Relativity Emerging from Microscopic Particle Behaviour and Time Rationing

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Abstract

This article presents a new theory or at least 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 :

Postulate 1: The speed of spatial motion of a particle is always c.

Postulate 2: Spatial motion and intrinsic motion continuously, linearly, and symmetrically rub into each other.

Postulate 1 seems reasonable because the Dirac model of electron (i.e. its **zitterbewegung** *interpretation [15][14], [16], [18],[20]) indicates that the speed in the intrinsic degrees of freedom of an electron is always c. If the spatial speed was different from c then transitioning 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 configuration, and therefore does not contribute to its measurable time. If an observer races against a photon, the photon will always lead ahead with a relative speed of c because light advances with respect to the observer only for the duration of the observer's intrinsic motion, i.e. for the full duration of its measurable time. During spatial motion, the observer moves at the same speed as the photon. Consequently the observed relative speed of light - i.e. the spatial advance of light divided by the measurable time is always c. Thus in the limited sense of racing a photon, constancy of its measured speed is a deduced result here. The broader question of relative velocity of an observer with respect to a photon or a light wave-front is clarified in section 5.*

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1 Introduction

Following is the definition of time as presented by Newton in his *Philosophiae Naturalis Principia Mathematica* [7]:

> *"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 [3] (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 relative motion of reference frames. The theory of relativity indicated that the observed time slows down mutually for relatively moving inertial reference frames.
The relativistic equations have been verified experimentally, but the theory itself has a few apparent logical inconsistencies and aspects that appear mystifying (e.g. as discussed in [5]).
This article aims at clarifying such mystifying aspects of SR by deriving its fundamental equations from intuitive microscopic behaviour. In doing so it incidentally becomes incompatible with some subtle aspects of SR, which can be verified through additional experimentation and re-examination of existing experimental results.

2 Derivation of the Relativistic Transform

The basic postulates of the proposed 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 the above postulates need to be stated in the language of equations.
Let us say that Newtonian time (t) is split into two parts - T and $\overline{T}$, where T is the part spent in intrinsic motions and $\overline{T}$ is the part spent in spatial motions. By postulate 1, if X denotes the spatial displacement after N cycles of spatial and intrinsic motions, we have:

$$X = N \times (c\overline{T}) \tag{1}$$

Similarly, corresponding to N cycles, the elapsed/accrued measurable time (let us call it τ) is:

$$\tau = N \times T. \tag{2}$$

Note: *Please note that the notion of cycles is used here mainly to clarify that T and $\overline{T}$ are not accumulated/accrued times but magnitudes of slices of time. The cycle*

count N also serves as a notation to connect X and τ so that they correspond to each other.
Postulate 2 may be written in the form of the following differential equations :

$$\frac{d\overline{T}}{dt} = kT \tag{3}$$

$$\frac{dT}{dt} = k\overline{T} \tag{4}$$

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 :

$$\begin{pmatrix} \cosh(\phi) & \sinh(\phi) \\ \sinh(\phi) & \cosh(\phi) \end{pmatrix} \tag{5}$$

where

$$\phi = \int_{t_0}^{t_1} k(t)dt \tag{6}$$

This gives

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

$$T(t_1) = \sinh(\phi)\overline{T}(t_0) + \cosh(\phi)T(t_0) \tag{8}$$

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 derivatives of both T and $\overline{T}$ are zero. So the time-shares don't change in that situation, and the corresponding finite-time transform is an identity matrix.
Accelerant events like absorption of a photon or interaction with a mutual field act like pulses or impulses i.e. $k(t)$ becomes 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 change of motion-state).
So now we know how the time-shares transform over a finite period of time under the action of an accelerant, 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 $\overline{T}(t_0)$:

$$v = \left.\frac{dX}{d\tau}\right|_{t=t_1} \tag{9}$$

Using equations 1, 2, and 9, we get:

$$v = \left.\frac{dX}{d\tau}\right|_{t=t_1} = \frac{d(c\overline{T}(t_1)N)}{d(T(t_1)N)} = \frac{d(c\overline{T}(t_1))}{d(T(t_1))} = c\frac{d\overline{T}(t_1)}{dT(t_1)} \tag{10}$$

Why do we assume that $\overline{T}(t_0)$ is frozen? Because the relative velocity in question is with reference to the particle's motion state at t_0. So we are computing the derivative in a reference frame where no change of motion state is happening on the top of the particle's motion state at time t_0.
On taking differentials on both sides of 7 and 8, we get :

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

$$dT(t_1) = \text{sinh}(\phi)d\overline{T}(t_0) + \text{cosh}(\phi)dT(t_0) \tag{12}$$

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

$$d\overline{T}(t_1) = \text{sinh}(\phi)dT(t_0) \tag{13}$$

$$dT(t_1) = \text{cosh}(\phi)dT(t_0) \tag{14}$$

Therefore

$$v = c\frac{d\overline{T}(t_1)}{dT(t_1)} = c\frac{\text{sinh}(\phi)}{\text{cosh}(\phi)} = \text{tanh}(\phi) \tag{15}$$

i.e.

