Are laser particle accelerator capable to propel spaceships in cosmic distance?

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In this study, an experiment is proposed to measure the space-time contraction due to the acceleration of an electric particle. According to the set-up suggested in this study, any change in the time-space orthogonality is measurable by detecting the phase changes in an integrated Michelson-Morley interferometer. Thereafter, by using the results of [1], the electric field due to the acceleration of electric charge has been considered as proportional to the changes in the orthogonal angle of the space-time. One of the goals of this experiment is to present a solution to measure the constant of this equivalency. For the observer located far enough from the accelerated particle origin, the time for the light traveling the interferometer arm that is near to the origin of accelerated particle is decreased; in other words, the apparent speed of light that is measured by the observer would be higher than c. Hence, using the particle accelerators capable of generating high energy gradient such as laser particle accelerators are introduced as an approach for creating a contraction in space-time.

Keyword : Warp drive, Laser Particle Accelerator, interstellar journey, propulsion, Special Relativity

Is there any possibility for interstellar displacement? Which type of propulsion force can displace the shuttles in a limited time within interstellar distances. In the design of the Daedelus Project, the propulsion force is supplied by the nuclear reactors aimed at traveling to the Bernard's star, in the distance of 6 light years [2]. This journey will take 50 years and the weight of the space shuttle would be 54000 mT. Almost 90% of the space shuttle volume is dedicated to the fuel of the fusion propulsion system. In another study, the project called Longshot aimed at traveling to the Alpha Centaury which takes 100 years and is performed by NASA and USA Navy mutually in 1980 [3]. The weight of this design equals that of International Space Station, ~400 mT. Supposing that the engineering problems are overcomed, the interstellar travels would last almost a human lifetime or even more than that. A group of scientists in NASA Johnson Space Center are working on the faster solutions for interstellar displacements. Dr. Harold "Sonny" White and his team have presented a proposal to search for a method to produce space shuttles with interstellar displacement capabilities [4].

The basis of space-time displacements based on Alcubierre metric derived from the General Relativity theory of Einstein has been introduced by Dr. Miguel Alcubierre in 1994 [5]. The results of this theory resembles that of "Warp drive" introduced in science fictions.

In this theory, the space-time around the space shuttle is expanded and contacted leading to its displacement. The speed of the space-time

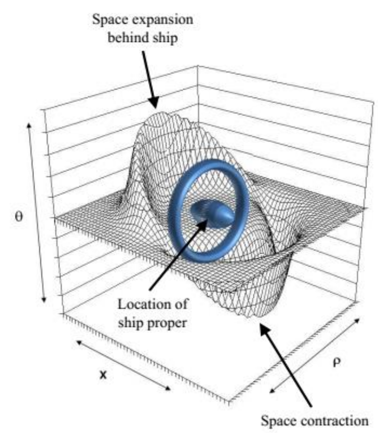

FIG. 1. Expansion and contraction of space-time around the space shuttle [4].

expansion and contraction is unlimited. The space shuttle can travel a limited time known as "York Time" within the interstellar distances with an apparent speed higher than the speed of light without violating the principle of light speed limit only by the contraction of the front space and the expansion of the rear space.

However, Alcubierre metric leads to a halo of negative energy density that violates several energy conditions and is classically non-physical.

Also, there exists no more details from the recent works of Dr. Harold “Sonny” White in the literature. The aim of the current study is to investigate a method for travelling in space-time with an apparent speed higher than the speed of light. This implies that the space shuttle speed does not locally exceeds that of light speed, however, by the contraction of space time, the possibility of a fast interstellar journey arises (According to the Special Relativity theory, the speed of light for all observers in inertial frames is independent of observer speed and equals c. That is for a state in which the space-time orthogonality is maintained.)

In the study of [1], a different view of the concept of space-time is introduced that verify the Special Relativity of Einstein. Based on the theoretical results obtained from this study, the electric field $E_\perp$ resulted from the acceleration of the particle with a charge of q when it accelerates from an initially flat space-time can be expressed as:

$$\mathrm{E}_\perp \propto {}^{c}/_{\cos\alpha_\mathrm{i}} - {}^{c}/_{\cos(0)}$$

$$\rightarrow \mathrm{E}_\perp \propto \mathrm{c}\left({}^{1}/_{\cos\alpha_\mathrm{i}} - 1\right) \qquad (1)$$

in which, c is the speed of light in the vacuum for a flat space-time, α_i is the angle between Time Distance Difference and Space Distance Difference vector around the accelerated particle [1]. For a flat space-time (points of space-time that is far from any distribution of mass or energy) $\alpha_\mathrm{i} = 0$ and the orthogonality of space-time axis holds. Also, for every point α_i depends on the magnitude of charge q and its acceleration $\dot{\boldsymbol{v}}$ as:

