Arguments for Continued emdrive Testing

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If special relativity describes a complex time relationship between objects in relative motion then there is an alternate explanation for electrical interaction, inertia and maybe even gravity, which allows a mechanism of action for emdrive propulsion.

These notions are exceedingly speculative but it is now necessary to find a theory of radiation which does not raise paradox. Refusal to experimentally investigate the functionality of emdrive propulsion by the physics community lacks courage. Considering the reasonable cost and relative ease of conducting these experiments properly and the enormous potential benefits to transportation, space navigation and physical science, it is a great shame that it has yet to be thoroughly tested by anyone but its inventor. The hurdles are theoretical, the Complex time required to resolve a mechanism of action for the emdrive may also resolve non-locality. This essay is a call for these question to be explored and these experiments to be conducted.

" What then are time and space? Are they real existences? Or, are they merely relations or determinations of things, such, however, as would equally belong to these things in themselves, though they should never become objects of intuition; or, are they such as belong only to the form of intuition, and consequently to the subjective constitution of the mind, without which these predicates of time and space could not be attached to any object? " [Emmanuel Kant, 'The Critique of Pure Reason' 1781]

Introduction

In a 2022 interview Lee Smolin stated the case directly, *" It's the most important question, what is time, what is space."* He asks this question because the the nature of time and space are yet to be clearly resolved. Special relativity has played an essential part in the development of general relativity and almost every theoretical investigation since but the assumptions of special relativity, upon which general relativity depends, are severely tested by Bell's crucial reality check of quantum mechanics. This essay intends to explore the questions this raises and to offer an unexplored resolution for them in hope that it will be considered and then tested with the aid of emdrive devices.

The necessity of complex relationships

" Without imaginary numbers you really couldn't describe the world of the quantum, and since quantum physics is really what describes reality these shouldn't be called imaginary numbers, their actually as real as anything else." [Marcus de Sautoy, BBC Radio 4 'In Our Time' 23/9/2010]

Complex numbers are not complicated, just extended into real and imaginary units. *" The obscurity of imaginary numbers is due to ill-adapted notation. If positive, negative and imaginary numbers had been called direct, inverse and lateral units, then no such obscurity would exist."* [Gauss … maybe]. What complex numbers do is describe actual relationships more clearly and compactly than mathematics is otherwise able. They are commonly used to describe relations in engineering, quantum mechanics and mathematics.

" ... are complex numbers really needed for a quantum description of nature? Here, we show this to be case by proving that real and complex quantum physics make different predictions in network scenarios comprising independent quantum state sources. This allows us to devise a Bell-type quantum experiment whose input-output correlations cannot be approximated by any real quantum model. The successful realization of such an experiment would disprove real quantum

physics, in the same way as standard Bell experiments disproved local physics." [Renou et al, 'Quantum physics needs complex numbers' 2021 arXiv:2101.10873]

But now we diverge into something unfamiliar, a notion that the measurement of time itself may require 'real' and 'imaginary' components to describe the dynamic progress between objects with relative velocity. These may already be present in the simplest expression of special relativity if, $y = (1 - x^2)^{0.5}$ is a complex number even when $x < 1$ does it not follow that, $t' = t(1 - v^2/c^2)^{0.5}$ is a complex relationship between t' and t.

" $(1 - x^2)^{0.5}$ is a complex number." [Freeman Dyson on U-Tube, 'Energy levels of Complex Systems' 2016]

" when $x < 1$, $(1 - x^2)^{0.5}$ is a complex number with a zero coefficient." [Mike Brisco, in conversation, 30/12/2022]

" The variation of the rate at which time passes as velocity changes destroys our concept of the absoluteness of time. Because of this, it becomes impossible to locate an event in time in such a way that all observers can agree. In addition, no event can be located in time until some evidence of the event reaches the observer, and that evidence can only travel at the velocity of light." [Isaac Asimov, 'Understanding Physics: Light, Magnetism and Electricity' Mentor, 1966]

" Imaginary time may sound like science fiction but it is in fact a well-defined mathematical concept." [Steven W Hawking, 'A Brief History of Time' Bantam 1988]