$$\text{tanh}(\phi) = v/c \tag{16}$$

Now we could use the following two hyperbolic trigonometric identities

$$\text{sinh}(\phi) = \frac{\text{tanh}(\phi)}{\sqrt{1 - \text{tanh}^2(\phi)}} \tag{17}$$

$$\text{cosh}(\phi) = \frac{1}{\sqrt{1 - \text{tanh}^2(\phi)}} \tag{18}$$

to rewrite the above state transformation equation as follows:

$$\overline{T}(t_1) = \frac{1}{\sqrt{1 - v^2/c^2}}\overline{T}(t_0) + \frac{v/c}{\sqrt{1 - v^2/c^2}}T(t_0) \tag{19}$$

$$T(t_1) = \frac{v/c}{\sqrt{1 - v^2/c^2}}\overline{T}(t_0) + \frac{v/c}{\sqrt{1 - v^2/c^2}}T(t_0) \tag{20}$$

This may be written in matrix form as follows :

$$\begin{pmatrix} \overline{T}(t_1) \\ T(t_1) \end{pmatrix} = \begin{pmatrix} \frac{1}{\sqrt{1-v^2/c^2}} & \frac{v/c}{\sqrt{1-v^2/c^2}} \\ \frac{v/c}{\sqrt{1-v^2/c^2}} & \frac{1}{\sqrt{1-v^2/c^2}} \end{pmatrix} \begin{pmatrix} \overline{T}(t_0) \\ T(t_0) \end{pmatrix} \tag{21}$$

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.

$$\text{Time dilation} = \frac{d(\tau \text{ at time } t_1)}{d(\tau \text{ at time } t_0)} = \frac{d(T(t_1)N)}{d(T(t_0)N)} = \frac{dT(t_1)}{dT(t_0)} \tag{22}$$

By equations 14 and 22, we have :

$$\text{Time dilation} = \cosh(\phi) = \frac{1}{\sqrt{1 - v^2/c^2}} \tag{23}$$

Thus we have derived the Lorentz transform matrix and time dilation purely in terms of the concrete state, response, and behaviour of a particle. And we did so without postulating that speed of light is constant irrespective of reference frames, or that there is 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 frames. 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 meaningfully attempt to derive Lorentz transform or time dilation in the context of uniform (inertial) motion. That is what created all the confusion and paradoxes ([5], [4]) of special relativity.

Note 1: The evolution equations (i.e. equations 3 and 4) 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 or interval decomposition). This fact is mathematically represented by the following equation. This is obtained on invoking properties of sinh and cosh functions, after multiplying the matrices on the left hand side of equation 24

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

$$\begin{pmatrix} \cosh(\phi_1 + \phi_2) & \sinh(\phi_1 + \phi_2) \\ \sinh(\phi_1 + \phi_2) & \cosh(\phi_1 + \phi_2) \end{pmatrix} \tag{24}$$

3 Justifications

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

3.1 Spatial Speed being Always c

Dirac's model of the electron indicates that the speed within the intrinsic motion of the electron is c. So it shouldn't be too surprising if it only ever moved at speed c, not just in intrinsic motions. It would be more surprising if it didn't, as that scenario would involve repeated cycles of accelerations and deccelerations within the particle's wave.

3.2 Non Reliance on Inertial Frame Symmetry

The proposed theory does not require inertial-frame symmetry in that two uniformly moving frames could have asymmetric mutual clock dilation. That might be a good sign, because in the particle physics world it has been observed time and again ([13][11],[12]) that the Lorentz symmetry is actually only approximate.

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 (i.e. Newtonian time). That might be a good sign. With all its symmetry construction *relativity of simultaneity* appears to be a statement in SR 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. There is no information-theoretic justification on how truth of events is conveyed by an electromagnetic wave-front.

3.4 Restoration of Absolute Time

It seems very intuitive that the true concept of time doesn't have to be attached to an observer's motion state. With the time-rationing notion it becomes obvious how relativistic time emerges from a limitation imposed by the microscopic behaviour of the physical substrate that everything is made of. Notions of such limitations of measurement are common in the quantum world (e.g. Heisenberg uncertainty principle).

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 any experiment? In practice every seemingly uniform motion could be a sequence of trillions and trillions of tiny jolts and jerks. The proposed derivation does not break down even if the acceleration is made of an arbitrary sequence of discontinuous energizations. Time dilation has been observed equally in arbitrarily accelerated motions. So it seems reasonable that uniform motion shouldn't be invoked as a premise for its derivation.