$$\alpha_i = \alpha_i\,(q.\dot{v}\,) \qquad (2)$$

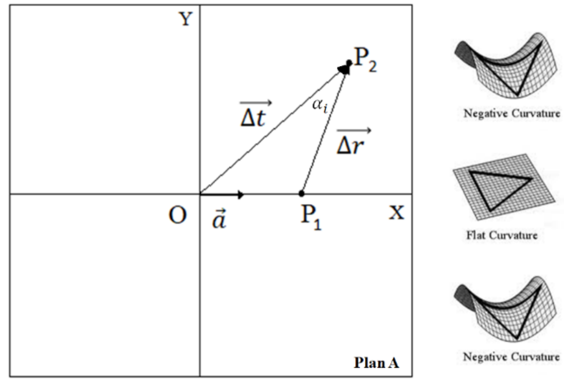

FIG. 2. The space-time contraction around the accelerated charge q in plane A is shown. It is illustrated that the space-time remains flat in the direction of x-axis while on the other two sides of x-axis, the space-time is contracted [6].

Therefore, if we select the equivalency constant as S, then:

$$E_\perp = S\ c\left({}^{1}/_{\cos\alpha_\mathrm{i}} - 1\right) \qquad (3)$$

If we take $c/cos\alpha_i$ equal to the apparent light speed in the space-time around the accelerated charge q, then the speed difference before and after the acceleration of the charge q can be expressed as:

$$\Delta c = c\left({}^{1}/_{\cos\alpha_\mathrm{i}} - 1\right) \quad (4)$$

Due to the acceleration of charge q, the angle between the space-time axis is decreased which implies that the space-time around the charge is contracted.

For the points in the direction of the x-axis which is the acceleration direction, the orthogonality of space-time holds (or $\alpha_i = 0°$). Therefore, the light speed in this direction equals c and the space-time is flat. For the points above and below the x-axis in plane A, ${}^{c}/_{\cos\alpha_\mathrm{i}} > \mathrm{c}$, which means that the space-time is contracted. The contraction of space-time is accompanied by the emission of photons meaning that the energy saved in the orthogonal space of space-time axis is released in the form of photons which have an electric field shown by $E_\perp$. Also the general superposition (distribution) of the photon momenta around charge q equals zero.

