Relativistic Locality

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Abstract:

This paper describes an extremely simple and fundamentally different view of the concept of “photon” which removes the mystery of wave-particle duality, locality versus non-locality (entanglement, etc.), causality, wave-particle duality for massive particles, superposition, and reveals the basic tenets of distance, time, and gravity. A proof is provided.

Introduction:

To understand this new view one must first agree to the following two principles:

The first is that all the laws of physics are obeyed in all inertial reference frames whether they contain observers or not. An observer traveling past this page at 9/10ths the speed of light will see the same laws of physics obeyed that we see obeyed, and those laws are obeyed in that frame whether that observer is awake, asleep, or not even there.

The second is that inertial reference frames traveling at light speed certainly exist. Nature allows asymptotes to play a part in reality. We might be able to understand at least a few things about them without worrying about certain infinities that arise when we try to put massive objects into such frames. Fortunately we don’t need to put a massive observer into such frames, anyway, in order to believe physical laws are obeyed in those frames.

If we were massless so that we could be placed in such a reference frame traveling at light speed, then for us in that frame Lorentz contraction would have foreshortened our environment completely. Our point of departure and point of arrival would be the same. Likewise our journey would take no time at all. Our point of arrival and point of departure would be *local* rather than non-local.

The concepts of local and non-local are fundamental in our understanding many things, including causality. We don’t worry so much about causality in what we have decided to call local interactions because there is no delay in the communication between the particles involved. However, we do have questions of causality in some interactions between particles that we assume are some distance apart. We presume there is a time delay between each communication between those particles, and there are situations in which we suppose some sort of a multi-step communication between particles is necessary in order to conserve energy in a given interaction, yet we don’t see an extra delay in the actual transfer of energy. So there are unanswered questions.

Our current view of a simple transfer of energy from one atom to another is that when an electron orbital in one atom is excited, it may emit a photon and that photon travels through space until it happens to encounter another atom that absorbs it.

But there are two reference frames in which those two atoms are local. One frame travels at light speed from the emitting atom to the absorbing atom, and the other travels at light speed from the absorber to the emitter. So it is reasonable to think of photons simply as a near-field energy transfer between local oscillators and therefore such transfers are not subject to causality. In the case of a simple transfer between two atoms either the classic view or this new view is fine. But in certain more complex cases, the second view is necessary to explain how causality, energy conservation, and the light speed limit were all obeyed, and to open the door to certain new concepts.

Application to the double slit experiment:

In the double-slit experiment we have one emitting atom, one absorbing atom, and two paths (one through each slit) between those atoms. Let's consider the path from an atom to a slit and from that slit to the other atom as a single reference frame since nothing interesting happens at the slit. So that gives us four light-speed reference frames: two going each direction, through each slit.

Now consider that the electron orbitals in those atoms are oscillators. In each of the four light-speed reference frames the atoms are local and there is some definite phase difference between the orbitals in the atoms. Since the laws of physics must be obeyed in each and all reference frames, energy will be transferred only in cases where the oscillators are in phase in all four of those reference frames.

An analysis reveals that energy will be transferred according to the laws of classic wave mechanics, and using classic wave mechanics to predict a double-slit interference pattern is nothing new. However, this view has far-reaching effects. The immediate result is that we see that nothing like a wave is present and therefore there is no confusion about whether the energy was transferred as a wave or as a particle. It was actually transferred as a near-field interaction between two local oscillators.

Thus it can now be understood how wave mechanics will be obeyed in the double-slit experiment while only one pair of atoms will participate in the transfer of the photon energy. There is no inconsistency in the concepts of counting individual photons and in wave interference. The obedience to wave mechanics arises not because there are waves, but because in those reference frames moving at light speed only certain oscillator phases between the emitter and absorber atoms are conducive to a transfer of energy.

Neutrino oscillation:

An entangled neutrino has three separate wavefunctions because it has three mass eigenstates. The phase of these three wavefunctions depends on the conditions of creation (muon, electron, or tau). Even if we didn't know the phase of the wavefunctions at a given emitter type (muon, electron, or tau) we could detect a neutrino's flavor both at the emitter and at the detector because of T-symmetry. Specifically, if a detector can be made that discriminates neutrino flavor, then an emitter can also be made that discriminates neutrino flavor.

The problem is that we can know the flavor (mass) of a given neutrino before the neutrino is detected, the neutrino travels below light speed so information on that emitted flavor can be sent ahead of it from emitter to detector, yet we see that the probability of detecting a given neutrino flavor depends on the distance from emitter to detector. So what if the observer at the detector took action based on that received flavor information before actual detection, which changes the detection probability of that flavor?

Regardless of the obvious apparent paradox of causality that still needs resolution, we must conclude, at least for neutrinos, that nature chooses the absorber at the time of emission.

Other implications:

The reason photons cannot be detected in transit is because there is no such thing as a photon in transit. Its all near-field, local interactions.

