Time and Non-Locality: Resolving Bell's Theorem

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Abstract: This paper presents a new basis for the analysis of Einstein's spacetime by presenting the idea of "time-points" in space consistent with "c" being a paradigm where time does not pass, and thus a potential sea of time-points in space, accounting for the idea of hidden "non-local" particles as time-points in space that interact to form mass, thus resolving Bell's Theorem.

Keywords: Special Relativity; General Relativity; Quantum Mechanics; Bell's Theorem; Copenhagen Interpretation; time-point; non-local; time

1. Introduction

The need to link mass/gravity with EM is the core issue for physics theory today. This has much to do with the relationship between light and mass according to the theoretic models in play of Einstein's Special Relativity (SR) and General Relativity (GR), and Quantum Mechanics (QM), in seeking to determine the precise relationship between the speed of light and the relative location of mass objects in space, more fundamentally though in seeking to determine the relationship between EM and mass, and owing to the theoretic tools in play, all of such being central to the aim of joining QM with SR/GR.

The thinking in physics is that a proper understanding between the idea of EM and mass should realize the proper relationship between EM and gravity. Yet that understanding has not been forthcoming, suffice to say that all manner of particle research is being done to reach that understanding, all of such through understanding the nature of particles, their intrinsic qualities, and how they relate more primarily

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to the nature of light, light modelled as a zero-mass particle. However, as consistently as the research is conducted, there appears to be a fundamental error in play between mass and light, and the question is why, namely, "what is the fundamental cause of the inadequacy of QM on the atomic and sub-atomic level to exactly locate particles/mass using the prescribed and described QM wave-function?".

This paper shall present the case of such a problem that exists in physics, and then propose a solution to this fundamental error in physics theory. As shall be shown, the fundamental problem to be addressed is entirely due to the formal logic of physics in play, namely in making mass the primary feature of reasoning as opposed to making time and space the fundamental theoretic constructs of reasoning, leaving time to be a secondary feature to mass itself. This feature shall be explained, and then corrected with a theoretic model that is able to properly account for all the data central to QM and the Standard Model (SM) of particles, a theoretic model that moreover and albeit fundamentally must challenge not only relativity physics yet classical physics, the two basic theoretic bastions of holding mass as the primary feature of mathematical congress (as per inertia and momentum).

In short, this paper will highlight the problem of SR/GR and QM, and why they fail to properly account for the location of a particle in space, and why they fail to fully link together as theoretic tools. The solution provided will be via a new way of using the dimensional constructs of time and space as a new dimensional mechanics between time and space and associated $temporal\ calculus$ [1-28] presenting the framework for the locality and non-locality of particles in the context of the field forces and associated constants.

2. A Question of Measurement

It does seem odd that to measure the exact location of mass there is a code in reality that says ultimately in a pure backdrop of space such is not possible, namely that mass cannot be measured exactly with light and its associated wave-function on the simplest backdrop of space, on the most fundamental level of all.

Physics is a process of measuring things exactly, so understandably physics faces a problem in not properly locating particles as they stand, as much as a fundamental particle needs to be measured where it stands (and *how* it stands). The measurement ruler as a theoretic tool that is used for the measuring of a particle location in space is light, the photon, comprising of an "abstract" analogue of what is considered to be *spacetime*, as a wave-function, that presents itself to have both wave and particle qualities. In short, on a gross level, on ***not*** the most fundamental level, measurements are quite simple to the naked eye, yet *it is the fundamental level* (the sub-quantum) that physics has trouble with. The question is "why".

The system of measurement exercised by physics is that ***things*** have to be measured where they stand to know how big they are as compared to other objects and what their respective motions (and associated momentums) may be, of course to judge their field interactions, and that in the least ***certain***

basic things need to be measured (such as mass and velocity (including particle spin) and charge) where ***those things*** stand as a reference; such is a fundamental premise of physics throughout history.

Most fundamental of all is the concept of the "primacy" of mass, considered as ***the most basic thing***, as per the logic of Einstein's theories of Special and General Relativity. As such, everything understood by the physical sciences today is by such a primacy of logic, namely making the measurement of mass primary, as much as QM is secondary to SR.

