Science in Wonderland

The Lorentz Gamma Factor as a Physicist's Magic Wand

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Abstract:

Things behave differently in Wonderland and, to make sense of experiments made over there, they must be conveniently processed by some kind of artifice in order to make sense in the real world.

In Wonderland there are no fixed reference frames and therefore it becomes very easy to choose a wrong model in trying to describe a given physical phenomenon. In a confused landscape you never know for sure where you are located and how to move about. One can eventually build a working description of a natural phenomenon starting from a wrong model, however at the cost of subsequent application of some ugly prostheses or patches as required to make the freak viable in real life. An emblematic example has been the ancient description of the astronomical orbits through the "epicycles" created by Aristotle and Ptolemy where they arbitrarily chose the Earth as a universal reference frame. It was not much different in the case of the many experiments of the ***Michelson and Morley*** type that also started up putting the Earth as the reference frame to build a model for a theory of the ether and light, a model that had to be patched by the physicist Hendrik Lorentz to justify its final outcome. In this case, that prosthesis became a magic wand in the hand of physicists to explain other phenomena related to the speed of light in space such as the ***relativistic time dilation*** and the ***relativistic mass increase,*** also to be revisited in this paper, which, as it happens, are also flawed concepts that have brought pitiful consequences for the modern scientific knowledge.

Start with the wrong question and you don't get the right answer!

Keywords:
Magic Wand, Gamma Factor, The Original Sin, Wonderland, Mass increase

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(1) The Original Sin:

A serious conceptual error has been committed along with the experiment performed by Michelson and Morley in the year 1887 conceived in order to detect the existence of an ether and whose null outcome gave rise to far-fetched speculations regarding the nature of light and the properties of space and time. The resulting fuss caught the attention of the physicist Hendrik Lorentz who, to cope with that result, suggested the application of an arbitrary correction factor to the equations describing the devised experimental model. In fact, this factor was introduced to suit an ill-conceived model to an unexpected outcome and, since then, it became a kind of convenient patch being applied as a panacea to mend other little understood phenomena in the Physics and Cosmology domain, and with honorable mention to Special Relativity.

However, after more than a century, no one realized, still, that the initial conception of the experiment had been structured on a wrong model. It's amazing that during all this time, nobody bothered to analyze in depth the theoretical design under which the experiment was conceived; more precisely the mechanism through which the phenomenon is produced.

In the years following the original experiment, a multitude of physicists repeated the experiment using more accurate or different methods and instruments but under the same wrong premise, just to get to the same disappointing result.
The basic framework as being taught by default in almost all universities is described as shown in the figure (1) bellow, taken from Beiser*, in which the lab and, consequently, the Earth are static in the Universe and being swept by a universal ether wind through which the light propagates. This experiment has been, obviously, structured on a wrong model figure (1)*****, where light is represented by a boat running with velocity **V** bu**t** being also dragged by an ether wind flowing with speed **v**. The letter **D** in the equations refer to the one way distance between a light source and a reflecting mirror located at distance **D** where it is being reflected back to a phase comparator. Letter **B,** in the figure**,** applies to the co-linear branch in Beiser's description which is the only one at stake in this paper since the transverse or orthogonal path, as has been already widely demonstrated elsewhere (**see appendix to the original sin),** could not be affected by the purported ether wind.

$$t_B = \frac{D}{V+v} + \frac{D}{V-v}$$

FIGURE 1-3 The speed of boat *B* downstream relative to the shore is increased by the speed of the river current while its speed upstream is reduced by the same amount.

