Relativity Emerging from Microscopic Particle Behaviour and Time Rationing

Jayanta Majumder, Shikha Majumder, Sambuddha Majumder

January 20, 2018

Abstract

This article presents a new interpretation of relativity whereby relativistic effects emerge as a result of rationing of Newtonian time into spatial and intrinsic motions. Unlike special theory of relativity, this theory does not need to postulate that speed of light (c) is constant for all reference frames. The constancy of speed of light emerges from more basic principles. This theory postulates that :

1. *The speed of spatial motion of a particle is always c.*
2. *Spatial motion and intrinsic motion continuously, linearly, and symmetrically rubs into each other.*

Postulate 1 seems reasonable because the Dirac model of electron already shows that the spatial speed of intrinsic degrees of freedom of an electron is always c. If the spatial speed was anything other than c then time-sharing between spatial and intrinsic motions would have entailed repeated cycles of high accelerations and deccelerations. Postulate 2 is also reasonable because it is the simplest and most symmetric way for the spatial and intrinsic time-shares to co-evolve in time. An observer's physical measure of time is entirely encoded by its intrinsic motions. This is the relativistic time. The time spent in spatial motion does not cause any change of the particle's internal state, and therefore does not contribute to measurable time.

Speed of light is constant regardless of the speed of the observer because light advances with respect the observer only for the duration of its intrinsic motion (i.e. during the relativistic time). During spatial motion, the observer moves with the light. Consequently the spatial advance of light divided by the relativistic time (i.e. the observed relative speed) is always c. Hence constancy of speed of light, which is a postulate for Einstein's relativity, is a deduced result here.

Contents

1 Introduction

Following is the definition of time as presented by Newton in his *Philosophiae Naturalis Principia Mathematica*.

> *Absolute, true, and mathematical time, of itself, and from its own nature, flows equably without relation to anything external, and by another name is called duration: relative, apparent, and common time, is some sensible and external (whether accurate or unequable) measure of duration by the means of motion, which is commonly used instead of true time; such as an hour, a day, a month, a year.*

This absolute concept of time ruled physics for centuries until Einstein came up with his special theory of relativity (to be called SR elsewhere in this article) that viewed time not as an absolute universal but as a part of an active fabric that is sensitive to the reference frame of motion. The fundamental equations of relativity indicated that time slowed down in moving reference frames. The relativistic equations agree with experiment but has aspects that appear to lack a microscopic interpretation, some of which this article aims at addressing.

2 Derivation of the Relativistic Transform

The basic postulates of this theory are :

1. The speed of spatial motion of a particle is always c.
2. Spatial motion and intrinsic motion continuously, linearly, and symmetrically rub into each other.

To derive Lorentz transform, all we need is to express the above postulates in the language of equations.
Let us say that Newtonian time (t) is split into T and $\overline{T}$, where T is the time spent in intrinsic motions and $\overline{T}$ is the time spent in spatial motions. By postulate 1, if X denotes spatial displacement then

$$\overline{T} = \frac{X}{c} \tag{1}$$

Postulate 2 may be written in the form of the following differential equations :

$$\frac{d\overline{T}}{dt} = kT \tag{2}$$

$$\frac{dT}{dt} = k\overline{T} \tag{3}$$

Where k could be some function of t. The finite-time evolution operator (say between time t_0 and t_1) that can be obtained by solving the above set of differential equations is as follows :

$$\begin{pmatrix} \cosh(\phi) & \sinh(\phi) \\ \sinh(\phi) & \cosh(\phi) \end{pmatrix} \tag{4}$$

where

$$\phi = \int_{t_0}^{t_1} k(t)dt \tag{5}$$

So we have

$$\overline{T}(t_1) = \cosh(\phi)\overline{T}(t_0) + \sinh(\phi)T(t_0) \tag{6}$$

$$T(t_1) = \sinh(\phi)\overline{T}(t_0) + \cosh(\phi)T(t_0) \tag{7}$$

The evolution equation describes how a particle responds to an accelerant $k(t)$. When $k(t)$ is zero, there is no accelerant, and the (Newtonian) time derivative of both T and $\overline{T}$ is zero. So the time-shares don't change when $k(t) = 0$ (i.e. the finite-time transform becomes an identity matrix).