As it stands, the simplest basis of mathematical formalism in physics is in making ***mass*** primary (momentum and inertia), which is as simple as physics can get as a basis. All theoretic models such as SR, GR, QM, and the SM of particles, represent theoretic tools that do their best to explain known data that they are designed as theoretic tools to explain upon such a basis. Or in other words, physics employs theoretic tools that are data dependent on the measurement of mass, primarily (momentum and inertia). Indeed, Einstein considered his Theory of Relativity to belong to a class of "principle-theories" employing an analytic method, namely that the elements of his theory are not based on hypothesis but on empirical discovery, or rather, data that is already observed and known, mass-born data. Nonetheless, there may be a better model than SR, than GR, than QM, and the SM of particles, yet the models that exist currently do so because they best explain known mass-born data. If a better and more holistic model comes about, it must explain the same data all the current models do, and reach the same data-conclusions these models currently seek to explain in their own albeit fractured way.

One thing that is certain regarding all the models currently in play is that these models cannot explain certain key fundamental facts, or in other words, they are lacking in linking properly with each other as theoretic models. What are they lacking in?

- SR is the basis for making mass primary (relativistic mass) yet is unable to account for gravity other than via GR theory which itself leads to huge cosmological discrepancies requiring the fixes of dark energy and dark matter.
- QM can only *approximate* the position of a mass particle through its (QM's) probability mathematical functions (Copenhagen Interpretation).
- Bell's Theorem highlights that there can be no hidden local variables in QM to precisely account for the location of a mass object, other than "non-local" hidden variables.
- QM is unable to account for the Standard Model of particles and their existence (Yang-Mills Existence and Mass Gap" problem) simply because elementary particles are much smaller than a quantum itself.
- Fundamentally, classical models cannot reason the data that QM and the SM explain.

Another thing that needs to be mentioned is Einstein's Special Relativity platform that all of such plays itself upon. This was accounted for in the previous paper ([28]: p9-10) as per:

(a) Mass having primacy over spacetime (accounted for most basically as the ability of mass frame-dragging spacetime).

(b) Spacetime having primacy over light (account for as time-dilations with mass).

(c) Light nonetheless behaving as a universal constant as though as space (accounting for the photon as the massless particle travelling at "c").

(d) Space metrically expanding in time with light (to account for the redshift effect).

(e) Yet Mass having primacy over spacetime, or in other words back to (a), a concept that does not fit well with the abridging ΛCDM model.

(f) If the photon is timeless and mass is the primary theoretic device (as though mass drags spacetime, as per *frame-dragging*), then mass can only be a type of primordial event incurring a *temporal* dragging of *space* as *spacetime*.

(g) The big bang event therefore would have had its origins from a super-massive, super-dense, mass structure that presumably underwent a temporal incursion in the form of an explosion where pieces of that singular mass source would have been broken free as the temporal incursions.

(h) The *front* of this expansion (as the redshift data presumes to suggest with Einstein's model), in accelerating (as all the data suggests), also suggests (according to Einstein's Relativity Theory) that, as a type of frame-dragging effect of the metric-expansion of space, there would need to be a massive amount of mass (or energy equivalent) *ahead of* this metrically expanding *spacetime being dragged outwards*, continually, *by this mass or energy*.

As presented there, all of such becomes a theoretic Penrose Stairs [29] scenario that has no real consistency, in violation of the very "Principle of Relativity", a patchwork of concepts aimed to accommodate for known observed data nonetheless. For such a Relativity Theory model, the bottom line (as it appears) is light and space (as constants) as one, with time being a secondary variable according to the primacy of mass effecting spacetime and therefore time effecting itself as a notion of space as masses in relative motion, mass being the primary cause of spacetime. Essentially, Einstein's SR and subsequent GR is a jigsaw of theoretic pieces that do not fit *overall* with each other, a jigsaw that cannot account for how mass and gravity actually relate with light as a physics per se, how EM links with G.