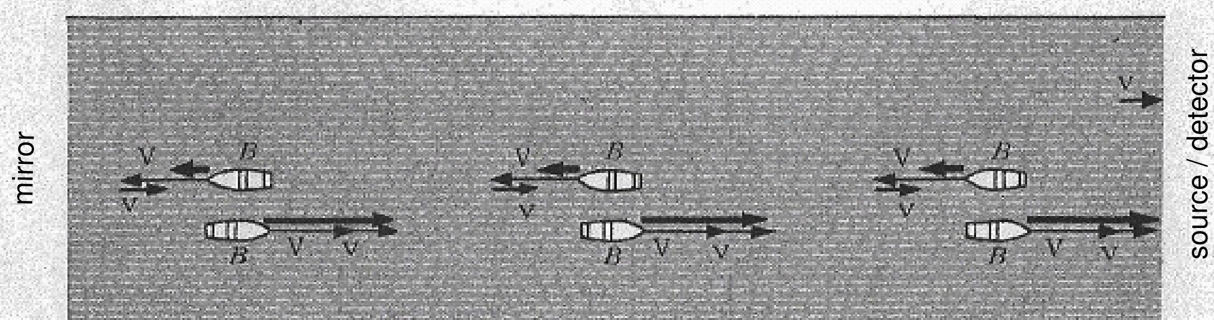

Fig. 1 THE SPECIAL THEORY OF RELATIVITY

The expected two way light travel time according to the equations and model in the picture above should have been

$$\mathbf{T} = \left(\frac{\mathbf{D}}{\mathbf{V}+\mathbf{v}} + \frac{\mathbf{D}}{\mathbf{V}-\mathbf{v}}\right) = 2\cdot\mathbf{D}\cdot\frac{\mathbf{V}}{\mathbf{V}^2-\mathbf{v}^2} \qquad \textbf{(1-1)}$$

However, the disheartening result of the experiment was one that should correspond to Eq.(2-1)

$$\mathbf{T} = \left(\frac{\mathbf{D}}{\mathbf{V}+\mathbf{v}} + \frac{\mathbf{D}}{\mathbf{V}-\mathbf{v}}\right) \quad \text{'='} \quad 2\cdot\frac{\mathbf{D}}{\mathbf{V}} \qquad \textbf{(2-1)}$$

that could only be satisfied by making **v = 0** indicating that there was no time (phase) shift whatever and corresponding, as such, to no ether wind at all.
To force the original equations in Fig (1) to suit the improbable result in eq. (2-1), Hendrik Lorentz suggested, perhaps candidly, applying a mending factor [1-(v^2/V^2)]^1/2 whose correct value should have been 1-(v^2/V^2) without a square root. What does that mean nobody knows for sure. George FitzGerald and Lorentz himself postulated, as an explanation, a length contraction for all bodies in movement (it's not clear in relation to what) and the idea, almost universally accepted, stuck, spread and, amazingly, became the sacred truth. A number of theories were proposed to explain the paradox, including the idea that the ether might in some way be "dragged along" by the Earth. George FitzGerald proposed the length contraction to explain it as a logical consequence of "*the speed of light being the same for all observers*". Lorentz and Poincaré extended this to the theory of special relativity and that became the accepted explanation, and the light and the ether, from there on, became magic entities.
Applying the revised Lorentz mending factor to the original equations in Fig,1 above

$$\left(\frac{D}{V+v}+\frac{D}{V-v}\right)\cdot\left(1-\frac{v^2}{V^2}\right)=\frac{2\cdot D}{V} \qquad \textbf{(3-1)}$$

and voilá, by a simple magic touch everything seems in it's right place. ***However...***

let's have a look at the true picture, fig.2.