Accelerant events like absorption of a photon or interaction with a mutual field act like pulses, or even impulses i.e. $k(t)$ is non-zero for a tiny interval and then it falls back to zero. The shape of the pulse is immaterial to the resulting transform, it's the area under the pulse that decides the extent of the transform (i.e. the overall acceleration).

Okay, so now we know how to transform time-share states, but we don't have a way of measuring actual time-share values. We can only measure clock time and distances and need to interpret the above equations in terms of space traversals and clock-time rates. Here is how we can deduce the physically measurable relative velocity in terms of time-shares:

The relative velocity v between the particle's initial motion state (i.e. the motion state at time t_0) and the final motion state (i.e. that at time t_1) is the following derivative under the condition that we have frozen $\overline{T}(t_0)$:

$$v = \frac{d(c\overline{T}(t_1))}{d(T(t_1))} \tag{8}$$

Why do we freeze $\overline{T}(t_0)$? Because the relative velocity in question is with reference to the motion state at t_0. Thus we are to compute the derivative in a reference frame where no spatial motion is happening for the particle's motion state at time t_0. On taking differentials on both sides of the above equations, we get:

$$d\overline{T}(t_1) = \cosh(\phi)d\overline{T}(t_0) + \sinh(\phi)dT(t_0) \tag{9}$$

$$dT(t_1) = \sinh(\phi)d\overline{T}(t_0) + \cosh(\phi)dT(t_0) \tag{10}$$

But $d\overline{T}(t_0)$ is zero because spatial motion $\overline{T}(t_0)$ is frozen for the reference frame in question. So we have :

$$d\overline{T}(t_1) = \sinh(\phi)dT(t_0) \tag{11}$$

$$dT(t_1) = \cosh(\phi)dT(t_0) \tag{12}$$

Therefore

$$v = c\frac{d\overline{T}(t_1)}{dT(t_1)} = c\frac{\sinh(\phi)}{\cosh(\phi)} = \tanh(\phi) \tag{13}$$

i.e.

$$\tanh(\phi) = v/c \tag{14}$$

Now we could use the following two hyperbolic trigonometric identities

$$\sinh(\phi) = \frac{\tanh(\phi)}{\sqrt{1-\tanh^2(\phi)}} \tag{15}$$

$$\cosh(\phi) = \frac{1}{\sqrt{1-\tanh^2(\phi)}} \tag{16}$$

to rewrite the above state transformation equation as follows:

$$\overline{T}(t_1) = \frac{1}{\sqrt{1-v^2/c^2}}\overline{T}(t_0) + \frac{v/c}{\sqrt{1-v^2/c^2}}T(t_0) \tag{17}$$

$$T(t_1) = \frac{v/c}{\sqrt{1-v^2/c^2}}\overline{T}(t_0) + \frac{v/c}{\sqrt{1-v^2/c^2}}T(t_0) \tag{18}$$

We could compute time dilation the same way that we computed relative velocity. Time dilation with reference to the initial state is the following derivative, when $\overline{T}(t_0)$ is assumed frozen.

$$\boxed{\text{Time dilation}} = \frac{dT(t_1)}{dT(t_0)} \tag{19}$$

By equations 12 and 19, we have :

$$\boxed{\text{Time dilation}} = \cosh(\phi) = \frac{1}{\sqrt{1-v^2/c^2}} \tag{20}$$

Thus we have derived Lorentz transform (and time dilation) without postulating constancy of the speed of light or perfect symmetry between inertial frames. Contrast this with how Einstein's derivation of Lorentz transform is in the context of a uniform motion and inertial reference frame. Lorentz transform in reality is only about the state transform of a particle when an accelerant is in action. During uniform motion $k(t)$ is zero, and hence the Lorentz transform matrix is an identity matrix. So one should not attempt to derive Lorentz transform in the context of uniform (inertial) motion. That is what created all the confusion and paradoxes of Einstein's version of special relativity.

Einstein probably stared long and hard at the the Lorentz transform equations (which by the way were inferred by Lorentz on the basis of Maxwell's equations) and tried to theorize it in the context of two inertial frames using a lot of obscure terminology - that mutual symmetry of inertial frames, observers, light clocks and so on. All that is smoke and mirrors. However, Einstein did an excellent job of analysing the ramifications of Lorentz transform.

