Physicists continue work to abolish time as fourth dimension of space

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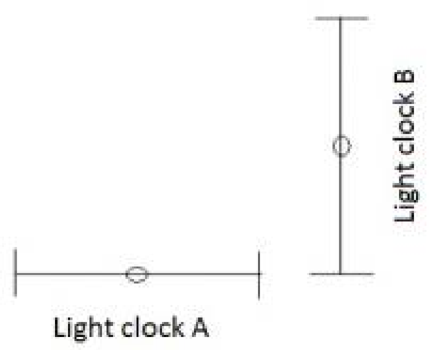

Light clocks A and B moving horizontally through space. According to length contraction, clock A should tick faster than clock B. In a new study, scientists argue that there is no length contraction, and both clocks should tick at the same rate in accordance with special relativity. Image credit: Sorli and Fiscaletti.

(Phys.org) -- Philosophers have debated the nature of time long before Einstein and modern physics. But in the 106 years since Einstein, the prevailing view in physics has been that time serves as the fourth dimension of space, an arena represented mathematically as 4D Minkowski spacetime. However, some scientists, including Amrit Sorli and Davide Fiscaletti, founders of the Space Life Institute in Slovenia, argue that time exists completely independent from space. In a new study, Sorli and Fiscaletti have shown that two phenomena of special relativity - time dilation and length contraction - can be better described within the framework of a 3D space with time as the quantity used to measure change (i.e., photon motion) in this space.

The scientists have published their article in a recent issue of *Physics Essays*. The work builds on their previous articles, in which they have investigated the definition of time as a "numerical order of material change."

The main concepts of special relativity - that the speed of light is the same in all inertial reference frames, and that there is no absolute reference frame - are traditionally formulated within the framework of Minkowski spacetime. In this framework, the three spatial dimensions are intuitively visualized, while the time dimension is mathematically represented by an imaginary coordinate, and cannot be visualized in a concrete way.

In their paper, Sorli and Fiscaletti argue that, while the concepts of special relativity are sound, the introduction of 4D Minkowski spacetime has created a century-long misunderstanding of time as the fourth dimension of space that lacks any experimental support. They argue that well-known time dilation experiments, such as those demonstrating that clocks do in fact run slower in high-speed airplanes than at rest, support special relativity and time dilation but not necessarily Minkowski spacetime or length contraction. According to the conventional view, clocks run slower at high speeds due to the nature of Minkowski spacetime itself as a result of both time dilation and length contraction. But Sorli and Fiscaletti argue that the slow clocks can better be described by the relative velocity between the two reference frames, which the clocks measure, not which the clocks are a part of. In this view, space and time are two separate entities.

"With clocks we measure the numerical order of motion in 3D space," Sorli told *Phys.org*. "Time is 'separated' from space in a sense that time is not a fourth dimension of space. Instead, time as a numerical order of change exists in a 3D space. Our model on space and time is founded on measurement and corresponds better to physical reality."

To illustrate the difference between the two views of time, Sorli and Fiscaletti consider an experiment involving two light clocks. Each clock's ticking mechanism consists of a photon being reflected back and forth between two mirrors, so that a photon's path from one mirror to the other represents one tick of the clock. The clocks are arranged perpendicular to each other on a platform, with clock A oriented horizontally and clock B vertically. When the platform is moved horizontally at a high speed, then according to the length contraction phenomenon in 4D spacetime, clock A should shrink so that its photon has a shorter path to travel, causing it to tick faster than clock B.

But Sorli and Fiscaletti argue that the length contraction of clock A and subsequent difference in the ticking rates of clocks A and B do not agree with special relativity, which postulates that the speed of light is constant in all inertial reference frames. They say that, keeping the photon speed the same for both clocks, both clocks should tick at the same rate with no length contraction for clock A. They mathematically demonstrate how to resolve the problem in this way by replacing Minkowski 4D spacetime with a 3D space involving Galilean transformations for three spatial coordinates X, Y, and Z, and a mathematical equation (Selleri's formalism) for the transformation of the velocity of material change, which is completely independent of the spatial coordinates.

Sorli explained that this idea that both photon clocks tick at the same rate is not at odds with the experiments with flying clocks and other tests that have measured time dilation. This difference, he says, is due to a difference between photon clocks and atom-based clocks.

"The rate of photon clocks in faster inertial systems will not slow down with regard to the photon clocks in a rest inertial system because the speed of light is constant in all inertial systems," he said. "The rate of atom clocks will slow down because the 'relativity' of physical phenomena starts at the scale of pi mesons."

He also explained that, without length contraction, time dilation exists but in a different way than usually thought.

"Time dilatation exists not in the sense that time as a fourth dimension of space dilates and as a result the clock rate is slower," he explained. "Time dilatation simply means that, in a faster inertial system, the velocity of change slows down and this is valid for all observers. GPS confirms that clocks in orbit stations have different rates from the clocks on the surface of the planet, and this difference is valid for observers that are on the orbit station and on the surface of the planet. So interpreted, 'time dilatation' does not require 'length contraction,' which as we show in our paper leads to a contradiction by the light clocks differently positioned in a moving inertial system."

He added that the alternative definition of time also agrees with the notion of time held by the mathematician and philosopher Kurt Gödel.

"The definition of time as a numerical order of change in space is replacing the 106-year-old concept of time as a physical dimension in which change runs," Sorli said. "We consider time being only a mathematical quantity of change that we measure with clocks. This is in accord with a Gödel view of time. By 1949, Gödel had produced a remarkable proof: 'In any universe described by the theory of relativity, time cannot exist.' Our research confirms Gödel's vision: time is not a physical dimension of space through which one could travel into the past or future."

In the future, Sorli and Fiscaletti plan to investigate how this view of time fits with the broader surroundings. They note that other researchers have investigated abolishing the idea of spacetime in favor of separate space and time entities, but often suggest that this perspective is best formulated within the framework of an ether, a physical medium permeating all of space. In contrast, Sorli and Fiscaletti think that the idea can be better modeled within the framework of a 3D quantum vacuum. Rather than viewing space as a medium that carries light, light's propagation is governed by the electromagnetic properties (the permeability and permittivity) of the quantum vacuum.

“We are developing a mathematical model where gravity is a result of the diminished energy density of a 3D quantum vacuum caused by the presence of a given stellar object or material body,” Sorli said. “Inertial mass and gravitational mass have the same origin: diminished energy density of a quantum vacuum. This model gives exact calculations for the Mercury perihelion precession as calculations of the general theory of relativity.”

More information: Amrit Sorli and Davide Fiscaletti. “Special theory of relativity in a three-dimensional Euclidean space.” *Physics Essays*: March 2012, Vol. 25, No. 1, pp. 141-143. DOI: 10.4006/0836-1398-25.1.141