" Since Schwinger's first proposal in 1958 ['On the Euclidian structure of relativistic field theory', National Academy of Science 44.9 (1958), pp. 956-965], over the years it has become increasingly clear that the quantum field theories governing our best understanding of fundamental physics have a much simpler behavior if one takes time to be a complex variable, and considers the analytic continuation of the theory to imaginary values of the time parameter. In imaginary time the invariant notion of distance between different points becomes positive, path integrals often become well-defined rather than formal integrals, field operators commute, and expectation values of field operators are conventional functions rather than the boundary values of holomorphic functions found at real time." [Peter Woit, 'Euclidian Spinors and Twister Unification' 2021 arXiv:2104.05099]

Do these considerations describe complex time as a necessity, maybe they do, what is now beyond doubt is that a feasible explanation of quantum mechanics is required in terms resolvable with relativity, and that is a very closely related question.

" In a theory in which parameters are added to quantum mechanics to determine the results of individual measurements, without changing the statistical predictions, there must be a mechanism whereby the setting of one measuring device can influence the reading of another instrument, however remote. Moreover, the signal involved must propagate instantaneously, so that such a theory could not be Lorentz invariant." [J S Bell, 'On the Einstein Podolski Rosen Paradox' 1964]

" Our experiment showed a strong violation of local realism using exacting experimental technique and rigorous statistical analysis. Employing state of the art random number generators, we space-like separated the setting choices, measurements, and emission event to close the locality and freedom of-choice loopholes simultaneously. We achieved high system heralding efficiencies and closed the fair-sampling loophole as well. In addition, we closed the coincidence-time loophole in our experiment by using locally-defined time slots. We closed the memory loophole by computing the statistical significance of the violation without assuming independently and identically distributed experimental trials. Our experiment provides the strongest support to date for the viewpoint that local realism is untenable." [Zeilinger et al, 'Significant-loophole-free test of Bell's theorem with entangled photons' 2015 arXiv:1511.03190v2]

Zeilinger was awarded the 2022 physics Nobel for this work because it is part of the now irrefutable demonstration of "non-locality" which has implications for far more than just quantum mechanics. Relativity already requires us to re-assess spatial relations. If special relativity is a complex relationship then we must also consider what that might mean.

The visualisation of complex time

" Our faulty assumption is that space is real." [Fotini Markopoulou, 'Space does not exist, so time can', Perimeter Institute 2008] This is not a denial of what you see with your own eyes, far from it, it simply suggests that your perspective is unique because of your rate of progress through the development of time, and because you see only outward from a point. Inanimate objects are not limited to such a narrow relationship with time and space, they interact with the entire universe and for them there is no distinction between one moment and another. Without the limits of the specific location in both space and time that consciousness requires, time and space may be very different.

Consider for a moment the light we can see. Light has a velocity relative to any location in any motion, known to be 3×10^8 meters per second, so everything you see is separate from you by the time it takes for light to come to you at that velocity. Relativity tells us that the velocity of light is the same from every perspective despite

the time dilation due to any relative velocity another perspective has relative to you. Special relativity also describes anything moving at the velocity of light as having its own progress through time dilated to nothing relative to the observer.

There is only one way to resolve this relationship and that is to accept that the progress of time is a complex relationship. From your perspective light travels across space and reaches you an amount of time ct later, but without progress through time from its own perspective because the universe it travels through travels at the velocity of light relative to it. The energy which light and other electromagnetic frequencies transmit, travels at 3×10^8 meters per second for you but arrives instantly from its own perspective. This is the almost obvious thing about the transmission of energy which is rarely discussed outside the math of relativity itself, but it is vital to our understanding of the physical structure of our world.

To visualise complex time you simply acknowledge three things concurrently; first, that your own passage through time is regulated by the rates of chemical reaction and inertia you experience; second, your time is similar to the proper time experienced by all objects of the universe but for the relative rate which changes with their velocity from your perspective and the acceleration they experience as described by relativity; third, that energy transmitted at the velocity of light experiences no passage of time and that these things are consistent and real.