Indeed, if light as QM is a measuring tool not sure if it is a particle or a wave, how is it going to locate a *particle* if its mechanics, namely whether it is a wave or a particle, are *uncertain*? As the data highlights, it is not as simple as that, as the idea of the wave-particle duality is *built on* classical mechanical thought, which obviously must be brought into question.

To note of interest, the very data-driven fact of Bell's Theorem presents the case that local and thus classical variables that are proposed by Einstein as potential hidden variables to better explain the uncertainty of QM ***violate*** data *already known*. Or in other words, trying to explain QM any further with classical mechanics is a false quest.

Thus, the key implication here is that in presenting a pan-theory to link all the data from SM to QM to SR/GR, to *even classical mechanics*, then all of such needs to be re-worked as a primary logic to arrive at a model that is better *well-founded in principle* in accommodating for all known data relevant to classical mechanics, SR/GR, QM, and SM. To find this model, the key issues of both QM and classical mechanics (locality) need to be discussed.

3. Quantum Mechanics, and associated problems with SR/GR

Quantum Mechanics holds that concepts of energy and momentum in regard to light (and how light is used as a theoretic measurement device of mass) is quantified into discrete measurable units known as quanta, and that through such a quantised measurement scaling system light registers mass paradoxically as having both particle and wave (wave-particle duality) properties, and not just mass, yet also the light itself that is seeking to measure/register the location of mass, which presents inherent limitations of measurement accessibility.

The limitation of this process (as a process of quantised wave-particle duality) is set by the process itself of measuring the value of a physical mass quantity prior to its measurement in having already factored the context of that mass which is being measured with the context of light doing the measuring. The description of this process based on experiments and associated data (in better solving the nature of the atom in a way classical physics and associated mechanics could not) is termed the Copenhagen Interpretation [30], developed by Niels Bohr and Werner Heisenberg in Copenhagen during the 1920s.

According to the Copenhagen Interpretation, material objects on a microscopic level generally do not have definite properties, despite existing, prior to being measured by QM, and that QM can only predict the probability distribution of a given measurement's possible results. The explanation for this is that the act of measurement itself is considered to affect the system being measured, causing the set of QM probabilities to reduce to only one of the possible values immediately after the measurement, a feature of QM as an incompatibility expressed quantitatively by Heisenberg's uncertainty principle.

All of such denies the QM wave-function the ability of capturing the EM image/information status of a mass particle it is seeking to measure, other than something entirely theoretical, in that (according to all the data gathered through research) the wave-function itself cannot account simultaneously for the exact location of particles being measured in regard to each other, yet only probabilistic accounts of *non-separable* particles, a feature of QM known to Einstein circa 1905.

Today, QM has developed into mathematical formalisms describing this process of measuring the basic properties of mass particles, most basically as mathematical wave-function formalisms, mathematical functions that provide information about the probability amplitude of energy, momentum, and other physical properties of a particle, of course in upholding the *primacy of mass* code and associated mathematical formalisms.

The question remains as to "why" all of such must be other than conforming to the data mandating such a process of theoretic construction. The "why" has led to some intriguing thought experiments and associated debates regarding the uncertainty principle, and the very exclusive disconnect that exists between a mass particle and the massless photon.

For instance, Einstein's EPR [31] thought experiment sought to demonstrate his local hidden variable theory for QM, namely that QM is an incomplete theory, that there are "hidden variables" in QM not yet accounted for by QM's then design that would thence with a better design (via proper explanation and analysis and associated data/proof) provide for the exact location of a mass; Einstein, Podolsky and Rosen (EPR) presented a scenario that, in their view, indicated that quantum particles, like electrons and photons, must carry physical properties or attributes not yet then included in QM, and the uncertainties in QM's predictions are due to ignorance of these properties, later termed "hidden variables". Their scenario involves a pair of widely separated physical objects, prepared in such a way that the quantum state of the pair is entangled, as quantum-entanglement (QE).

