Relativistic Locality

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Abstract:

This paper describes an extremely simple and fundamentally different view of the concept of “photon” which leads to a fundamentally different view of several other concepts. On the surface the view clearly and concisely removes all the mystery of the wave-particle duality in photons. Diving deeper we see it open the door to a better understanding of locality versus non-locality, causality, entanglement, wave-particle duality for massive particles, superposition, along with a few other things.

Introduction:

Photons are certainly not waves and they are certainly not particles. We can say this because by definition particles never act like waves and waves never act like particles. So is it mere coincidence that photons just happen to behave exactly like classic particles only when measured one way and behave exactly like classic waves only when measured another way? The purpose of this paper is not to defend any definition or interpretation of the wave-particle duality. Rather, this paper will show that the mystery and confusion come from a bad presupposition about the nature of photons and that a radically different fundamental view of the transfer of energy we call a “photon” removes any need for questions and argument in that respect.

A new paradigm:

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 concept is that there is no reason for us to pretend there is no such thing as a reference frame traveling at light speed. Let us assume such frames exist and that 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 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 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 an 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 us enumerate the various light-speed reference frames involved. There is a light-speed reference frame moving from the emitter to slit 1, from slit 1 to the absorber, from the absorber to slit 1, from slit 1 to the emitter, from the emitter to slit 2, from slit 2 to the absorber, from the absorber to slit 2, and from slit 2 to the emitter. To simplify, 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 reference frame the atoms are local and there is some definite phase difference between the orbitals in the atoms. In each reference frame there is a different phase of the oscillators. 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 reference frames.

An analysis reveals that energy will be transferred according to the laws of classic wave mechanics, and using wave mechanics to predict an interference pattern is nothing new. However, this view has far-reaching effects. The immediate result is that we see that no waves are 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 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.

Implications:

The reason photons cannot be detected in transit is because there is no such thing as a photon in transit.

Since superposition is described in part 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.

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 that light 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. So all light is “confined” in some sense and it contributes mass to the emitter and absorber. However, remember that everything is local. So a “photon being deflected by the gravity of a star” is really simply related to the phase and changes in the phase of the various oscillators involved. There is no photon in transit.

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).

There is no attempt here to unify general relativity and quantum physics. However it is hoped this might lead us in that direction, since the concepts of space and time are inherently altered in this view.