When you look at a distant star, which is in your past by an amount of time which is relative to its separation from you in your proper time, you see light that left that star at the same moment that you see it, from the perspective of the energy transmitted. If that makes sense to you then we are ready to describe the next unexpected consequence of accepting complex time, which is that electrical and inertial interactions may have two different mechanisms by which they are transmitted, by discreet quantum interactions and also by continuous electrical interaction.

Non-quantum interaction

What we require to make sense of this is a description of how discreet quanta transmit energy between atoms and how charges continuously interact with all other charges. The following notions really are speculative but if it has become necessary to re-evaluate both the nature of time and the nature of interaction generally, then speculation is the inevitable starting point. If time is complex then a possible mechanism of interaction becomes apparent whereby change of relative velocity or a change of acceleration between charges alters their mass energy relative to each other. Does special relativity not make this a necessity anyway. If that happens then there is an obvious source for the energy of attraction and repulsion between charges which is the change in relative mass energy between them with change in their relative velocity or acceleration. It may not be quite as simple as that but if that energetic relationship

could be specified it would surely resolve conservation of energy better than any simplistic assumption of attraction and repulsion.

If attraction and repulsion are somehow proportional to and consequent upon change in the relative proper times between charges as they approach or disperse then that mechanism could act continuously yet still allow the discreet quantum interactions which clearly take place. When we combine the possibility of continuous interaction with the instantaneous transmission allowed by complex time and with the asymmetric separation of opposite charges within the atom, then there is a mechanism for the action of inertia which could include both electromagnetism and gravity but still allow quantum interactions.

The asymmetry between opposite charges within the atom whereby positive charges are concentrated in the nucleus and negative electrons orbit somehow around them, has long been assumed to be of negligible effect over separations larger than millimetre scale due to its geometry, but that could be an assumption made because the balance of these forces is so small in comparison to the electrical forces which swamp them. Such forces would only need to be about one part in 10^{40} the strength of electrical forces for this to be worth consideration as a mechanism for long distance interaction. Add to that the cumulative effect of universal interaction where the sum of forces increase by the square of the radius considered (in a universe with approximately even density of matter at large scales) but the continuous forces between all individual pairs of charges diminish by the inverse square of their separations, the result being inertia proportional to the mass of the universe and local gravity proportional to the mass of nearby matter.

These are long leaps conceptually and would not be suggested were it not necessary to fully accept the lessons of relativity.

"... a real field is a mathematical function we use for avoiding the idea of action at a distance." [Feynman, Leighton, Sands, 'The Feynman Lectures on Physics' Vol II, 1963]

Action at a distance is the primary feature of complex time within which fields have no objective reality. Action at a distance is an improvement upon fields as an explanation for interaction, unless of course you are persuaded by descriptions of the dilation of time in empty space.

"How is it possible for something immaterial, like a region of space, to act on a material body?" [Andre Assis, 'Relational Mechanics' 2014]

"... this much seems fairly certain : new elements which are foreign to the continuum concept of the field will have to be added to the basic structure of the theories developed so far, before one can arrive at a satisfactory solution to the problem of matter." [W Pauli, 'Theory of Relativity'1921, English translation, final paragraph]

To appreciate how simple all of this can be we turn to the source of relativity theory,

"... we have finally completed the general theory of relativity as a logical structure. The postulate of relativity in its most general formulation (which makes space-time co-ordinates into physically meaningless parameters) leads with compelling necessity to a very specific theory of gravitation that also explains the movement of the perihelion of Mercury. However, the postulate of general relativity cannot reveal to us anything new and different about the essence of the various processes in nature than what the special theory of relativity taught us already. The opinions I recently voiced here in this regard have been in error. Every physical theory that complies with the special theory of relativity can, by means of the absolute differential calculus, be integrated into the the system of general relativity theory – without the latter providing any criteria about the admissibility of such physical theory." [Albert Einstein, DOC. 25 'Field Equations of Gravitation' (p. 847) Session of the physical-mathematical class on November 25, 1915]

"... space-time is not necessarily something to which one can ascribe a separate existence, independently of the actual objects of physical reality. Physical objects are not in space, but these objects are spatially extended. In this way the concept " empty space" looses its meaning." [Albert Einstein, 'Relativity' 1916, English translation by Lawson, Crown NY 1954, Note to the fifteenth edition, added June 9th 1952],

" There is no such thing as an empty space, i.e. a space without a field. Space-time does not claim existence on its own, but only as a structural quality of the field.