Bell however [32] carried the analysis of QE further still. He deduced that if measurements are performed independently on the two separated halves of a pair, then the assumption that the outcomes depend upon hidden variables within each half implies a constraint on how the outcomes on the two halves correspond if QE is to be upheld using hidden variables. This became known as the Bell Inequality. Bell then showed that QM predicts correlations between two halves that violate this inequality (in using hidden variables to explain QE). Consequently, the only way that hidden variables could explain the predictions of QM in the manner of QE (non-separability) is if they are "non-local" (non-classical physical), somehow associated with both halves of the pair and able to carry influences instantly between them no matter how widely the two halves are separated.

The idea of locality prescribes that a mass particle is directly influenced *only* by its immediate environment, and theories that abide by this principle are considered as "local theories", such as the field theories of classical physics, namely that the space between points such as a field must mediate the action between points, such as a wave or particle, carrying the influence. Einstein's Special Relativity for instance limits the speed of this localised field to "c", hence implying that an event at one point cannot cause an *immediate* result at another point. Therefore, the idea of QE in being non-local goes against *spacetime* theory, yet the data of non-locality has not been proven to be incorrect, making *spacetime* theory lacking in its ability to account for the non-local features of QM.

To date, tests of Bell's Theorem have found that the hypothesis of local hidden variables is inconsistent with the way that physical systems do in fact behave. The simplest explanation, yet the one with the most profound implications, is that SR is in fact not the theory of choice, that another theory must be prescribed to fundamentally explain the non-local features of particles and their relationship with light. The question then is how to propose a new basis for relativity theory that supports "non-locality", taking the idea of non-locality to a level of *primary* theoretic importance.

4. A new case for non-locality using time-points

The solution to be proposed here takes a fundamental weakness in Einstein's SR and GR, namely the weakness of the idea of mass holding primacy of logic over "time", as presented in points (a)-(h), a solution proposed to such as per by not making ***time*** a "secondary" feature of mass objects moving in space, yet a "primary" feature that gives the concept of a point in space "non-locality", namely as "time-points", by choice of definition, and to then build a model of space with such a model for time as time-space, as upon the principle of time-points in space, and to then derive all the standard equations and constants known to SR/GR, QM and the SM of particles from that new a priori basis.

The principle here is asking why time would be "non-local", as "time-points" in space. The solution to this is that a time-point in space would be non-local because quite simply a time-point would not be space, and thus not be defined per se as a *local* thing, yet something else, something clearly not thought of before, yet something that is decided by design to carry the description of "non-locality" to space, simply because it is not space yet "time" as a time-point. Or more simply, a time-point when associated to space would create a type of uncertainty of spatial reference making that point "non-local" in regard to space.

The task that is to be presented by this new postulate/axiom definition for time is how time-points in space relate with space, and how time-points relate with each other, and how that then relates with the idea of mass and all the qualities of mass leading to the known field forces, constants, and equations. The non-locality of time-points thus cannot assume mass in space as a reference, yet instead implement time-points as the theoretic tool of choice, one point in time to the next, and so on and so forth, prescribing a "distance" in space defining which can then *estimate* locality.

One of the fundamental errors of Einstein's relativity theory is that his entire scheme suggested that primarily time does not exist as per (a)-(h), while according light with "c" and that at the speed of light time does not pass, despite light being a common feature of space, and that space holds priority over light in that if space can expand metrically then so too must light (as the explanation for the redshift effect of light). Much data has supported such a theory, primarily the nature of light as "c" as a universal constant.

The idea of time-points being proposed here is that "c" is still being recognised, and fundamentally so, not as a photon, yet as a *particular process* in a *field* of "points", as a particular *quantum* process in a field of time-points mandating the existence of time-points by the principle of time not passing at "c". For indeed, if time does not pass at "c", time can be considered as a point. The question is how this field of points would inter-relate with each other and with space as a feature of light and energy.