4 Connection with Newton's Second Law

Recall that section 2 presents the Lorentz transform as a state transformation in response to an accelerant (as opposed to a mutual relationship between two inertial frames). Therefore it can be seen as an update or refinement of Newton's second law ($F = m\frac{dv}{dt}$, in the usual notation). Although it looks like a definition of force, the second law tells us something very specific about the particles in our universe. It decomposes the phenomenon of motion into two factors - a stimulus (the force) and a response (acceleration). It tells us that particles respond to extraneous stimuli by matching it with a proportionate acceleration, as opposed to, for example, velocity itself, or the rate of change of acceleration. Other kinds of responses emerge in compound systems - e.g. a spring responds with displacement, a damper responds with velocity, and a combination of mass, springs, and dampers can give rise to complex responses with a mix of many derivatives of spatial displacement. So, Newton's second law tells us that a particle in our universe has a simple response to forcing/stimulation - it just gets a proportionate acceleration. Based on Newton's second law, we can write down the expression for velocity change corresponding to the application of a force $F(t)$ between time t_0 and t_1 on a particle of mass m.

$$\Delta v = \int_{t_0}^{t_1} \frac{F(t)}{m} dt \tag{25}$$

Using the results of section 2 (in particular equations 6 and 15), we can write down as follows the expression for speed change between motion states due to $k(t)$ acting on the particle between times t_0 and t_1:

$$\Delta v = c \ \text{tanh}(\int_{t_0}^{t_1} k(t) dt) \tag{26}$$

The tanh function ensures that the relative change of speed can never exceed c. Also the plots of $y = \text{tanh}(x)$ and $y = x$ looks coincident for small values of x. So we can see why Newton's second law behaves similarly to the Lorentz (transform) law of motion for small speed changes. Using the behaviour for small magnitudes, we can equate the similar terms and get the following:

$$k(t) = \frac{F(t)}{mc} \tag{27}$$

This relationship connects the parameters of Newton's second law of motion with that of its relativistic refinement .

Just the way Newton's second law tells us that a particle responds to a force with a proportionate acceleration, Lorentz transform tells us that it responds with a mix of hyperbolic functions, but that response almost coincides with the proportionate-acceleration behaviour for low speeds. Lorentz transform also tells us that it is not just that the particle's spatial speed changes, its intrinsic clock speed also changes.

One key implication of the time-rationing model of relativity is that there exists a state of absolute rest for which the object/particle spends no time in spatial motion and all its time in intrinsic motions. It may be possible to determine the speed with respect to this absolute if sufficiently precise measurements can be made. One such measurement follows from the *second law of motion* view of Lorentz transform.

Combining equations 27 and 26, and renaming variables such that the speed of the observed particle goes from 0 to v as time goes from 0 to t, we get

$$\text{tanh}^{-1}(v/c) = \int_0^t \frac{F(T)}{mc} dT \tag{28}$$

Differentiating both sides with respect to t, we get.

$$\frac{1}{c} \frac{1}{1 - v^2/c^2} \frac{dv}{dt} = \frac{F(t)}{mc} \tag{29}$$

i.e.

$$F(t) = \frac{m}{1 - v^2/c^2} \frac{dv}{dt} \tag{30}$$

This looks similar to the relativistic form of the relationship between force and acceleration, but not quite. Firstly in the relativistic form there is a square root over the $1-v^2/c^2$ in the denominator, and the acceleration is in terms of the measurable time. Here the derivative $\frac{dv}{dt}$ is with respect to Newtonian time. Using the relationship between Newtonian time and measurable time we can get closer to the relativistic form as follows. The measurable time τ for the observer is the result of dilation with reference to the absolute state of rest. If we call v_a the speed of the observer with respect to that absolute rest, then we can write the relationship between t and τ as follows:

$$t = \frac{1}{\sqrt{1 - v_a^2/c^2}}\tau \tag{31}$$

or

$$\tau = \sqrt{1 - v_a^2/c^2}t \tag{32}$$

or

$$\frac{d\tau}{dt} = \sqrt{1 - v_a^2/c^2} \tag{33}$$

Thus, by applying the chain rule of differentiation in equation , and calling we get:

$$F(t) = \frac{m\sqrt{1 - v_a^2/c^2}}{1 - v^2/c^2}\frac{dv}{d\tau} \tag{34}$$

In this equation, v, $\frac{dv}{d\tau}$, and $F(t)$ are all measurable quantities. If these measurable quantities can be determined precisely enough, v_a can be calculated by solving this equation. Thus it may be possible to determine one's absolute velocity by observing the relative speed and force-response of a particle.

5 Revisiting Michaelson-Morley Experiment

It was the Michaelson-Morley experiment that led Einstein into developing the special theory of relativity. In this section we try to explain the findings of this experiment in light of the proposed theory. The Michaelson-Morley experiment is an interferometer arrangement that was meant to show the interference fringes between coherent monochromatic light that has travelled in two different spatial directions a path of equal length. It turned out that there were no interference fringes no matter what the spatial alignment of the interferometer arms were. The new explanation would involve examining the light-wave and the interferometer in the framework of Newtonian time. In this framework we are acknowledging the existence of an absolute rest-frame (although not claiming to detect it easily). The Michaelson-Morley interferometer in effect compares the phases of two waves that have travelled along two orthogonal directions. Let's call *phase detector* the spatial point at which the phase comparison gets done. Let's say that in absolute space, the *phase detector* has an absolute velocity with component u along the spatial direction of one of the arms of the interferometer. Here u is the resolved component of the speed along the arm, i.e. if v is the actual speed and θ is the angle that the arm makes with the direction of v, then

