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Can a computer simulation determine what happens at super luminal speeds?

Pitambar Sai Goyal

Department of Information Technology, Loyola-ICAM College of Engineering and Technology, Chennai, India

Corresponding Author: lasawfwiah@gmail.com

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***Abstract*—** Special Relativity prohibits masses from moving faster than the speed of light. Einstein makes a plausibility argument for this, illustrating that time would appear to go backward at super luminal velocities. However, this argument includes nothing from special relativity, and only contains the assumption that light travels at a finite speed. Thus, we may use the Galilean transformation along with this assumption so as to avoid the imaginary time problem at super luminal speeds. In this document we run a computer simulation of the observation of a clock from two distinct inertial frames. We run a relativistic simulation as well as a non-relativistic simulation. We compare the two and observe a clue to time dilation inherent in non-relativistic mechanics. Besides this, some interesting qualitative observations are made. Finally, for super luminal velocities, we use only the Galilean transform, and make observations, keeping in mind Einstein's argument.

***Keywords*—** Relativity, Einstein, Galileo, simulation, time travel, special relativity

I. THE PROBLEM OF SUPER LUMINAL SPEEDS IN SPECIAL RELATIVITY

It is well established by special relativity that no mass can travel at a speed higher than that of light. This arises from the form of the Lorentz factor:

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

which appears in the Lorentz transformation, in the relativistic mass equation etc. In the Lorentz transformations, it prohibits v from exceeding c, since this would make the length and time measurements- both real quantities- imaginary. It then becomes exceedingly speculative as to how one must interpret that.

It also prohibits v from equalling c since this would make these quantities infinite.

II. EINSTEIN'S PLAUSIBILITY ARGUMENT AGAINST SUPER LUMINAL SPEEDS

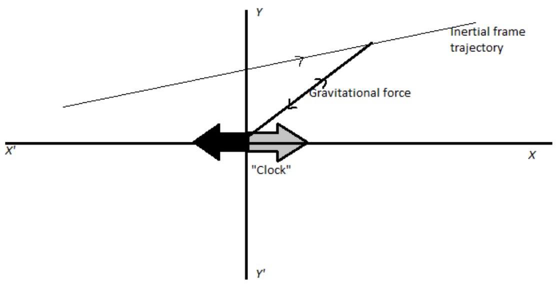
We quote Andrew Robinson [1]:
"Were we to travel faster than light, Einstein imagined a situation in which we should be able to run away from a light signal and catch up with previously sent ones. The most recently sent light signal would be detected first by our eyes, then we would see progressively older signals.

> 'We should catch them in reverse order to that in which they were sent, and the train of happenings on our earth would appear like a film shown backwards, beginning with a happy ending.'"

If we parse this statement carefully enough, we find that no mention is made of the postulates of relativity. It is sufficient to assume Galilean relativity and the proposition that light travels at a finite speed. However, the suggestion that time would travel backward for the super luminal object indicates that time is relative to velocity, despite the lack of any relativistic assumptions.

III. GALILEAN TIME DILATION?

Careful analysis indicates that this is due, not to any real relativity of time inherent in Galilean relativity, but, rather, a relativity will be perceived by our visual senses, inasmuch as they cannot perceive anything not conveyed by light. We shall try to simplify this. In the Galilean construct, there was no ceiling on the speed of a signal, so that gravitational attraction was conveyed between objects at infinite speed [4]. This meant that any sense by which we could perceive a gravitational pull could act as our window to the instantaneous universe, neglecting any delay in the transmission of a nervous signal to our brains. Thus, we could perceive Newton's absolute time [3] by maintaining a heavy object which oscillates about a chosen origin, and, regardless of our velocity, calculate the time as a simple function of the force registered on a force measuring device at rest relative to ourselves.



But if we referred our measurement and perception to signals of finite speed, such as that of light, time becomes relative.

Admittedly, a scientist in the pre-relativity era would have no reason to do this. Among signals of finite speed in the Galilean era, light was known to be the fastest. This fact, combined with the postulate that no signal travels at infinite speed, yields a world view which includes quasi-relativistic effects, not just at super luminal speeds. In this document we focus on time effects.

IV. THE SIMULATION

We simulate the Galilean time effects alongside the Lorentz time effects in the following way.

A digital clock that has been running eternally, and with no memory constraints, is situated at the origin and is emitting electromagnetic radiation at a constant rate. An object, capable of perceiving this radiation, is travelling at a constant speed along the x-axis in the positive direction.