Note 1: The evolution equations (i.e. equations 2 and 3) show that translatory motion evolves with a *symmetric* linear operator, just the way rotation (including spinor rotation) evolves with an *anti-symmetric* linear operator. This pattern is very satisfying and indicates a beautiful consistency.

Note 2: The finite time evolution operator **associates** for contiguous intervals of Newtonian time (i.e. there is no preferred start point). This fact may be mathematically represented by the following equation:

$$\begin{pmatrix} \cosh(\phi_1) & \sinh(\phi_1) \\ \sinh(\phi_1) & \cosh(\phi_1) \end{pmatrix} \times \begin{pmatrix} \cosh(\phi_2) & \sinh(\phi_2) \\ \sinh(\phi_2) & \cosh(\phi_2) \end{pmatrix} = \begin{pmatrix} \cosh(\phi_1+\phi_2) & \sinh(\phi_1+\phi_2) \\ \sinh(\phi_1+\phi_2) & \cosh(\phi_1+\phi_2) \end{pmatrix}$$

3 Justifications

Following is a brief listing of reasons that suggest that the proposed theory may have some truth in it.

3.1 In support of the hypothesis that spatial speed is only ever c for all matter

Dirac's model of the electron indicates that the spatial speed of the intrinsic motion of the electron (should we say "sub-electron wisp" instead of electron because it is not the motion of the electron as a whole) is "c" (i.e. the speed of light). So it shouldn't be too surprising if the whole thing also only ever moved at c. It would be more surprising if it didn't, as that scenario would involve lots of repeated cycles of accelerations and deccelerations at wisp level.

3.2 Special Relativity as the Unusual Perfect Symmetry

We are aware that the proposed theory (at least the energization bit) violates inertial-frame symmetry which would be noticeable in the extreme cases. That might be a good thing. In the quantum world it has been observed recently (well, parity violation is not even recent) that the revered symmetries are actually only approximate. Inertial frame symmetry stood in the middle of that scene as a perfect symmetry, given the mighty geometric edifice that special relativity is. It seems only natural that the little wiggly things (that the universe is teeming with) are incapable of upholding such a perfect symmetry. The relativity of motion states may after all be an epistemic one rather than a strictly mathematical one.

3.3 Lack of Relativity of Simultaneity

In the proposed theory, relativity of simultaneity does not arise because simultaneity is not violated in the true time (Newtonian time). We think that this is a good thing. With all its symmetry construction *relativity of simultaneity* appears to be a statement in the theory without any deep justification. It appears to suggest light as a conveyer of truth without suggesting how any odd photon could convey the truth of an arbitrarily complex event (i.e. there is no information-theoretic justification that truth of events is conveyed by the wavefront moving at speec c).

3.4 Return to an underlying absolute time

It seems very intuitive that the concept of time doesn't have to be attached to an observer. The physical world may be constrained by its intrinsic motions, but imagination is not. This may be best understood by considering a time sharing computer in which the processes don't have any visibility of the global clock time. They get time slices of the computer to execute programmed code and keep track of time accrued through the time slices. The processes may not have a concept of the global system time, but that doesn't mean that the global time doesn't exist. The processes might be able to reason about the behaviour of an *always running* process to figure out the existence of a global time.

3.5 Non Reliance on the Flimsy Concept of Inertial Frame

The proposed deduction of Lorentz transform does not depend on the elusive concept of an inertial frame. The concept of inertial frame is fundamentally flakey. Is true uniform motion even realisable? In this quantum world every seemingly uniform motion could be a sequence of trillons and trillions of tiny jolts and accelerations. The proposed derivation deals with the average velocity over a finite period, and doesn't care how that average speed is composed. There could be arbitrary number of jerks and jolts but that does not have any effect on the derivation.