$$u = v\cos(\theta) \tag{35}$$

We request the reader to recognize that we are talking about absolute velocities and absolute time only to clarify the behaviour. We do not need to actually measure them because, if the proposed theory is correct, the absolute quantities cancel out in the expression for the measured quantities.
Let us make the setting more abstract in the interest of generalization. So a source emits light, which gets detected by an observer. If the observer is moving towards (i.e. *approaching*) the source at a speed u, the separation between any arbitrarily chosen phase-point on the wave and the observer reduces at the speed of $c+u$. Similarly when the observer is moving away (i.e. *receding*) from the source with an absolute velocity of u, the separation between any chosen phase point and the observer reduces at the speed of $c-u$. So if the distance between the source and the detector is L, the Newtonian time elapsed between emission and the detection in the two cases are as follows :

$$\Delta t_{approaching} = \frac{L}{c+u} \tag{36}$$

$$\Delta t_{receding} = \frac{L}{c-u} \tag{37}$$

If the emission frequency is f_0, the detector, due to its motion will see the wave as compressed or dilated according as whether the observer is approaching the source or receding away from the source, according to the Doppler effect. The observed frequencies for the approaching and receding cases are as follows:

$$f_{approaching} = \frac{c+u}{c} f_0 \tag{38}$$

$$f_{receding} = \frac{c-u}{c} f_0 \tag{39}$$

The phase (denoted by Φ below) detected by the detector is **elapsed time**$\times$ **apparent frequency**.Thus the phase in the two cases are:

$$\Phi_{approaching} = \Delta t_{approaching} \times f_{approaching} = \frac{c+u}{c} \frac{L}{c+u} f_0 = \frac{Lf_0}{c} \tag{40}$$

$$\Phi_{receding} = \Delta t_{receding} \times f_{receding} = \frac{c-u}{c} \frac{L}{c-u} f_0 = \frac{Lf_0}{c} \tag{41}$$

Thus we can see that the detected phase is not only independent of whether the detector is approaching or receding, but also independent of the absolute speed v and the angle θ. This is what we claim to be the real reason behind Michaelson-Morley not finding any phase difference in their interferometer.
Readers might object to the above derivation on the ground that - since the interferometer arm is a rigid object, the source, mirrors, and the detector are all at relative rest with respect to each other. So the Doppler effect at the emission and the doppler effect at the detector should cancel each other out. This is where we invoke a big claim, albeit a testable one - that there is no Doppler effect at the emission. Interferometric detection is all about how the detector traverses the phases of the

photon, and not about the intrinsic content of the photon itself. So the classical style Doppler effect manifests in the detector, but emission frequency is quantum mechanically linked to conservation of energy (by Planck's law), so the energy difference due to frequency change would be paradoxical. Photon emission is a quantized transaction and does not need to behave like classical wave emission.

If we examine Einstein's relativistic Doppler effect closely, it becomes clear that it too suggests the absence of Doppler effect due to emitter's motion. The Doppler effect in special relativity [23] for the same scenario is given by the following formula:

$$f_{observed} = \frac{1 - v\,\mathsf{cos}(\theta)/c}{\sqrt{1 - v^2/c^2}} f_0 \tag{42}$$

Next let us go back to the Doppler effect by the proposed theory (we shall come back to Einstein's version again soon). It says that in the frame of Newtonian time, the observed frequency is as follows (by substituting equation 35 into equation 39) :

$$f_{observed} = (1 - v\,\mathsf{cos}(\theta)/c) f_0 \tag{43}$$

However, if the observer measures the frequency using a clock to time the interval between two consecutive corresponding phase points (crests or troughs for example), the measured frequency would be different from the above. Let's denote the Newtonian interval by t and the measurable time by τ. Equation 43 is equivalent to the following in terms of *time-period* of the wave (using the notation $\Delta t_{observed} = 1/f_{observed}$ and $\Delta t_0 = 1/f_0$).

$$\frac{1}{\Delta t_{observed}} = (1 - v\,\mathsf{cos}(\theta)/c) \frac{1}{\Delta t_0} \tag{44}$$

Next, using the relationship between τ and t as in equation 31, we can write:

$$\frac{\sqrt{1 - v^2/c^2}}{\Delta \tau_{observed}} = (1 - v\,\mathsf{cos}(\theta)/c) f_0 \tag{45}$$

Now, $\Delta \tau_{observed}$ is $1/f_{measured}$, where $f_{measured}$ is the frequency that we can measure using a relativistic clock. Thus the last equation becomes:

$$f_{measured} = \frac{(1 - v\,\mathsf{cos}(\theta)/c)}{\sqrt{1 - v^2/c^2}} f_0 \tag{46}$$

It is easy to see that this formula is structurally identical to the Doppler effect formula from special relativity (i.e. equation 42), with the exception that the velocity here is that of the observer in an absolute sense. As a special case, the relativistic transverse Doppler effect formula is also identical in the proposed theory - we just need to put $\theta = \pi/2$ or recognize that there is no Doppler effect in the Newtonian frame, and it arises purely due to time dilation.