The object starts at some arbitrary instant. In the Galilean case, the time registered in the clock, as perceived (via light) by a user at some point at a distance r from the origin will be equal to [5]:

$$t - r/c$$

where t is according to a universal clock. Because of this universal clock, the time as perceived by the travelling object will be given by:

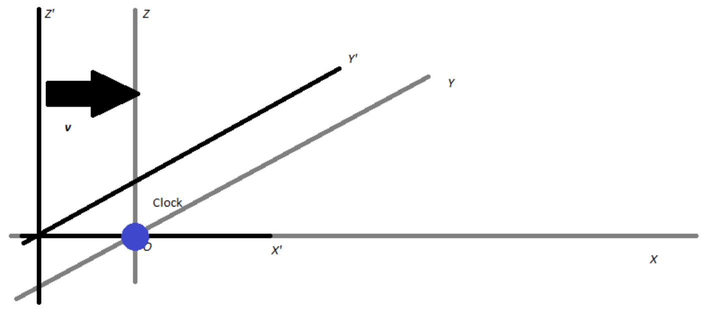
$$t - |x(t)|/c$$

where $x(t)$ is the trajectory of the moving object, linear in t.

In the Lorentzian case, the first expression above will hold for all observers at rest relative to the clock, thus excluding the moving object. For the moving observer, it will have the form:

$$t' - |x'(t')| /c$$

where t' and $x'(t)$ are related to t and $x(t)$ by the Lorentz transformation.



We run the simulation taking the factor v/c as input, and observe the clock as seen from the moving frame according to Galilean and Einsteinian relativity. Then we make observations.

V. QUESTIONS ANSWERED

How does Galilean time dilation compare to Lorentzian at subluminal speeds?

Below are results from the simulation run at various values of v/c. The left column contains the Galilean view of the clock, sampled every second according to the rest frame, and the right contains the same thing for the Lorentzian view.

$v/c = 0.1$

0.000000	0.000000
0.900000	0.994987
1.800000	1.989975
2.700000	2.984962
3.600000	3.979950
4.500000	4.974937
5.400000	5.969924
6.300000	6.964912
7.200000	7.959899
8.100000	8.954886

$v/c = 0.5$

0.000000	0.000000
0.500000	0.866025
1.000000	1.732051
1.500000	2.598076
2.000000	3.464102
2.500000	4.330127
3.000000	5.196152
3.500000	6.062178
4.000000	6.928203
4.500000	7.794229

$v/c = 0.99$


```
0.000000        0.000000
0.010000        0.141067
0.020000        0.282134
0.030000        0.423203
0.040000        0.564269
0.050000        0.705339
0.060000        0.846405
0.070000        0.987471
0.080000        1.128538
0.090000        1.269608
```

Clearly, there is a discernible correspondence between these. It may be that the difference may be of the order of magnitude of a quadratic polynomial.

What happens at v=c?

About this Einstein says:

"If I pursue a beam of light with a velocity *c*, I should observe such a beam of light as a spatially oscillatory electromagnetic field at rest. However, there seems to be no such thing, whether on the basis of experience or according to Maxwell's equations."

The Lorentz factor forbids the setting of *v* to *c*, so that we can only simulate the Galilean case.

$v/c = 1$

```
0.000000
0.000000
0.000000
0.000000
0.000000
0.000000
0.000000
0.000000
0.000000
0.000000
```

In other words, time ceases to flow.

What happens at super luminal speeds?

Here too, we can only turn to the Galilean case, and we test Einstein's argument in the beginning of the document.

$v/c = 1.2$

```
0.000000
-0.200000
-0.400000
-0.600000
-0.800000
-1.000000
-1.200000
-1.400001
-1.600000
-1.800000
```

$v/c = 1.5$

```
0.000000
-0.500000
-1.000000
-1.500000
-2.000000
-2.500000
-3.000000
-3.500000
-4.000000
-4.500000
```

Hence, we observe time flowing backwards.

VI. CONCLUSIONS

The simulation offers the possibility of time travel into the past at superluminal speeds. The question is, does the correspondence between the Galilean, "optical" time dilation and the Lorentzian case as observed at subluminal speeds signify something persistent? Can we, using this, get rid of the square root in the Lorentz transformations (and thus problems with imaginary time) and come up with a relation which tells us what happens at super luminal speeds? The possibilities are intriguing.

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Authors Profile

The author is a student in the 3rd year of a B.Tech Degree course in the Department of Information Technology in Loyola ICAM College of Engineering and Technology, Chennai.