As a start, the idea of joining the time-points would create a relationship from one reference of "c", one point of "c", to another. The question is how a seemingly infinite spatial void full of time-points, time-points each as a concept of "c", would interact and thence give rise to energy, mass, and all associated equations and constants. Included in that description would be the following:

- *Locality* would be considered as a classical mechanics based and thus *grossly defined* mass-based knowledge of the location and trajectory of a gross mass particle.
- *Non-locality* here paradoxically would be any instance of a particle location *inferred by time*, by definition, as being a part of time-points in space, as data shows, on the physical microscopic level of analysis.
- The universal "c" immediacy of time (time not passing) would present the condition for the non-locality of a particle central to time-points in space regarding this general "c" back-drop for the microscopic particle level.

In short, *temporal calculus* proposes non-locality to represent the concept of time as a sea of *time-before* time-points that stream in time with the datum reference of space as time-now *into* time-after, and that such gives *time* primacy of definition itself in regard to all else, as initially proposed in papers 1 [1] and 8 [8], a feature overlooked by the designers of contemporary physics theory (SR/GR).

This is the key feature that has been overlooked by physics theory as exercised by SR/GR making time a secondary feature to "mass", the problems of which are presented in points (a)-(h).

The question is, "*how are time-before time-points related to each other and to a time-now datum reference, and thence time-after, what are the dimensional mechanics between time-points and space, and what ultimately therefore represents the required temporal calculus of time-points in space for this new proposal to be upheld, to accommodate for all the known physical data and associated equations and constants*?".

The answer to this has been provided in the preceding papers leading to this current paper, papers 1-28 [1-28], more specifically as a dimensional mechanics and *temporal calculus* presented in papers 20-28 [20-28]. As presented in the preceding papers [1-28], the proposed *temporal calculus* does not make mass primary, yet "time-points", like a time-before time-point aether, and then determines how these time-points interact with time-now space, mathematically, all described in the papers, resulting in the standard equations ([24]: p16-18) found already with mass-primacy mathematical formalisms, except with *temporal calculus* a general link is formed between classical mechanics, QM, and the SM of particles using this one *temporal calculus* structure of time-points (and associated mathematical time-point formalism), thereby solving the "Yang-Mills Existence and Mass Gap" problem [25].

Ultimately, the idea of particles in being structured by the particular association of time-points in the context of a general "c" field of time-points prescribes that there must always exist an uncertainty between the idea of a time-point and space and therefore particle location, described in *temporal calculus* as the Time-Space Uncertainty principle ([20]: p11-13), a time-point basis analogue of Heisenberg's Uncertainty principle.

Fundamentally, the time-points would represent a natural disruption for space *in space seeking to be a uniform/flat 3-d vacuum while being faced with an apparent non-local (time-before) sea of time-points*, and such a disruption would give rise to the dimensional mechanics between time and space, giving rise to the arrow of time, energy, mass, and thence the overall shape of reality that presents to human awareness, all of such accounted for in the preceding papers, key of which being papers 20-28 [20-28].

5. Conclusion

The proposal in this paper in seeking to resolve Bell's Theorem has been to present a new basis for the analysis of Einstein's *spacetime* by presenting the idea of non-local "time-points" in space consistent with "c" being a paradigm where time does not pass, and thus a proposed sea of time-points in space that prescribe a "non-locality" of hidden variables as *time-before* time-points in space, as prescribed by the proposed time-equation of $temporal\ calculus$.

Owing to the proposal requiring a reworking of Einstein's SR theory in making time of primary importance and not secondary to relativistic mass, a reworking that has been termed $temporal\ calculus$, all the equations and constants central to data that SR/GR, QM, and the SM of particles accommodate for must then be reworked into if not derived by this $temporal\ calculus$. The results of the preceding papers [1-28] confirm this proposal and achieve all of such, with particular attention to papers 20-28 [20-28].

As a most fundamental conclusion, with all such granted, is that for physics to properly and most thoroughly explain physical phenomena, then the simplest and most-basic premise of making mass primary is the incorrect path to take, yet the more correct one being based on all the data available crunched to an ultimate paradigm of non-local time as time-before time-points in space, from which all equations central to energy and mass and associated constants can be derived in the one time-point theoretic model [1-28], thence forming a theoretic link between EM and gravity that can be experimentally demonstrated.

Conflicts of Interest

The author declares no conflicts of interest; this has been an entirely self-funded independent project.

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