4 Moving Objects in the Universe

Suppose you jumped off of a plane in a foggy sky with some friends, and you are stoned (not recommended, by the way). You don't know where you came from or where you are going (or if you are moving at all - ignore the wind for the purposed of this analogy). You see some relative motions but have no way of ascertaining any absolute reference. You see a bird flying by, maybe the light from an aeroplane in the distance and so on. Next you see your friend who was next to you pushing a button and he zooms away. You infer that the button makes things accelerate. If your friend is stoned enough he can think so too. But in reality it could be a button that actually deccelerates the object in the opposite direction (e.g. to an observer on the earth, if she can see you through the fog, would see that you continue free-fall at terminal velocity and your friend deccelerates to a new slower terminal velocity - the button activated a parachute). Of course in this analogy there is a superior reference - the earth. But in the proposed theory of particles/wisps suspended in the universe there is no such superior reference, and we have only relative motions to go on. Objects in the universe have some state of motion decided by some unknown initial conditions and subsequent interactions and there is no way to determine what the absolute state is but that does not mean that the absolute motion does not exist. Einstein's relativity says that there is no absolute direction or speed except for the speed of light. If a light beam can have an absolute direction and speed, why can't matter? After all matter is fundamentally the same stuff as light (recall mass-energy equivalence). Also, matter can have a definite 3d undirected line of motion, then why not a direction and a magnitude. We posit that an absolute state of motion does exist, but we have no of knowing it, or at least no easy way of knowing it. It is epistemologically unavilable, not fundamentally non-existent.

5 Verification

Einstein did an excellent job of recognizing the importance of Lorentz transform and analyzing the ramifications of it ($E = mc^2$ and all that), but the theorization he put around Lorentz transform has room for improvement.

His theory around Lorentz transform states *perfect symmetry* of inertial frames, but I think that is most likely an incorrect statement. Two inertial frames (assuming that it only means uniform motion) may be asymmetric by how fast clocks run on them, which is an asymmetry arising from the difference in indeterminate motion content between two frames (objects really).

Someone on social media commented that "but special relativity has been verified using experiments". Indeed. But the experimental verification done so far are of the form - *whether time dilation happens* - i.e. whether SR effects exist at all or not. The experiments did not test the disagreement between SR and a competing theory that differs very subtly from SR. New tests are thus needed.

The proposed theory and SR and very similar in that they both arrive at the same Lorentz transform. But SR postulates symmetry between inertial frames (i.e Joe think Moe's clock has slowed down and Moe thinks Joe's clock has slowed down) whereas the new theory suggests that "no, there would be an asymmetry, after a well conducted experiment Joe and Moe will agree that one of them has a slower clock". We have not done such an experiment so far.

If you read the following articles, many of the questions the authors raise are perfectly reasonable. So far such attempts have been brushed aside because there isn't an alternative theory that addresses them. The proposed theory (i.e. rationing of

Newtonian time) actually addresses them, and it only very slightly differs from SR, and those slight differences are testable.

http://www.sciencedirect.com/science/article/pii/S2211379717310124
http://vixra.org/abs/1506.0148

It is likely that Einstein looked long and hard at the Lorentz transform and did his best to come up with a theory behind it, but the theory is logically inconsistent due to the strong postulate he made about mutual symmetry of inertial frames. If you look at a textbook derivation of Lorentz transform, it barely makes use of the strong statement of inertial frame symmetry. The symmetry is used merely in order to claim that if $L(v)$ is the Lorentz transform matrix, $L(-v)$ is the inverse of $L(v)$. That is an overly conservative use of such strong claim. It feels like killing a fly with some disproportionately big weapon.
So, how do we verify the asymmetry? We could conduct a Hafele–Keating type experiment using two planes flying at different speeds and communicating clock times via radio during their mutual approach. In a sense the usual Hafele–Keating test also established this asymmetry but we didn't recognize it because we were not seeking it.
Another experiment that indirectly points towards the proposed theory is one that was conducted in the Glasgow university recently. Following are two web-pages describing this experiment:

https://tinyurl.com/yd2frwxe
https://tinyurl.com/y7t47sdf

In this experiment researchers introduced intrinsic motion (orbital angular momentum in this case) into a photon to slow down its spatial speed. This most likely indicates that all sub-light speeds arise by splitting Newtonian time into intrinsic and spatial motion. It might be interesting, if possible, to carry out a Michaelson-Morley type experiment with such a slowed down photon to see how the interference fringes behave, since it is expected that intrinsic motion will make light's speed observer dependent.