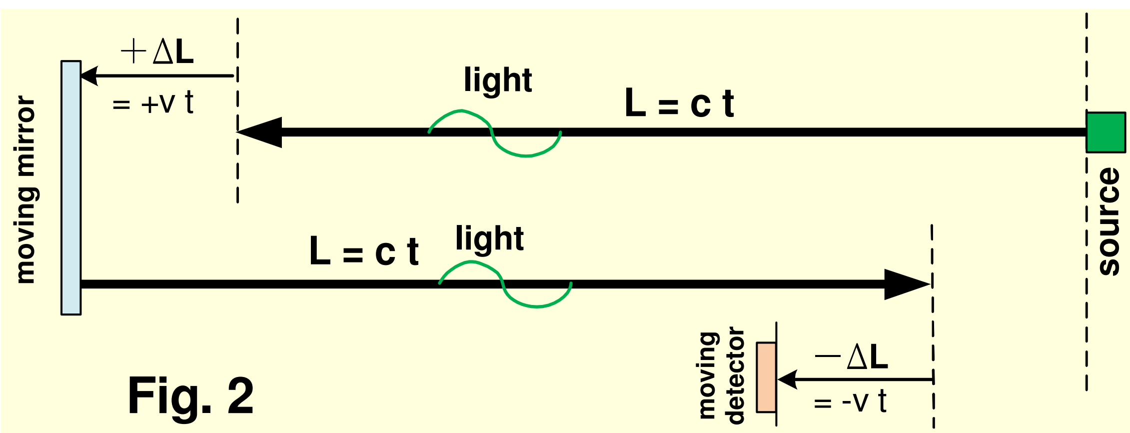

Fig. 2

This kind of experiment consists in observing the phase, or time, difference between light propagating in a static and in a moving system. Since phase is directly related to time, we chose to refer to time to simplify the explanation. Let's, then, consider the measuring instrument of length **L** oriented so that a light flash emitted by the source and directed towards the mirror follows co-linearly the direction of movement of the Earth (lab), in its orbit around the Sun, with velocity **v** fig. (2). For a static system, **v = 0** and **Δ L = 0** and the distance **L** the light has to travel to reach the mirror will be **c x t** where the time **t = L/c** will be the reference time to which the moving system measurements are to be compared. In the moving system, let's first consider the light and the lab running in the same direction, here called forward direction The total forward distance $\mathbf{D_f}$ light has to travel to reach the mirror in the forward direction must be

$$D_f = L + \Delta L \quad = \quad c \cdot t + v \cdot t \qquad \textbf{(4-1)}$$

Note that the light, once emitted, has no longer any link with the source and, from there on, moves independently through it's own propagation medium (ether or whatever) with speed **c**.
Since **ct** and **vt** occur simultaneously at time **t**, the time the light flash will take to move from the source to the receding mirror will be

$$t_f = \frac{c \cdot t}{c} + \frac{v \cdot t}{c} = t \cdot \frac{c + v}{c} \qquad \text{or} \qquad t_f = t + t \cdot \frac{v}{c} \qquad \textbf{(5-1)}$$

where, as shown above $t = \frac{L}{c}$

In the actual experiment, the same light flash is being reflected back, this time against the approaching detector. And here the light flash will hit the detector sooner as as the backward distance $\mathbf{D_b}$ will be shorter by $\mathbf{-v \times t = -\Delta L}$

$$D_b = L - \Delta L \quad = \quad c \cdot t - v \cdot t$$

and the light backward travel time t_b to the advancing detector

$$t_b = \frac{c \cdot t}{c} - \frac{v \cdot t}{c} = t \cdot \frac{c - v}{c} \qquad \text{or} \qquad t_b = t - t \cdot \frac{v}{c} \qquad \textbf{(6-1)}$$

In a static system as should have been indicated by the transverse interferometer arm, $\Delta L = 0$ and the round trip time would be

$$\frac{2 \cdot L}{c} = 2 \cdot t \qquad \textbf{(7-1)}$$

Here we can recognize equations (5-1) and (6-1) as the Doppler equations for a fixed source and an advancing and a receding observer respectively. The length **L** is totally irrelevant to the outcome of the experiment! All the above assumes a co-linear displacement between lab and light. For lab and light following in the same direction we got

$$t_f = t + t \cdot \frac{v}{c} \qquad \textbf{(5-1 bis)}$$

and, conversely, for the reflected light

$$t_b = t - t \cdot \frac{v}{c} \qquad \textbf{(6-1 bis)}$$

The Michelson - Morley type of experiment compares the round trip travel time (or phase) in the co-linear arm to the reference or static time **2 x L /c** given by the transversal interferometer arm

$$\frac{2 \cdot L}{c} = 2 \cdot t$$

$$\left(t + t \cdot \frac{v}{c}\right) + \left(t - t \cdot \frac{v}{c}\right) - 2 \cdot t = 0 \qquad \text{a phase difference} \qquad \Delta\varphi = 0$$

and a Sagnac interferometer compares the two opposite, split wave, path time difference to obtain a first order result

$$\left(t + t \cdot \frac{v}{c}\right) - \left(t - t \cdot \frac{v}{c}\right) = 2 \cdot t \cdot \frac{v}{c} \qquad \text{or a phase difference} \qquad \Delta\varphi = 4 \cdot \pi \cdot \frac{L}{\lambda} \cdot \frac{v}{c} \qquad \textbf{(7-1)}$$

Now, what's the relation between the the true model here presented and the mistaken M/M original model ?

$$\frac{\left(t + t \cdot \frac{v}{c}\right)}{\left(\frac{L}{c - v}\right)} = 1 - \frac{v^2}{c^2} \qquad \frac{\left(t - t \cdot \frac{v}{c}\right)}{\left(\frac{L}{c + v}\right)} = 1 - \frac{v^2}{c^2}$$

obviously, the Lorentz, revised, gamma factor!