This structural similarity of Doppler effect equations strengthens the hypothesis that Einstein's Doppler effect formula is also indirectly suggesting that photon Doppler effect is independent of the source's motion.

A big question that arises now is that - *how do we justify the Doppler-like effect inferred from stellar radiations*. Especially, how do we explain the longitudinally varying Doppler shift from which we infer spin velocity of a star, and the long-range red-shift from which we infer the expanding universe? We believe that the answer lies in photonic inelasticity. Extremely long range propagation probably reveals that the photons have a tiny inelasticity that accounts for the cosmological red-shift (which we currently attribute to the notion that galaxies are receding at a rate proportional to the distance between them - the Lemaitre model [26]). This theory of *"distance-porportionate receding"* has certain absurdities that can't be explained in the current physical theory. Most notable among them is what is dubbed as *the worst theoretical prediction in the history of physics* - a theoretical result that is off by 120 orders of magnitude.
In spinning stars too, the longitudinal variation that we infer as Doppler effect could actually be due to energy-exchanging photonic interactions as the photon travels through the stellar volume. The stellar spin ensures that on *one longitudinal side* the photons directed towards the observer are moving through *favouring* traffic and *on the other side* it's moving through *opposing* traffic so to speak, which creates the observed longitudinal gradient. A careful analysis involving thermal motions and the presumed spin might reveal a discrepancy in the prevalent explanation. Such an analysis is thus invited. It may also be possible to recreate the phenomenon under laboratory conditions in which light is made to pass through *along* and *against* a fast jet of atoms at speeds similar to that within the spinning stars. We claim that opposite frequency shifts would be observed for the two directions.
As an aside, the prevalent cosmological model tells us that *not only the universe is expanding roughly proportionately to the mutual distances of galaxies, its expansion rate is also accelerating*. If the emission Doppler effect can be ruled out by conclusive experiments, the long range photon erosion model could explain the apparent "acceleration" as the emergence of second and higher order terms of a slow exponential erosion.

6 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 purposes 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 on the scale of 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 (unambiguous) 3d undirected line of uniform motion, then why not a direction and a magnitude? We posit that an absolute state of motion does exist, but we have no way of knowing it, or at least no easy way of knowing it. The absolute motion state is epistemologically unavilable, not fundamentally non-existent.

7 Verification

Einstein did an excellent job of recognizing the central importance of Lorentz transform and analyzing the ramifications of it ($E = mc^2$ and all that), but the theorization he put around Lorentz transform itself seems to have room for improvement. His theory around the Lorentz transform asserts *perfect symmetry* of inertial frames, but we claim that it is most likely an incorrect statement. Two inertial frames (by which we mean two objects or observers in uniform straight motion) may be asymmetric by how fast clocks run on them, which is an asymmetry arising from the difference in indeterminate absolute motion state between the two frames.
Although there have been numerous experiments (e.g. the Hafele-Keating experiment [9]) to verify special theory of relativity (SR), the null hypotheses of those experiments has been *the absence of relativistic effects*. The proposed theory differs from SR only subtly, so we need experiments that focus on the difference between the two theories.
The proposed theory is similar to SR in that it arrives at the same expressions for Lorentz transform and time dilation, but different in that it asserts an asymmetry between two uniformly moving frames in terms of clock rate. By way of contrast SR postulates perfect symmetry between two uniformly moving frames. Borrowing cogent expressions from Feynman [6], *Joe thinks Moe's clock has slowed down and Moe thinks Joe's clock has slowed down*. The proposed theory contradicts that, and claims that after a well conducted experiment carried out in a state of uniform motion, Joe and Moe will agree that one of them has a slower clock. Thus we could, for example, use two planes with vastly different speeds communicating their precisely measured clock time via radio and taking into account communication latencies.
As an aside, if the claimed scalar nature of motion state is true, and if the physical basis of Lorentz transform as presented in section 2 is true, the actual Hafele–Keating test [9] is a confirmation of the proposed asymmetry.
Another experiment that points towards the proposed theory is one that was conducted in the Glasgow university recently [8]. In that experiment the 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. In light of this knowledge it also seems likely that light moves slower in a refracting medium because of intrinsic motion rather than because of absorption/re-emission latencies.
The fact that violet light gets higher slow-down than red light (whence is the VIBGYOR pattern of all rainbows) may also suggest that the same extraneous perturbation induces greater intrinsic motion in bulkier (i.e. more energetic) photons, which in turn may be verified with photon slow-down experiments (like [8]) using different wavelengths of light.