6 An Image of the Sub-Particle World

This theory draws on the existence of a rich world of intrinsic degrees of freedom below the level of sub-atomic particles. We call the constituent material at that level sub-particle wisps. The sub-particle wisp may be a swarm of tiny things or an actual continuum but that distinction is immaterial. The smallest space scale is presumed to be Plank scale (10^{-35}m) and a proton (10^{-15}m) is 20 orders of magnitude bigger - that's nearly the same scale factor as Avogadro number. From our experience with Avogadro number and fluids, we know how perfectly good continuum-like behaviour can be made by an assembly of 10^{20} tiny discrete objects. So a wisp can be essentially viewed as a swarm of a huge number of entities that are tiny beyond our contemplation. One key aspect of this picture is that this wispy material is **always moving at the speed of light**. For some reason, perhaps in a compact state, these wispy material formed swarms (like social groups with some sort of group-identity). These swarms carry out some intrinsic group-dance all the time to maintain the loyalty to the group, otherwise they would have scattered around and lost all individuality. Not all wisps live in such groups. There are other wisps that have no sense of identity and just hurtle around aimlessly, only to occasionally colonize the territory of organized wisp groups that have individuality and group-identity. Light photons belong to that category. An organized group is often perceived as a point particle but remember they are wisps after all and are vastly distributed in space. Two parts of the same wisp may be miles apart, and yet they can belong to the same particle due to their intrinsic motion cycles that connect the parts together. Imagine that a sub-atomic particle is like a huge troupe of dancers or a gigantic murmuration of birds where two dancers/birds may be far apart in space but their collective motion is producing a rythmic visual sequence and structure. Two distant parts can potentially come together as if intersecting the group with itself or superposing with itself.

7 Discussion

Following are transcripts of conversations we had with friends and strangers on the internet. Special thanks to Ashani Ray for his questions.

> **Enquirer:** But time (t) is not absolute ? Isnt it always with respect some ref frame/observer ?

The concept of time doesn't have to be with respect to some observer. We are taking the *God's eye view* of the process, so to speak. The physical world may be constrained by when its intrinsic processes flow but our imagination is not. Think of a hypothetical time-sharing computer in which the processes don't have any visibility of the global clock time. They get time slices and run accordingly. The programs themselves have no concept of the global system time, but that doesn't mean that the global time doesn't exist. In fact "intelligent" programs can reason about the behaviour of an always running real-time process (e.g. running on a dedicated processor core) and recognize the existence of a global clock. That's exactly what we can do by observing constancy of speed of light.

> **Enquirer:** I am not getting the evolution equation. Both particle and intertial observer is in "Minkowski plane (2d)"...right ?

Let's not geometrize it prematurely. Please think of it in terms of a continuous linear process of mutual exchange between two distinct processes - intrinsic motion and spatial motion. However, mutual exchange doesn't need to mean growth of one side is negatively related to the other (such an exchange would lead to rotation, oscillation etc.). We also avoid the *rotation* view of relativity because the imaginary time axis treatment obscures physical insight.

> **Enquirer:** Is t the time experience by the particle and T the time experienced by the observer?

No, t is hidden from both the observer and the particle. Think of the particle as an enormous flock of birds engaging in murmuration as well as translating as a group in a particular direction. The intrinsic motion is like murmuration. That motion is superimposed with full-flock translation. The more time fock spends in intrinsic murmurations, the less time it spends in overall bodily translation of the flock, so the lower its flock-level speed. The former time was denoted by $\overline{T}$ and the latter by T. The flock-level speed is decided by the time rationing, whereas the bird-level speed is always c. Now imagine that the flock's measure of time is entirely recorded by its murmuration. That should give a good picture of a particle exhibiting relativistic behaviour.

> **Enquirer:** Since the speed is decided by time share, it is possible to have a state when the particle is spending all its time in intrinsic motions. Wouldn't that imply a state of absolute zero velocity.