The true model here described frees the light from its mystical aspect. As you see, the gamma factor served the purpose of transposing phenomena occurring in Wonderland to the real world
The M/M experiment pertains to the realm of Wonderland!!!

***)Arthur Beiser**
Concepts of Modern Physics
McGraw-Hill Series in Fundamental Physics

Appendix to The Original Sin:

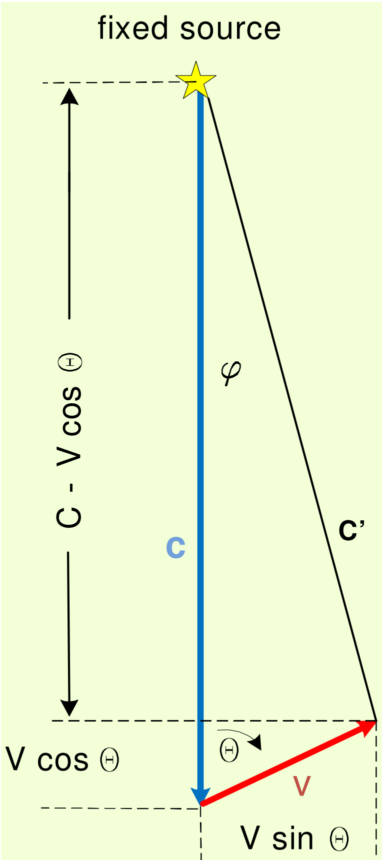

Fig (3)

The trigonometric cosine law

$$c' = \sqrt{c^2 + v^2 - 2 \cdot c \cdot v \cdot \cos(\theta)}$$

can be written as from (Fig.3)

$$c' = \sqrt{(c - v \cdot \cos(\theta))^2 + (v \cdot \sin(\theta))^2}$$

where

$c - v \cdot \cos(\theta)$ <== co-linear velocity component

$v \cdot \sin(\theta)$ <== orthogonal velocity component

if the source follows the detector, then the relative speed

$v = (\mathbf{v_d - v_s}) = \mathbf{0}$

where v_d = detector speed and v_s = source speed

and, under this circumstances the sine component vanishes, v **x** sin (θ) = **0** and c\` becomes

$$c' = c - v \cdot \cos(\theta)$$

since in our case, θ is either zero or π, then

$$c' = c \mp v$$

The M/M interferometer transverse arm two way light travel time must be just $T = \frac{2 \cdot D}{c}$

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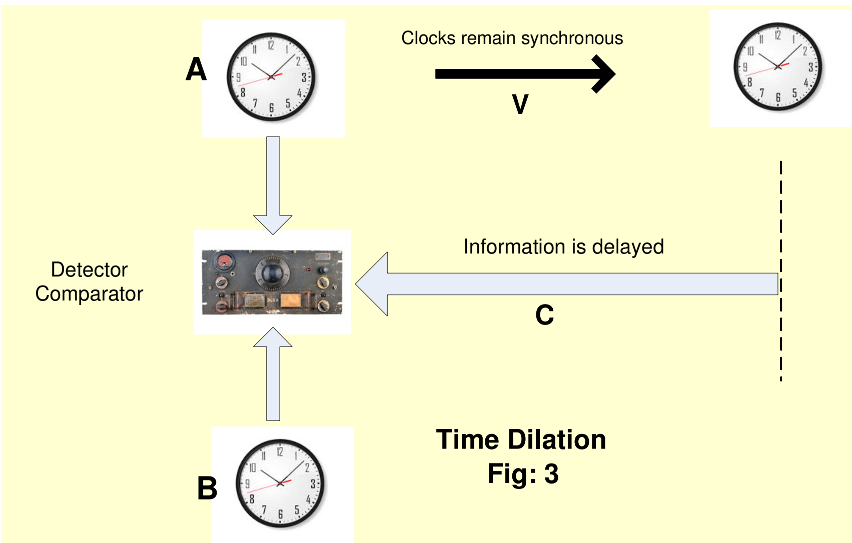
(2) Relativistic Doppler:

Both chronometers **A** and **B** in fig(3) are synchronized in the laboratory and thereafter clock **A** is sent flying in space at speed **v**
Clock A can lose some timing during the acceleration period since the force applied thereupon does not differ substantially from the force of gravitation



Time Dilation
Fig: 3

$$d = v \cdot t$$

Important: disregarding acceleration, clocks remain synchronized in spite of velocity **v** or distance **d**. It all happens as if the same clock time indicated by **B**, in the laboratory, is being time delayed and fed back to the"detector/comparator"

relativistic proposal:

$$\Delta t = \frac{t}{\left(1 - \frac{v}{c}\right)} \cdot \frac{1}{\gamma} \qquad \textbf{(1-2)}$$

where

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

correct, real world, value:

$$\Delta t = t + \frac{v \cdot t}{c} = t \cdot \left(1 + \frac{v}{c}\right) \qquad \Delta t = t \cdot \left(1 + \frac{v}{c}\right) \qquad \textbf{(2-2)}$$

the wrong model has been patched by the inverse gamma factor brought as an inheritance from the M/M experiment

$$\frac{t}{1 - \frac{v}{c}} \cdot \left(1 - \frac{v^2}{c^2}\right) = t \cdot \left(1 + \frac{v}{c}\right) \qquad \frac{t}{1 + \frac{v}{c}} \cdot \left(1 - \frac{v^2}{c^2}\right) = t \cdot \left(1 - \frac{v}{c}\right)$$

Relativistic Doppler pertains to the realm of Wonderland !!!

(3) Gravitational Time Delay:

All modern evidences point to the fact that the gravitational field must be the sole responsible for the phenomenon of time dilation by, in some way, being capable of modulating space's electric permittivity as has been made apparent by the Sun grazing light experiments done by Irwin Shapiro in 1964 and also convincingly being demonstrated by the GPS system. Let's have a look at the picture...

$$v_{esc} = \sqrt{\frac{2 \cdot G \cdot M}{R}}$$ <= gravitational escape velocity $\mathbf{v_{esc}}$ **(1-3)**

equaling the escape velocity to c, as the maximum attainable velocity, and solving for R we obtain the Scwarzschild radius R_{ss} from where, according to this postulation, light can still escape!

$$\sqrt{\frac{2 \cdot G \cdot M}{R}} = c$$ and solving for R $$R_{ss} = \frac{2 \cdot G \cdot M}{c^2}$$ **(2-3)**

If, hypothetically, you consider the total Earth mass concentrated in the center of an undefined spherical volume, the Scwarzschild radius $\mathbf{R_{ss}}$ can be taken as a convenient reference point together with the Earth surface and outer Space, where to anchor some scale of values; in our specific case space electric permittivity $\boldsymbol{\varepsilon}$ and index of refraction **n**.

Normalizing to $\boldsymbol{\varepsilon} = 1$ as the electric permittivity of space at the Earth surface, which is where all our measurements are being performed, then

$$\varepsilon = \frac{R_{ss}}{R} - \frac{R_{ss}}{R_E} + 1 \qquad \textbf{(3-3)}$$

and the refraction index referenced to the Earth surface, where our measurements are made, must be

$$n = \sqrt{\frac{\varepsilon}{\varepsilon_0}} = \sqrt{\frac{R_{ss}}{R} - \frac{R_{ss}}{R_E} + 1} \qquad \textbf{(4-3)}$$

Seen from a lab on the Earth:

$M_E = \mathbf{5.97223} \cdot 10^{24} \cdot kg$ <= Mass of the Earth

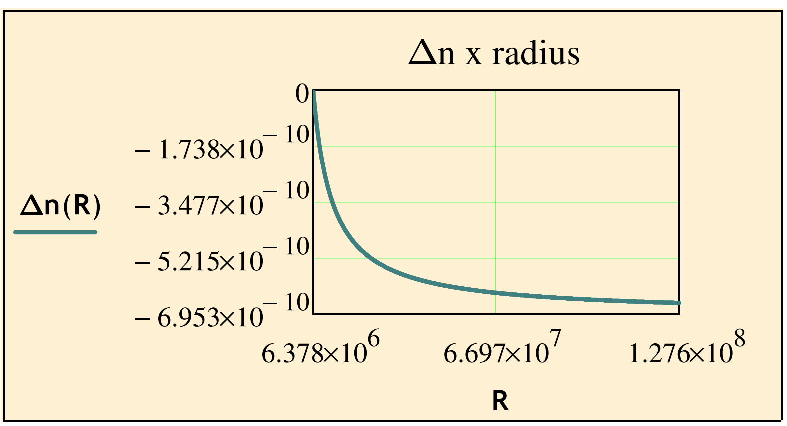
$R_E = 6378140 \cdot m$ <= Equatorial radius of the Earth

$G = 6.67390 \cdot 10^{-11} \cdot \frac{m^3}{kg \cdot s^2}$ <= gravitational constant

$$R_{ss} = \frac{2 \cdot G \cdot M_E}{c^2} \qquad n(R) = \sqrt{\frac{R_{ss}}{R} - \frac{R_{ss}}{R_E} + 1}$$

Index of refraction versus height radius above Earth surface:

$$\Delta n(R) = n(R) - n(R_E) \qquad \textbf{(5-3)}$$



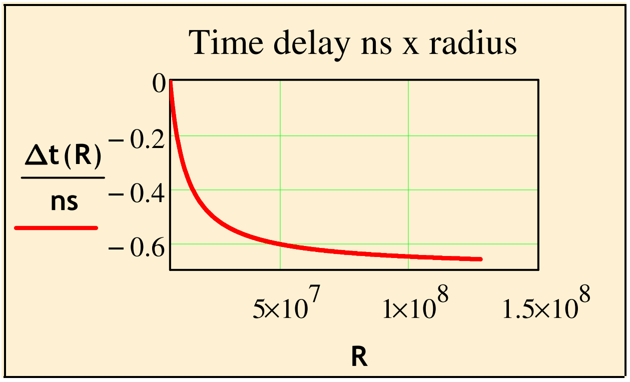
$n(\infty \cdot m) = 0.9999999993046863$
$n(R_E) = 1$
$n(R_{ss}) = \sqrt{2}$

$\Delta n(\infty \cdot m) = -6.953 \times 10^{-10}$
$\Delta n(R_E) = 0$
$\Delta n(R_{ss}) = 0.414$

Time delay versus height radius above Earth surface:

$t(R) = s \cdot n(R)$ <= gravitational time delay **(6-3)**

$\Delta t(R) = t(R) - s$ **(7-3)**



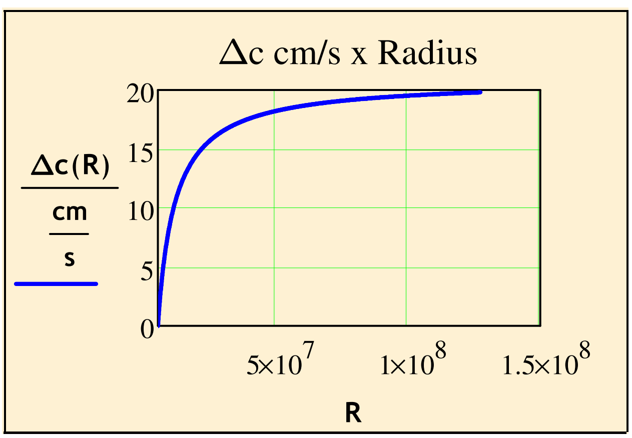
$$t(\infty\cdot m) = 0.9999999993046863\cdot s$$
$$t(R_E) = 1\,s$$
$$t(R_{ss}) = 1\cdot\sqrt{2}\cdot s$$

$$\Delta t(\infty\cdot m) = -0.695\cdot ns$$
$$\Delta t(R_E) = 0\,s$$
$$\Delta t(R_{ss}) = 0.414\,s$$

Light velocity versus height radius above Earth surface:

$$c'(R) = \frac{c}{n(R)} \qquad \textbf{(8-3)}$$

$$\Delta c(R) = c'(R) - c \qquad \textbf{(9-3)}$$



$$c'(\infty\cdot m) = 2.9979245820844977\times 10^{8}\,\frac{m}{s}$$
$$c'(R_{ss}) = \frac{c}{\sqrt{2}}$$
$$c'(R_E) = c$$

$$\Delta c(\infty\cdot m) = 20.845\cdot\frac{cm}{s}$$
$$\Delta c(R_{ss}) = c\cdot\frac{\sqrt{2}}{2} - 1$$
$$\Delta c(R_E) = 0\,\frac{m}{s}$$

Gravitational time delay pertains to the real world !!!