8 The Zitterbewegung Interpretation

The proposed theory both draws upon and corroborates the *zitterbewegung* interpretation of quantum mechanics ([15],[14]). In this interpretation, the classical path of a particle is only the average path taken by the centre of the packet. Zitterbewegung (to be called *zbw* in the rest of this section) is an intrinsic motion of the electron which is presumed to be the cause of spin and magnetic moment of an electron. It provides a physical interpretation for the complex phase factor in the Dirac wave function. According to [15], *zbw* extends to a coherent physical interpretation of the entire Dirac theory, and it implies a physical interpretation for the Schroedinger theory as well. Schroedinger himself noted the existence of an interference between positive and negative energy states rapidly oscillating with a circular frequency of $\omega_0 = 2mc^2/\hbar$. He interpreted this as an intrinsic motion at the speed of light c, and that interpretation is consistent with the well established value of an electron's spin angular momentum ($\hbar/2$).
There is a large body of research papers and books ([17], [15], [16], [18],[20],[19]) in the quantum mechanics literature that analyse the *zbw* interpretation and there is no evidence that conclusively discredits this interpretation. The proposed interpretation of relativity ascribes a central role to *zbw* in the emergence of relativistic behaviour of particles. It suggests that the classical motion of a particle is the net effect of rationing time into intrinsic *zbw* and spatial packet-level translation.

9 The Proposed Sub-Particle World

This theory draws on the existence of a rich world of intrinsic degrees of freedom for motion of matter below the level of sub-atomic particles. For the want of a better word, let's call the constituent material at the sub-particle level **wisp**, for the purposes of this section. The sub-particle wisp may be a swarm of tinier still things or an actual continuum but that distinction is immaterial. The smallest space scale is presumed to be Plank scale (10^{-35}m) and sub-atomic particles are about 20 orders of magnitude bigger than that - about the same scale factor as Avogadro number. From the experience with Avogadro number and fluids we know how perfectly believable continuum-like behaviour can be produced 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 individually tiny beyond our contemplation. The key aspect that we have speculated in 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 stable swarms that we identify as particles. These swarms carry out some intrinsic motion all the time to maintain the identity and state of the particle. Without the characteristic intrinsic motion the constituent wisp wouldn't be that particle, it would scatter away as pure energy that is devoid of any individuality or identity. Not all wisp carry out intrinsic motion. Photons fall in that category (although it has recently been possible to artificially introduce intrinsic motion into a photon [8]). A particle's wispy existence can be widely distributed in space, perhaps spanning hundreds of miles but they are called particles because they only produce effects measurable in the macroscopic world when they are concentrated to a highly localised form. That doesn't mean that they don't leave any tell-tale sign of their spatially distributed secret-life. They do so in the form of spatially distributed patterns formed by individual localised sightings.

Since abstract behaviours often manifest on widely different scales, it is sometimes useful to imagine analogies from familiar scales. As such, it might be a good idea to imagine each particle wisp as distributed murmurations consisting of trillions of tiny birds. Two or more of those wisps can potentially pass through each other or co-exist in the same space without interacting. The crucial aspect of that picture that is relevant to this article is a distinction between the particle's overall bodily motion and intrinsic motion, and that all these motions have the same speed in the microscopic view - equal to c.

10 Results and Discussions

Following are the key results of this article:

- Lorentz transform arises from rationing of absolute time into spatial and intrinsic motion
- Lorentz transform describes the response of a particle to an accelerant, and can be seen as a refinement to Newton's second law of motion
- Two relatively moving inertial frames can have different clock rates during uniform relative motion depending on their absolute state of motion.
- An absolute spatial reference frame exists, as does an absolute Newtonian time, and it may be possible to determine it through high precision measurement and calculations.
- Relative velocity of an observer with respect to a photon can be different from c
- The absence of interference fringes in the Michaelson-Morley experiment arises from perfect cancellation of relative velocity difference by Doppler effect.
- Light does not get Doppler shifted due to the emitter's speed.

- Greater refractive index (i.e greater slow-down) of violet light in an optically dense medium compared with red light may be because the same extraneous perturbation induces greater intrinsic motion in a buliker photon.

The remaining part of this section is excerpted from discussions that we had with friends and strangers. Special thanks to **Ashani Ray** and **Arun Sivaramakrishnan** for their questions.

Question 10.1. *But isn't time (t)* always relative*? Isn't it always with respect to some reference frame or observer?*

The concept of time doesn't have to be with respect to some observer. Here we are taking an outsider's view of our world, 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 processes don't have any visibility of the global clock time. They get time slices according to their priority. 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 the behaviour of light.

Question 10.2. *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.

Question 10.3. *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 super-imposed 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-share was denoted by $\overline{T}$ and the latter by T in section 2. 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.

Question 10.4. *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.

Question 10.5. *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.

Question 10.6. *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.

Question 10.7. *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 A definitely 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.

Question 10.8. *So time doesn't flow symmetrically between inertial frames?*

Physical measure of time (i.e. clock rate) changes with changes in absolute 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.

Question 10.9. *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.

Question 10.10. *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. When it was ejected and reached you at relative velocity of 0, the ambiguity about A's motion state is cancelled by the ambiguity as to whether the ejected object accelerated or deccelerated to reach your speed.

Question 10.11. *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 velocity 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 i.e. to know whose absolute motion state is faster (hint: it's the one with the slower clock, as will emerge from the communication).

