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EINSTEIN'S RELATIVITY – AND WHAT IT REALLY IS

Svante Westerlund
Causal Consulting, Vintergatan 9 B,
SE-39351 Kalmar Sweden,
www.causal.st

Abstract

Causal physical theory, expressed by means of fractional derivatives, gives rise to the same physical phenomena as the principle of relativity. In addition, in causal theory there is no longer any mystery why these phenomena occur. We conclude that causal theory is to prefer before the conventional theory with its addition of relativity. In fact, reality is not relative at all.

1. Introduction

Einstein's principle of relativity is difficult to comprehend because it conflicts with common sense. It is a separate concept which does not fit in with the rest of theoretical physics, and relativity is not part of any other theory. We do not understand why a body becomes heavier when moving, or why a clock runs slower when moving and other similar relativistic phenomena that do occur. Because, there is no doubt that relativistic phenomena are real. In clock transports relativistic time shifts amounting to fractions of microseconds often occur and corrections are introduced routinely when needed.

Light plays a major role in all discussions on relativity. But the nature of light is obscure. Is it a stream of particles (photons) as claimed by Planck and Einstein, or is it continuous electromagnetic wave propagation as believed by Maxwell and Hertz? In relativity the velocity of light occupies a position apart from all other velocities. It is considered to have a universal maximum value. In addition the velocity of light is taken to be a universal velocity in all cases of action at a distance through a vacuum. But we know that light experiences dispersion like every other wave motion, so it is not self-evident that the relativistic precept is beyond dispute. We intend to explore these and other mysteries and paradoxes, and use our imagination for the purpose of making physical theory more comprehensible. Many of the issues discussed in this paper have been treated earlier and in more detail by Westerlund (2002).

2. The causal mass

The model of the kind of mass dealt with in the theories of Newton and Einstein is a constant, m, that specifies the magnitude of the mass in kilos. Such a mass has no other property than its mass. Its weight is exact, it has no temperature, no electric charge, no colour, and no elastic properties and in theories it appears either as a rigid body or a point mass. This is sometimes acceptable as an approximation of a mass, but we know that few masses are well described by a point mass or a rigid body.

A causal mass model is described by a process with two parameters $c_{\varnothing}^2$ and 2α. The mass is time dependent (Westerlund, 2002)

$$(1) \qquad \frac{d^{-2\alpha}W(t)}{dt^{-2\alpha}} = m(t)\cdot c_{\varnothing}^{2} \qquad t>0,\ 0<2\alpha<2$$

The causal mass, m(t), is the extensive output from the process above and W(t) is the intensive energy input. These two, m(t) and W(t), always exist together and are in dynamic balance as defined by eq. (1). The model constant $c_{\varnothing}^2$ is usually a large number and the energy that belongs to even a diminutive mass is, therefore, very large. Eq. (1) also implies that where there is mass, there is energy. Thus, any mass is always surrounded by its energy ‘smell’. We may not be able to recognize it, but it is still there. The causal mass, m(t), is a causal variable. Statistically it has no maximum, no minimum, no average. The time, t, belongs to the process and every process has its own time.

Eq. (1) is a causal counterpart to Einstein’s mass/energy equivalence, $E=m\cdot c^2$. For pedagogic reasons eq. (1) has been written on a form that resembles Einstein’s equation, but we have used W for energy, and not E as Einstein did. The model described by eq. (1) is, as already inferred, something entirely different than the mass/energy equivalence of Einstein. It is a process and it is dynamic. The mass process has a lifetime, which is longer the more mass the process controls (Westerlund, 2002). The mass process is a producer of mass and a consumer of energy, which means that it violates the energy principle. If we extend the mass concept to include all extensive constituents of nature we can say that the process model of eq. (1) is general and represents all processes in nature. Everything that occurs there aims at producing mass at the expense of energy. Extensive is everything that requires space, like mass.

3. The twin paradox

The twin paradox is a thought experiment in which a twin makes a space travel while his twin mate remains stationary on the surface of the earth. The discussion leads to the result that the stationary twin is older than the travelling twin when the latter returns after the space trip. This experiment is good in the way that it is in some touch with reality even if the effects we discuss are very small indeed.

First we try to predict the outcome of the experiment by means of our knowledge of causal processes. Each twin is a system of causal processes. Characteristic of causal processes is that they are coupled to the environment. They have lifetimes that end when they coalesce with the environment. After that they cannot continue to produce entropy. The twins were born simultaneously, and they have grown up together in the same environment. We can, therefore, expect them to be equally old when the experiment starts. If now one twin makes a space trip and returns they have not stayed in the same environment for the time of the travel, and since causal processes are irreversible their expected lifetimes will remain different even if the travelling twin returns to the point of departure. But we do not immediately know which is the older of the two but we know that they are of different ages. In order to find out about their ages we consider how the mass of the travelling twin changes during his trip, because we know that the heavier the process the longer its lifetime, everything else being the same (Westerlund, 2002).