(4) Relativistic Mass increase:

The silliest explanation one could come up with is that the bodies in motion undergo a mass increase and when the speed approaches the speed of light, the mass tends to infinity. And then again the Lorentz gamma-factor became the magical wand. Currently, a few physicists maintain a more weighted attitude with respect to that explanation and say that you should not take it at face value and interpret it as an increase in momentum instead

mass M:

$$M' = \frac{M}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad \lim_{v \to c} M' = \infty$$

momentum **p**:

$$p = \frac{M \cdot v}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad \lim_{v \to c} p = \infty$$

Doesn't look much better. Both tend to infinity; always a sure symptom that something has gone astray!

Let's have a look at the true picture:

Pertinent units and symbolism:

M = mass being accelerated in kg **Φ** = propellant flux in kg/sec

ϖ = maximum attainable propellant speed in m/s **α** = acceleration in m/s^2

t = time in seconds

$$F = M \cdot \alpha$$ <== Force

$$\alpha = \frac{F}{M}$$ <== Acceleration

$$v = \alpha \cdot t = \frac{F}{M} \cdot t$$ <== speed

$$\Phi = \frac{kg}{s}$$ <== propellant flux

A universal basic principle can be borrowed from aeronautical or space engineering, and perfectly relevant to the case at hand, that states that a vehicle can't accelerate past its exhaust flux velocity as it would imply a negative thrust. The flux **Φ** can be the exhaust gas flux expelled by a jet engine; the mass of air impelled by an airplane's propeller; the wind carrying away your hat or a traveling electromagnetic wave dragging a charged particle... As will be implied in this topic, **ϖ** stands for any practical limiting speed attainable by any propellant meant by the flux **Φ** and eventually also to the velocity of light since, as will be seen, the physics involved is not a particular attribute of light.
The speed of light is determined solely by the electromagnetic characteristics (magnetic permeability and electric permittivity) of its propagation medium and, as seen in the topic above, varies accordingly.
Light in a vacuum, and far from gravitating masses, is still the fastest thing known to exist but, as a

matter of fact, there is no demonstrable physical reason that precludes something to move at a higher speed than light should you find some faster propellant.
In ideal conditions, disregarding practical effects such as thrust efficiency, friction, etc. the force **F** exerted by the gas flux **Φ** being expelled by a jet engine is a function of the speed difference between the velocity ϖ of the propellant and the instantaneous speed **v** of the vehicle carrying the jet engine.

$$F = \Phi\cdot(\varpi - v) \qquad \textbf{(1-4)}$$

The resulting instantaneous acceleration **α** will be.

$$\alpha = \frac{F}{M} = \frac{\Phi\cdot(\varpi - v)}{M} \qquad \textbf{(2-4)}$$

Initially, when **v = 0** we have full acceleration and when **v** approaches ϖ acceleration **α** tends to zero.

$$\lim_{v \to \varpi} \frac{\Phi\cdot(\varpi - v)}{M} \to 0 \qquad \textbf{(3-4)}$$