Question 10.12. *In equation 36 you seem to suggest that the relative velocity of the wave-front with respect to the observer is greater than c. Does this not violate relativity?*

The relative velocity of the wave-front can be greater than c if the observer is approaching the source. It is true that nothing can move faster than c but here the relative velocity is not that of any matter (or even photon for that matter), it is just the rate at which the distance between the wave-front (or any chosen phase point) and the observer is reducing. It is a notional speed, not a material speed. In *time-of-flight* experiments people may have measured slight super-light relative speeds of photons, or even neutrinos (e.g. the OPERA experiment [21]) but attributed it to experimental errors. Results of *time-of-flight* experiments with photons are expected to vary slightly depending on the current state of our absolute motion with reference to absolute Newtonian space. We never acknowledged it because it went against the established theory.

By the way, ours is not the first work that claims that Lorentz transform can be derived without requiring an invariant speed - [25] and [24] present other derivations of the Lorentz transform that exclude the invariant speed requirement of Einstein's theory.

There is a very interesting story about fluctuations in the measured speed of light but since the story was popularized by Rupert Sheldrake, an author who also writes about metaphysical pseudo-sciences (which we do not endorse in any way), people tend to not take the story seriously.

Sheldrake researched old volumes of physics handbooks (purportedly from the Patent office library in London, so it is a perfectly verifiable claim) and found that the speed of light dropped by about 20 kilometers per second between 1928 and 1945, and then in 1948, it suddenly rose again, and metrologists began getting the same increased speeds from different pieces of equipment around the world. 20 km/s is a huge difference compared with the measurement precision. So he spoke to the head of the metrology department in the revered National Physical Laboratory, London, who admitted that this was embarrassing but they didn't have a physical explanation for it, and he went on to say that they solved the problem by **fixing** the speed of light **by definition** in 1972.

We hope that our theory can finally bring closure to this anomaly by providing a perfectly physical explanation. Michaelson-Morley experiment's result is not because of constant relative velocity of light with respect to all observers, instead it is due to perfect cancellation of relative velocity difference by difference in Doppler shift, as derived in section 5.

All texts on the special theory of relativity start with the Michaelson-Morley experiment as the motivation but none that we know of mathematically derives the absence of interference fringes (i.e. that the phase at the detector is independent of the spatial direction of the interferometer arm). Our derivation is so simple that even a high school student would understand it.

Question 10.13. *So if this theory is correct, that would mean that the space-time fabric is just a mathematical artifice, right?*

Yes, and there is nothing wrong with that as long as we recognize that it is an artifice. The space-time fabric is no more real than the grid cells in a finite element analysis, or complex valued voltages and currents in an AC circuit analysis. It may be a problem only when people assign too much realism to it. There are examples of writings in popular science that speculate things like - "the fabric could become so twisted that we could travel to past/future", "the fabric could fold-over or self-intersect and give us short-cuts to otherwise distant parts of the universe", or any other weird thing that can be done with a piece of fabric. On the other hand these might be good ingredients for sci-fi/movie plots.

Question 10.14. *Do we know for sure that Einstein actually suggested mutually symmetric time dilation for inertial frames? Could it have been added by other authors?*

Since we couldn't read the original paper (in german), we were humouring the possibility that Einstein did not actually suggest mutually symmetric time dilation between two inertial frames,and perhaps it arose like a game of chinese whispers over time. However, following is an excerpt from a book [22] by Einstein's own student, Rev. Fr. Goreux, which seems to suggests otherwise.

> *Let an observer O, who is at rest on the earth observes an astronaut O' who is sent to a journey around the moon and ultimately comes back at rest at O.*
> *We might easily conceive a paradox: Each observer declares that the clock of the other is* slow. *Thus finally, which clock will be slow compared to the other, when O' has come back to O?*
> *We remark that, in the course of his journey, the astronaut will not be always in constant velocity with respect to O. He will be submitted to strong accelerations and retardations. And our study of the L-transformation does not tell us anything of what happens during these changes of velocities. The question remains open. This questions has given rise to heated controversies among leading scientists. Ultimately the question seems to remain open.*

Question 10.15. *Can you explain how you infer equations 11 and 13 from 6, 7, and 8? What is the dependent variable being differentiated, the Newtonian time right? In which case, shouldn't ϕ also to be taken for differentiation by chain rule?*

Excellent question. Equations 11 and 13 are just build-up towards deriving what are essentially the following partial derivatives:

$$\frac{\partial \overline{T}(t_1)}{\partial T(t_1)} \tag{47}$$

$$\frac{\partial T(t_1)}{\partial T(t_0)} \tag{48}$$

As with partial derivatives, we treat the other things as constants. So that's the mathematical definition pinned down, but why should we treat the sinh(ϕ) and cosh(ϕ) terms as constant? I think the following lines from section 2 gives the answer:

> "Accelerant events like absorption of a photon or interaction with a mutual field act like pulses or impulses i.e. $k(t)$ becomes 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 change of motion-state)."