Indeed. We speculate that such a state exists, but we have no easy way of getting there or recognizing it. We mostly have relative transforms to go on. In this theory an absolute definition of motion state is admissible (unlike special relativity) not just because we didn't need to preclude it in the derivation. It seems natural that motion of matter intrinsically has a direction and magnitude. It's because we are suspended in the universe with an unknown motion-state doesn't mean that the absolute does not exist. It may be hard to know, or even perhaps unknowable, but it does exist. Take the example of a light beam. We all agree on its direction and magnitude of speed, irrespective of reference frame. Now imagine that we introduce some orbital angular momentum on its photons so that the beam slows down. Now it behaves like matter (because now its speed is no longer reference frame independent) but we can all agree that its direction is the same as that before the slow-down. Why should that be any different for matter? The epistemological unavailability of absolute motion seems perfectly natural, whereas complete non-existence seems magical.

> **Enquirer:** Are you saying that the Laws of physics can be slightly different in different inertial frames?

Depends on what statements qualify as *laws of physics*. We can of course have a law that acknowledges an indeterminate absolute state and gives a transformation law about how energization/de-energization (i.e. incremental change of motion states) changes the absolute state. Such a law would then be applicable in all inertial frames.

> **Enquirer:** You are saying that two inertial frames can have different clock rates? Special theory of relativity seems to say that by symmetry, both clocks slow down with respect to each other.

Special theory of relativity gets it wrong there. When two objects are moving at uniform motion with respect to each other, one can *absolutely* have a different clock rate from the other. They can for example, communicate clock-rates via radio and agree that one of them has a slower clock than the other. Motion has history, and that's what decides the clock rate. Lorentz transforms capture the transform during acceleration, not during uniform relative motion. It just is a mathematical coincidence that the time dilation factor does not depend on the details of the accelerant pulse, and depends entirely on the relative speed between the two motion states.

A Hafele–Keating experiment using two planes flying at different speeds communicating via radio during their closest approach would be a good test for this hypothesis. In some sense the actual Hafele–Keating test has also established the asymmetry. The asymmetry is hidden in plain sight.

It's just that so far we haven't had an alternative theoretical basis for relativistic behaviour that could address the asymmetry. It's all Einstein's fault that he theorized Lorentz transform based on symmetry between inertial frames.

> **Enquirer:** Say A and B has relative velocity of v in space. Whose clock will be faster? Can it be predicted?

In the general case (say two random objects in space, where we know nothing about their history) we can't tell whose clock will run slower. But when you know that for example, that A sped up (energized) from B to achieve that relative velocity, you can tell that the Lorentz transform (and its corresponding time dilation) must have applied to A during the acceleration phase.

> **Enquirer:** So time doesn't flow symmetrically between inertial frames?

Physical measure of time (i.e. measurable time - clock rate) changes with motion state. There is an underlying hidden absolute time, which we can ignore for physical measurements. The universal time just plays a theoretical role of *clarifying the behaviours*, just like the idea that absolute motion exists but is indeterminate. In practice we only have relative measures to go by.

> **Enquirer:** An object A is flying by in space with relative velocity v with respect to me. From A, something eject having relative velocity 0 with respect to me and lands on my reference frame. So is it possible that we will be sitting next to each other with different clock rates?

No.

> **Enquirer:** Why is that? We can't predict whether A's clock is slower or faster than mine!

We don't know what the absolute direction of motion is. But when the speed difference is zero, the absolute direction doesn't matter. You are unambiguously in the same motion state as the object.

> **Enquirer:** I see an object moving in space with relative velocity v and A is sitting inside it. I cannot predict the clock speed of A due to lack of knowledge of direction. At that point I fire a spaceship from my frame having person B, with vel v in the same direction as A's ship. B sees A to be stationary and jumps into A's ship. A and B are now sitting side by side with relative velocity 0. So their clock speeds are same. Now, I can predict the clock speed of B as it has my inertial ancestry. But I couldn't predict the clock speed of A in the first place. Isn't this paradoxical?

Excellent question! You see A approaching and launch B to match the relative speed. You don't know if your absolute direction is actually the same as A or opposite to A. In one case you are accelerating B and in the other case you are deccelerating B (w.r.t its absolute direction). You don't know if B needed to speed up or slow down with respect to its absolute direction to catch up with A. You probably saw B fire a thruster but you have no way of knowing whether it was to speed up or slow down. So there is no paradox. By the way, in this hypothetical situation, communicating clock-rates via radio is the best way to resolve the ambiguity (and know the absolute direction. Alternative clues may come from thruster direction, if you are on a driven space-ship and not a random floating rock.