" Thus Descartes was not so far from the truth when he believed he must exclude the existence of of an empty space. The notion indeed appears absurd, as long as physical reality is seen exclusively in ponderable bodies. It requires the idea of the field as the representative of reality, in combination with the general principle of relativity, to show the true kernel of Descartes' idea ; there exists no space "empty of field"." [Appendix V of the same edition]

Does the emdrive produce propulsion without equal and opposite reaction?

The emdrive developed by Roger Shawyer of SPR Pty Ltd in the UK is a simple device consisting of an empty copper cone or wedge of a few litres capacity truncated by flat plates at either end and fed with microwave energy at a frequency resonant to it. It is not an easy experiment to repeat due to several factors including change of resonant frequency and loss of coherence with heat distortion, the danger of sudden release of accumulated microwave energy and the great difficulty of accurately measuring any thrust production from the relatively crude devices so far

constructed by brave experimenters.

Many such devices were built and tested around the world before physicists and some experimenters joined in the conclusion that there was no future for it. The nay-sayers may be wrong and the inventor may yet be vindicated if a higher quality of testing could be funded and conducted.

The suggestion made here by these unusual arguments is that resonant energy within the chamber of the device reaches coherence being reflected from the flat unequal size plates at each end in turn. The mechanism of reflection of microwaves from conductive surfaces, unlike the reflection of light from a mirror, occurs when the current engendered in the surface reaches a boundary or discontinuity which causes emission of the reflected wave. The different sized end plates then contain the momentum of the energy they reflect between its absorption and its emission and the larger plate contains that momentum for longer. While that momentum is contained in the current at the surface of the reflecting end plate it has an electrical relationship with the wider universe made possible by complex time and the unshielded nature of a momentarily stable current. This asymmetry of duration for the momentum intermittently held at either end of the device, can then accumulate to an acceleration of the entire device. The equal and opposite reaction acts upon the charges of the distant universe. The possibility of complex time allows this explanation because it does not require any thrust produced to have an equal and opposite reaction locally, so enabling it to thrust continuously in open space.

This explanation was originally detailed in October of 2014 by this author, and is available at viXra.org/1405.0252 It maybe better described there. Roger Shawyer's original experiments are still detailed at emdrive.com.

Conclusion

No conclusion is made here because these are open questions, the validity of which is for the reader to decide. It would be a tragedy if any potential the emdrive has was lost to history because the funds for proper experimentation never became available. It would also be a strange reflection upon academic physics if the complexity of time and its consequences were demonstrated first by mathematicians or amateurs.

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P 7 *"We very often hear complaints of the shallowness of the present age, and of the decay of profound science. But I do not think that those which rest upon a secure foundation, such as mathematics, physical science, etc., in the least deserve this reproach, but that they rather maintain their ancient fame, and in the latter case, indeed, far surpass it. The same would be the case with the other kinds of cognition, if their principles were but firmly established. In the absence of this security, indifference, doubt, and finally, severe criticism are rather signs of a profound habit of thought. Our age is the age of criticism, to which everything must be subjected. The sacredness of religion, and the authority of legislation, are by many regarded as grounds of exemption from the examination of this tribunal. But, if they are exempted, they become the subjects of just suspicion, and cannot lay claim to sincere respect, which reason accords only to that which has stood the test of a free and public examination."*

P 288 *"The investigations and calculations of astronomers have taught us much that is wonderful; but the most important lesson we have received from them is the discovery of the abyss of our ignorance in relation to the universe..."* [Emmanuel Kant, 'The Critique of Pure Reason' 1781]

"The long and constant persuasion that all the forces of nature are mutually dependent, having one common origin ... " [Michael Faraday, 'Researches' 1850, #30 – 2702]