If we apply the product rule and then the chain rule, the differential $d(\sinh(\phi)T(t_0))$ becomes $T(t_0)\cosh(\phi)k(t)dk(t) + \sinh(\phi)dT(t_0)$. Note that the first term has $k(t)$ as a factor. So during the action of an accelerant pulse, this term could be non-zero but beyond the duration of the pulse, $k(t)$ falls back to zero. Hence the first term vanishes and we are left with the term $\sinh(\phi)dT(t_0)$. Thus in equations 11 and 13, we have assumed that $k(t_0) = 0$ and $k(t_1) = 0$. The interval between t_0 and t_1 can have an arbitrary history of accelerations, which will be captured by the integral defined in equation 6.

I agree with you that *during* the action of a continuous acceleration (e.g. as in a potential field), the time dilation will have an additional contribution from the accelerant, in addition to the usual Lorentz factor dilation. Going by the *equivalence principle* of general relativity [2], the time dilation arising from acceleration may be equivalent to the gravitational time dilation derived from the Schwarzschild metric.

11 Conclusion

This article is ambitious to say the least, in that it is incompatible, albeit only in subtle ways, with a very well established theory. Most readers would recoil at the suggestion of disagreeing with Einstein. We suggest that a fresh re-examination may be due in light of the new information we have since special relativity was developed.

Even if the proposed theory turns out to be correct, one should not blame Einstein for not digging deeper into the nature and causes of maximality of speed of light. When he was investigating relativity, it was still not known that the sub-particle intrinsic speed within an electron's spinor rotations was c. It was also not known that it is possible [8] to slow down a light photon by introducing intrinsic motion into it.

Einstein did his best to come up with a theory behind the Lorentz transform, but the theory became logically difficult (if not inconsistent) due to the strong postulate he had to make about mutual perfect symmetry of inertial frames. A standard SR derivation of the Lorentz transform (e.g. that in [10]) makes a very slight 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 a strong claim. It feels like killing a fly with a disproportionately big weapon. Even there are matrices different from the Lorentz transform that has the property $L(-v) = L(v)^{-1}$. Following are a few examples, for what they are worth.

$$L_1(v) = \begin{pmatrix} \frac{1}{1-v/c} & \frac{v/c}{1-v/c} \\ \frac{v/c}{1-v/c} & \frac{1}{1-v/c} \end{pmatrix} \tag{49}$$

$$L_2(v) = \begin{pmatrix} \frac{1}{1+v/c} & \frac{-v/c}{1+v/c} \\ \frac{-v/c}{1+v/c} & \frac{1}{1+v/c} \end{pmatrix} \tag{50}$$

$$L_3(v) = \begin{pmatrix} \frac{1}{1-v/c} & \frac{-v/c}{1-v/c} \\ \frac{-v/c}{1-v/c} & \frac{1}{1-v/c} \end{pmatrix} \tag{51}$$

$$L_4(v) = \begin{pmatrix} \frac{1}{1+v/c} & \frac{v/c}{1+v/c} \\ \frac{v/c}{1+v/c} & \frac{1}{1+v/c} \end{pmatrix} \tag{52}$$

Many people have been vexed by SR's logical inconsistencies and many paradoxes have been proposed (e.g. [4], [5]) but those have not made into mainstream physics because there have not been any plausible alternative theory that could broadly agree with the relativistic results like time dilation and yet clarify the paradoxes. Counter-intuitive notions like *relativity of simultaneity* have been justified merely with a *mathematical symmetry* construction, not with a physical argument that truly clarifies the paradox. Admittedly the case for or against a *mathematical symmetry construction as a physical theory* may ultimately be subjective, a matter of taste perhaps, in that some people are fine with a mathematical construction while some others keep seeking a deeper physical interpretation. Insofar as the calculation methods are adequate, one might argue, seeking a deeper meaning may be unimportant. However it has been seen time and again that a deeper philosophy can be useful in extending the understanding and for applying ideas to new problems. As a result, it is more satisfactory when mathematical equations/invariants (that might have been constructed axiomatically or empirically) can be seen as emerging from microscopic behavioural descriptions.

To give an analogy from another physical problem - consider the case of *diffusion*. Laplace's equation ($\nabla^2\phi = 0$) describes it's equilibrium state, and so does the variational form (minimize $\int\int\int(\frac{\partial\phi}{\partial x})^2 + (\frac{\partial\phi}{\partial y})^2 + (\frac{\partial\phi}{\partial z})^2 dxdydz$), where ϕ is the concentration of the diffusing species of fluid. That would be sufficient to *shut up and compute*, but Einstein's proof [1] that diffusion is equivalent to the microscopic random motion of atoms and molecules brings a much deeper insight into the actual phenomenon. So much so that it is widely held as the final theoretical confirmation of the atomic theory. Analogously, this article proposes a microscopic explanation of relativity, and gives a glimpse of the wispy wavy world that underlie sub-atomic particles, in that it indicates that the in the sub-particle world view, a sub-atomic particle is actually a spatially-distributed wave or wisp that is always moving at the speed of light but its intrinsic part of the motion, like the murmumuration of an enormous bird-flock, is on one had giving rise to the particle's identity and individuality, and on the other hand deciding the observable spatial speed and clock rate of the particle.

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