Since superposition is described by the double-slit experiment, and this view explains the mysteries of the double-slit experiment, it should help in resolving the mysteries of superposition.

Light speed is not the “speed of photons”, since photons in transit do not exist. Light speed is simply the speed limit of the universe.

You can’t have a photon without an emitter and an absorber. This is also provable by use of T-symmetry: If someone claims a photon can be emitted without ever being absorbed, then they are also claiming a photon can be absorbed without ever having been emitted.

Everything is local in some sense, and therefore in some sense can be thought of as entangled. Its possible this mediates Mach's principle (in the more general, modern interpretation).

It may be that particles do not reside in space-time, but rather particle interactions are what define space-time. That is, space-time is a purely statistical view of the large-scale behavior of many particles. It is phase differences that actually define distance, and therefore time. And even then space and time have no meaning until there has actually been an energy transfer. So this notably demotes the rank of space-time from axiom to statistical behavior, and there is a sort of phase space that is more fundamental than classic space-time.

Thought experiments of a box of light with massless walls are invalid. The walls must have some mass because the light actually exists as energetic states of the particles of those walls. More classically, you can't reflect light without storing it momentarily, and you can't store light in a massless device because a massless device cannot contain potential energy. We normally think of light in a mirrored box as “confined” light and so we can think of the so-called “relativistic mass” (admittedly an archaic and ambiguous term) of the light as a contribution to the invariant mass of the box. But since there is always an emitter and an absorber and photons don't exist in transit, then all light is “confined” in some sense and it contributes mass only to the emitter and absorber. However, remember that everything is local. So a “photon and star being deflected by their mutual gravity” is really simply related to the phase and changes in the phase of the various oscillators involved.

Velocity and acceleration is related to phase shift and frequency of the oscillators, where everything is local in that phase space (there is no space time, except statistically).

Anything that can be described as a continuum is classical and purely statistical and was learned solely from studying classical mechanics. Continua play no part in quantum physics.

Consider two macroscopic clocks sitting next to each other on a shelf. They run at pretty much the same rate. This makes us assume there is a scalar field called 'time' encompassing both clocks, and its magnitude must be the same for each clock. Specifically, we assume each clock is ‘aware’ of the time instantaneously from the field in which it is immersed.

But a closer inspections shows that those macroscopic clocks are undergoing a myriad of quantum interactions with each other and with the rest of the universe in the form of transfers of virtual and real photons and particles.

So what happens if we remove those interactions?

If we make microscopic adiabatic clocks and cool them down to almost absolute zero to force them to behave adiabatically, the clocks will run independently of each other and the rest of the universe. Between interactions with each other and the rest of the universe (adiabatic processes), they run infinitely fast.

So the reason macroscopic clocks run at about the same rate is not because there is some field called 'time' within which they were both immersed. Rather, it is because the non-adiabatic processes in the clocks prevent them from advancing until some non-adiabatic interaction occurs (a transfer of energy with the rest of the universe). Therefore time does not exist.

Likewise our concept of space is also purely classical. Everything is local in quantum physics and there is no non-locality. So the only issue of causality comes when a non-adiabatic process occurs.

Space-time is obedience to causality, causality is a facet (rule) of order. On the quantum level space-time is a measure of a sequence of interdependent quantum events. So one observer may see event 'A' cause event 'B' cause event 'C' and say 2 time units have elapsed. A nearby observer may see event 'W' cause event 'X' cause event 'Y' cause event 'Z' and say 3 time units have expired. Our macroscopic measurement of time is an average of the local quantum event count per sequence of causes and effects. Only when a sequence of interactions splits and then merges is there disagreement by different observers over the amount of time that has elapsed.

Look at this sequence of events:

Let's say one event caused two others, then only one of those two caused another event, then those two last events caused a single fourth event. An observer watching (interacting with) one sequence would see time elapse by two, and an observer watching the other sequence would see time elapse by 3. The observers agree that the first split (one event causing two) and the last merge (two events causing one) was the same point in time, but they disagree with the amount of time that has elapsed between those two points in time. This is relativity on the quantum level. It also shows why two observers may disagree on a distance between two points (the 'space' part of space-time). A classical moving observer sees, on the average, different paths of interaction between his surrounding objects.

Note that only when the two observers interact (split or merge their sequences of events) do they disagree on the local time rate, and likewise the local distance between two objects.

Since our macroscopic view of space-time (not on the quantum level) is a relative measure of the number of interactions between objects, an observer outside a gravity well sees objects within the gravity well experiencing more interactions because there is more to interact with there. Thus the time rate is less for the object in the gravity well. Since there is a statistical wave-nature of matter, objects near another object “refract” toward each other. This is gravity.

So both time and gravity are purely statistical in nature, rather than fundamental.

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References:

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Data table for Lorentz and CPT violations

http://arxiv.org/abs/0801.0287

The ultimate Neutrino page
http://cupp.oulu.fi/neutrino/