We let one of the twins start his travel. He enters the space ship, which is accelerated and leaves the neighbourhood of the earth. Its maximum velocity is a substantial fraction of the velocity of light. After a turn in space the vehicle returns to the earth, brakes, and delivers the travelling twin back to his stationary twin brother. There are three effects that will influence the weight of the travelling twin in relation to the stationary twin: 1) The kinetic energy associated with his velocity. 2) His liberation from the gravitational attraction of the earth. 3) His acceleration.

The first effect is relatively simple to establish. The travel starts at time t_0, at which time the mass is $m(t_0)$. At a later time, t, when the kinetic energy is W(t) the mass is m(t) as computed by means of eq. (1). Here, however, we come into conflict with conventional relativity in which velocity is relative. This makes it impossible to find out if the velocity of the space vehicle should be added or subtracted from an unknown velocity. For that reason it has been considered impossible to assess if the velocity of travel adds or subtracts time from the age of the travelling twin. In causal physics the situation is much better, but we will leave that discussion to the next section. What we have found is that the mass of the travelling twin, while he travels, is increased by a factor

$$(2) \qquad \gamma = m(t)/m(t_0)$$

which is slowly increasing with time, even after his return. The mass increase is not nullified completely at the end of the travel because of the irreversibility of the real process and the model, eq. (1).

The second effect is due the liberation of the twin from the gravitational field. This requires that energy is added to the twin, which contributes to his mass in the same way as when kinetic energy was added. Addition of kinetic or gravitational energy produces the same effect, the total mass increases. The mass contribution does not disappear completely after return to the starting point, due to the irreversibility of the process.

The third effect is due to the acceleration of the twin. This is not accounted for by the energy process modelled in eq. (1). We have instead another causal law that corresponds to the second law of Newton (Westerlund, 2002)

$$(3) \qquad F(t) = m_{\varnothing} \cdot \frac{d^{n-1}a(t)}{dt^{n-1}} \quad t>0, \quad 0<n<1$$

F(t) is the mass and a(t) is the acceleration. The model constant, $m_{\varnothing}$, is not the mass. The mass is instead m(t)=F(t)/a(t). We can solve for mass by taking the Laplace transform of eq. (3), introducing a step input for the acceleration, a(s)=A/s, and solving for mass, m(s). We obtain the Laplace solution, which transforms to the time domain as

$$(4) \qquad m(t) = \frac{A \cdot m_{\varnothing}}{\Gamma(2-n)} \cdot t^{1-n} \quad t=0, \quad 0<n<1$$

where Γ is the gamma function. That the problem is linear we see from eq. (3). We can then use eq. (4) in superposition to derive the mass response of an input acceleration pulse. We see also that the contribution to the mass is positive both during the acceleration and the deceleration phases.

The result is that all the three effects discussed contribute to the final mass increase of the travelling twin, but in the two first cases a lasting contribution to the mass is a result of irreversibility.

4. Discussion

Evidently, causal theory gives rise to several effects that are rather similar to effects in conventional relativity. In both theories we find that the mass of a moving body increases. Further, in causal theory the lifetime of a moving twin increases in comparison to the lifetime of the stationary twin, or we can say that time runs slower in the moving body. The body of the travelling twin becomes heavier by the addition of energy. That is signified by the fractional derivative in eq. (1). Since the number of atoms of his body does not increase the mass of each atom increases, which in its turn means that the movement of the electron in each atom slows down. Thus if we had sent out an atomic clock instead of a twin we would be able to directly read off how much younger the moving clock was relative to a stationary clock, when it came back to the earth. Due to irreversibility and acceleration the time difference will continue to increase with time after the return of the travelling twin.

A third common effect is that a moving body shrinks, and the higher its mass the longer it can continue shrinking.. According to the causal model the shrinking produces entropy and releases energy. The larger its mass the longer it can produce entropy, i. e. the longer is its expected lifetime.. Production of entropy, is the whole purpose of nature.

All these effects occur according to both theories but in the causal case it occurs irrespective of what kind of energy we add to the body. In addition the causal model can be applied to explain almost all physical phenomena while conventional relativity cannot be combined with any other theory in physics. It seems, therefore, that causal theory provides a better model than does conventional relativity (Westerlund, 2002). When using causal theory there is no need to even think about relativity, it is all included.

Eq. (2) gives the γ-value that measures the magnitude of the mass increase when energy of any kind is supplied to the mass process. If the mass is only weakly coupled to the environment (i. e. the 2α-value is almost equal to zero) the γ-value becomes

(5) $$\gamma \approx (mc^2+mv^2/2)/(mc^2) \quad 2\alpha \approx 0$$

In conventional physics we would expect the mass to increase by a factor γ_L, which is known as the Lorentz factor

(6) $$\gamma_L = \frac{1}{\sqrt{1-v^2/c^2}}$$

where v is the velocity of the rigid body and c is the velocity of light in the vacuum in which the rigid body is moving. If we assume that v<<c we can see that eq. (6) gives rise to the same factor as eq. (5). We can thus conclude that a hard and reasonably small body moving at low velocity in a rarefied medium and weakly coupled to the environment gives rise to the same mass increase in both theories. Eq. (6) is a manifestation of the strange postulate of Einstein that states that the velocity of light is a constant of nature. This postulate lies behind most of the oddities in the theory of relativity. We will reject eq. (6) and adopt eq. (2) instead. We assume that the velocity of light is a wave velocity of the same kind as all other wave velocities and that light velocities exceeding c are allowed. In the same spirit we assume light to be a dispersive wave motion like all other wave motions we know. This makes theory comprehensible and expresses properties of nature that we are well acquainted with.