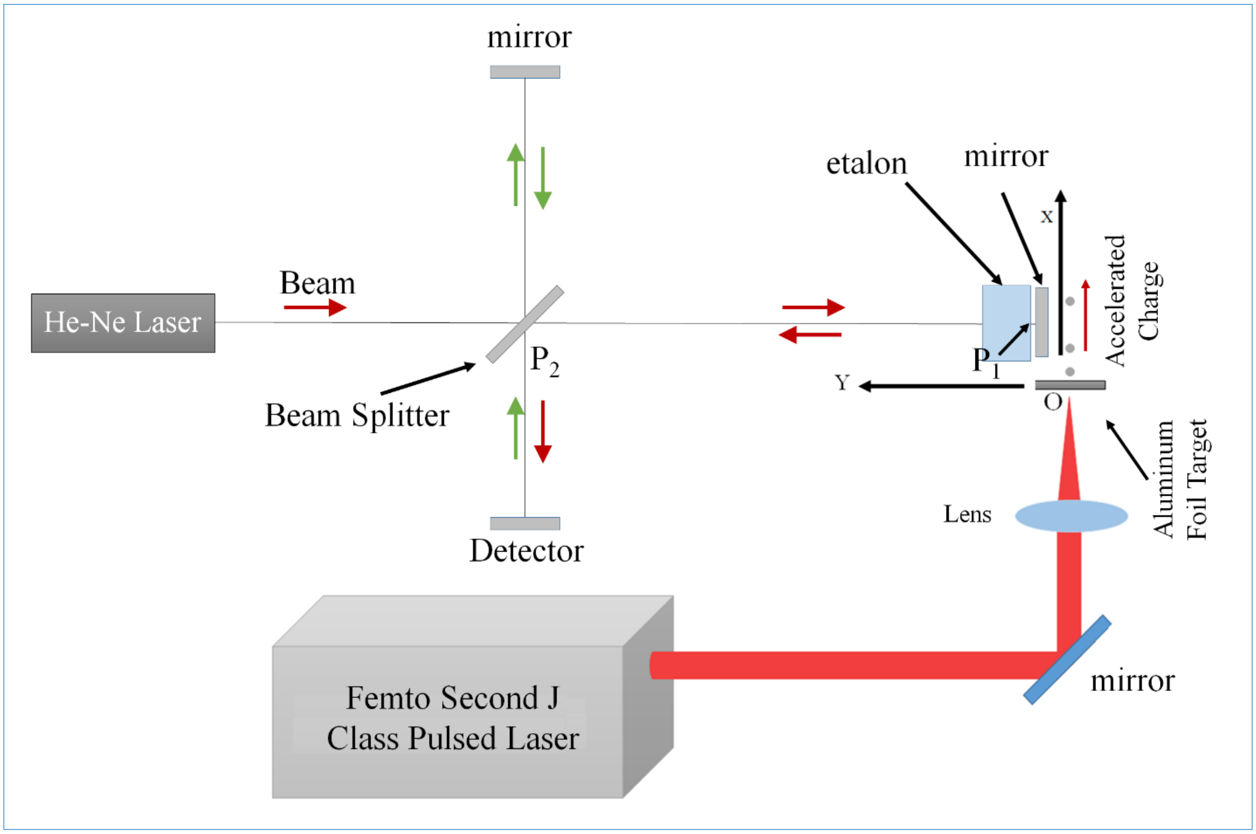

FIG. 3. The Michelson-Morley interferometer set-up to measure the changes in the apparent light speed is shown. A femtosecond laser as expressed by [7] accelerates the ions in the x-direction.

To verify the above claims, we propose an experiment. The set-up includes a Michelson-Morley interferometer with a He-Ne laser. As shown in Fig. 3, the particle charged q is accelerated from point O in the x-direction. The contraction of space-time around the charge q can decrease the optical path length (OPL) between point P_1 and P_2. In other words, for an outside observer, light travels this path with an apparent speed higher than c.

In one of the arms of the interferometer that is close to the point O, an ethalon can be used to multiply the detected signal. In order to accelerate the charged particles, a femto-second laser with an energy close to joules can be employed. Today, the laser accelerators are capable of increasing the particle energy up to several GeV in a limited distance.

In a set-up, an ultra-short pulse can be triggered towards an aluminum foil the same as the method proposed in [7]. If light travels from P_1 to P_2 with an apparent speed higher than c (due to the contraction in space-time), detector records an equivalent signal (In fact, the contraction of space-time is equivalent to the decrease of OPL from point P_1 to P_2 that results in the changes in the phase difference and is recorded by the detector.)

In order to record a certain change in the light speed, a significant amount of electric charge (ions or charged particles) should be moved with high acceleration.

The laser beam in the x-direction coincides with an aluminum foil, then, the ions are disparted from the foil surface due to the laser momentum (or the electric field of the laser pulse) in the x-direction. The repetition rate of laser pulses with an energy up to joules is limited to 10 Hz. Consequently, if the prediction of this experiment accompanies a physical fact, then, the signal due to the changes in the apparent light speed from P_1

to P_2 (due to the contraction of space-time) can be recorded with every laser pulse.

Also, instead of using the above set-up for accelerating the particles and generating currents of kA and energies of GeV order, the Laser wakefield acceleration or a set-up similar to what proposed in [7,8] can be employed.

By measuring the phase difference (equal to OPL) as equal to the Δc, the apparent light speed (c^*) from P_1 to P_2 can be derived as follows:

$$c^* = \mathrm{c} + \Delta c. \qquad (5)$$

and in any point from P_1 to P_2:

$$c_i^* = {}^{c}\!/\!{}_{\cos \alpha_i} \qquad (6)$$

Alternatively, by using the Larmor Law and measuring the magnitude of the accelerated charge and its acceleration resulted from the laser, the electric field $E_\perp$ from P_1 to P_2 can be derived. Therefore, the results obtained from this experiment can measure the conversion constant by using the following formula:

$$S = \left. \int_{P_1}^{P_2} dE_\perp \right/ c \int_{P_1}^{P_2} \left({}^{1}\!/\!{}_{\cos \alpha_I} - 1 \right) d\alpha_i \qquad (7)$$

In this study, we investigated several efforts in the field of interstellar space shuttles. We also proposed an experiment according to the study in [1] based on which if certain physical quantities are measured, then it can prove that in the event of the acceleration of a charge particle, the space-time around it is contracted.

This experiment is different from that proposed by Dr. Harold "Sonny" White and his team. In the event that the results expected in this experiment are verified, in similarity with "Warp Drive" and the work of Dr. Harold Sonny White and his team, we can follow the design of a space shuttle travelling interstellar with an apparent speed higher than c.

Also, if this experiment is followed by measurable results, then, it can be expressed that what exists in the universe are certain mathematical functions of energy. This definition includes: photons, charged particles, space-time and what included inside that.

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