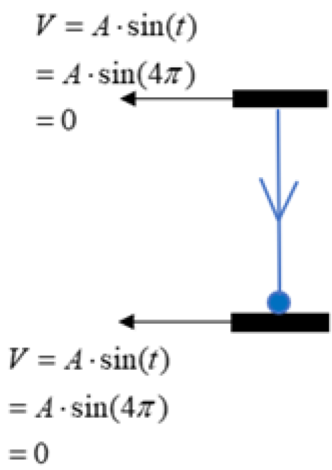
(f) t = 5π/2 ; H = 3/4L



(g) t = 3π ; H = L/2



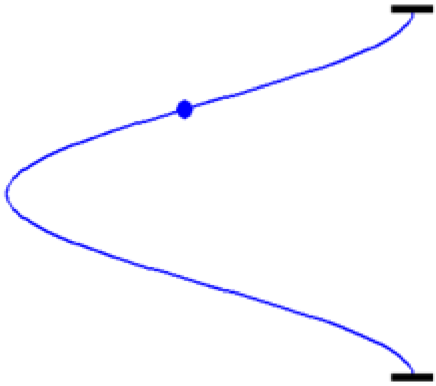
(h) t = 7π /2 ; H = L/4



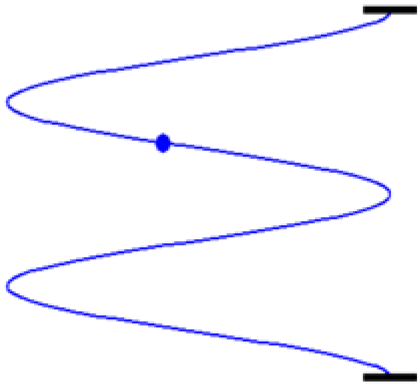
(i) t = 4π ; H = 0

Figure 1 A process corresponding to one tick of the oscillating light clock

3. Light Bending



$$(a)\ \omega = \frac{2\pi}{\Delta t}$$



$$(b)\ \omega = \frac{4\pi}{\Delta t}$$

Figure 2 Curved light trajectories 'seen' by the mirrors in the oscillating frames

In fig.2, it shows that the mirrors 'see' the different curved light trajectories in the different oscillating frames with different quantized angular velocities that correspond to different quantized oscillating frequencies.

4. Conclusion

The underlying mechanism of an oscillating clock is analyzed, and it is demonstrated that time conservation is possible in moving frames. This possibility corresponds to some quantized values of the angular velocity of the oscillation.

References

[1] G. F. R. Ellis, R. M. Williams, Flat and Curved Space Times, Oxford University Press, 2000.
[2] R. Ferraro, Einstein's Space - Time: An Introduction to Special and General Relativity, Springer Science, 2007.
[3] T. Jia, Rotational Light Clocks and Visualization of Spins, International Journal of Science and Research, 10 (5), 2021.
[4] T. Jia, Spinning Light Clocks Reveal Time Contraction in Spinning Noninertial Frames, International Journal of Science and Research, 10 (5), 2021.