There are some more arguments in favour of a rejection of eq. (6). Firstly, velocity v is only defined when the moving body is rigid. If the ‘body’ is a galaxy, a gas cloud, or the degenerate matter in the interior of a white dwarf star there is no way to define velocity because mean velocity has no meaning in causal or real processes (Westerlund, 2002). One consequence of that is that a body moving with a velocity v, and not subject to any external forces will not continue to move with that velocity but will lose velocity with time. This is a violation of the first law of Newton. This result can be studied by means of eq. (3), which we can write

(7) $$F(t) = m_{\varnothing} \cdot \frac{d^n v(t)}{dt^n} \quad 0<n<1, \quad t>0$$

If we put F(t)=0 in the equation above we obtain the integral equation

(8) $$\frac{d^n v(t)}{dt^n} = 0 \quad 0<n<1, \quad t>0$$

When n=1 eq. (8) becomes a differential equation with the solution v(t)=constant, which reflects the response of a rigid body. A realistic body slows down. In solving eq. (8) we need to include a mechanism for putting the body in motion. If we assume that an impulse force acts on the body at t=0 we find the solution to eq. (8) to be (Westerlund 2002)

(9) $$v(t) = \frac{F_0}{m_{\varnothing} \cdot \Gamma(n)} \cdot \frac{1}{t^{1-n}} \quad t=0, \ 0<n<1$$

where F_0 is the amplitude of the impulse that started the movement. Thus the velocity of a real body decreases towards zero when t increases. Infinite time is not involved since all processes have finite lifetimes.

The notion that rotation is absolute but translation is relative has been cherished in physical theory since about 100 years. If we consider the solar system we find that the angular momentum of the sun is about one per cent of the total angular momentum while the mass of the sun is about 99 per cent of the total mass of the solar system. This means that rotational energy is consumed by the solar system. Otherwise the angular momentum should be distributed in proportion to the mass throughout the solar system. Eq. (9) expresses the same thing, that energy is consumed, for translation and we realize that, as long as bodies are realistic, there is really no difference between translation and rotation. These two concepts have been created by us to fit our theories. Nature does not need them! Both forms of motion are absolute! But this should be understood in the causal sense. Kinetic energy is a causal parameter which has a causal distribution the characteristics of which are that it has no maximum, no minimum, no mean.

It is now time to discuss the difficulty that exists in the theory of relativity and which is due to the assumption that velocities are relative and not absolute. The special theory of relativity is based on two postulates. The first is that the velocity of light in vacuum is always constant and independent of the velocity of the source. The second is that in inertial systems (which all move with constant velocities relative to each other) all physical laws are the same. We can say about the first postulate, the constancy of the velocity of light, that this is what one would expect if everything were stationary relative to the medium. When both observers and sources of light stay on some celestial body, the halo of that body (or those bodies) provides the propagation medium, which remains at rest (always in a causal sense) with respect to the body. Einstein's postulate is then fulfilled. There is a long and interesting history related to the hypothetical medium called the ether. Einstein ignored the ether and replaced it with his postulate. We also ignore it but we do not have to replace it with anything because when we observe light it is always in the neighbourhood of a large celestial body the halo of which is stationary, or almost so, in relation to us and the celestial body. The earth has a halo, the moon has another halo, and the sun a third halo and so on. But these halos that are quite close to each other also have velocities that are strongly correlated. For instance the velocity of the solar wind has a velocity of about 1000 km/s which is 0.3 % of the velocity of light. Many physical phenomena are masked by the large velocity of light in comparison with almost all other velocities.

The velocity of light is then a normal propagation velocity with no strange properties. The velocity of a realistic body, however, cannot be defined in causal theory since all causal bodies are elastic. But we return to the twins and let one of them settle at the North Pole and the other at the equator. The rotation of the earth corresponds to a velocity of 460 m/s at the equator. The difference in kinetic energy will make the twin at the equator younger relative the twin at the North Pole. We can express this as follows: Every atom is different from all other atoms because they all have both different environments and different energies (velocities). Einstein's second postulate, that about the inertial systems, is true in causal theory but with the reservation that atoms of the same element have different atomic weights in different inertial systems.

If we now consider what Einstein did about 100 years ago we realize that his postulates agree well with what we have used in this report even if we did not need to call them postulates. He approached the problem from the wrong direction when he tried to introduce causality in a theoretical framework that was acausal. Still, many of his result are correct. I think his work represented a great achievement.

References

Westerlund, S. *Dead Matter has Memory*, Causal Consulting, Kalmar, Sweden 2002. ISBN 91-631-2332-0. www.causal.st