$$\Phi = \frac{M\cdot v}{t\cdot(\varpi - v)} \qquad \textbf{(4-4)}$$

Solving the above for **v**, the velocity at any instant will be

$$v(t) = \frac{\Phi\cdot t\cdot\varpi}{\Phi\cdot t + M} \qquad \textbf{(5-4)}$$

and the force F as a function of time

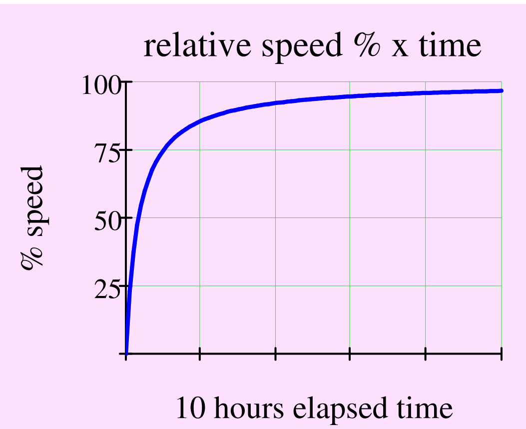
$$F = \Phi\cdot(\varpi - v) \quad ==> \quad F(t) = \Phi\cdot\left(\varpi - \frac{\Phi\cdot\varpi\cdot t}{M + \Phi\cdot t}\right) \qquad \textbf{(6-4)}$$

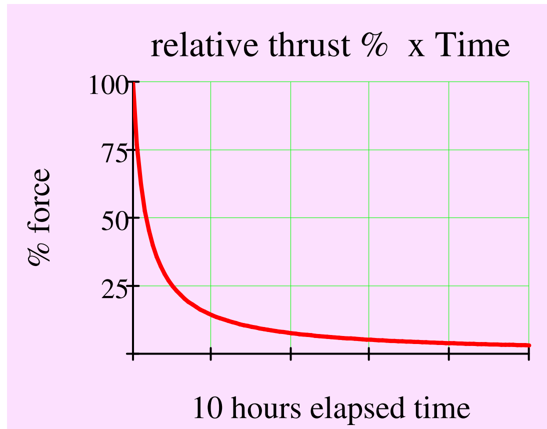
To keep strictly on theoretical grounds, consider an hypothetical, external, unlimited propellant supply flux of **Φ = 1 kg/s** with velocity ϖ impelling a space ship with a mass of 1200 kg**.** Note that ϖ can be any limiting speed you chose. In this example we chose light velocity as the limit of limits and make

$\varpi = c$ $M = 1200 \cdot kg$ $t = 0, 0.1 \cdot hr .. 10 \cdot hr$ $\Phi = 1 \cdot \frac{kg}{s}$

and then check

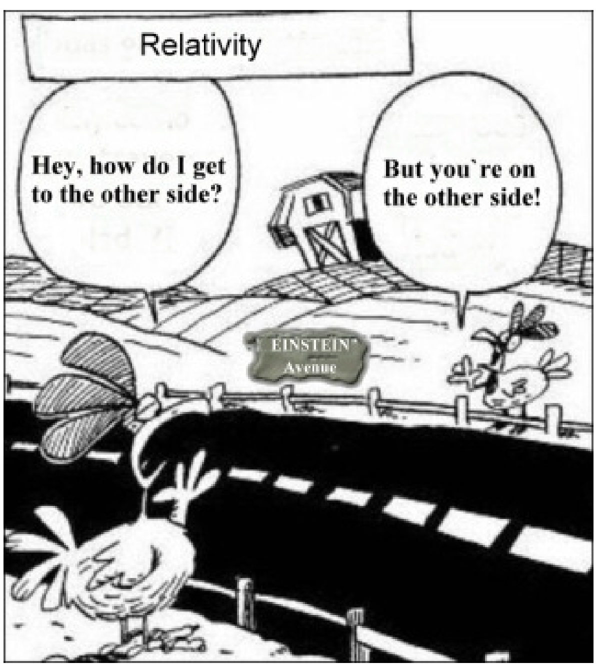
$$v(t) = \frac{\Phi \cdot t \cdot \varpi}{\Phi \cdot t + M} \qquad F(t) = \Phi \cdot (\varpi - v(t))$$





as you can see, a lack of thrust instead of mass increase!

Relativistic mass increase pertains to the realm of Wonderland !!!



From time to time we will discover that our previous scientific understanding was built on a flimsy foundation and must be urgently shored up or even abandoned.
Some scientists might make definitive statements, but others must then take on the task of trying to undermine them. New experiments, new thoughts, and new discoveries turn our thinking on its head, reverse a trend, expose the flaws in previous experiments, or poke holes in a celebrated scientist's thinking. The initial result is usually panic or denial, anger or derision often all of the above. Eventually, though, after months, a year, a decade or a century, there is resigned acceptance of the new.

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