MODIFIED PATH INTEGRAL INTERPRETATION (MOPI) AND SUGGESTED EXPERIMENTS CHALLENGING SPECIAL RELATIVITY

By

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Abstract

Concerning the constancy of the speed of light, we indicate that Feynman's "sum-over-paths" theory of quantum mechanics implicitly relates also to velocities of a photon from C to infinity through the paths, and not only to paths alone taken by the photon. We suggest a modification of Feynman's approach according to which every single photon not only travels from source to destination in all possible paths, but also in all the velocities from zero to infinity, through each of the paths. Matter, however (as already suggested by Israel Shapira several years ago), is tuned to interact with photons only at the special relative velocity C. It follows that the behavior of light as stated by the second postulate of special relativity can result from this suggested physics. We propose experimental setups that challenge special relativity in this regard.

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LIGHT: A VARIETY OF SPEEDS, ONE MEASURMENT RULE

One day during March 2012, Meir read a talkback written by Israel in an internet site (http://www.hayadan.org.il/astronomers-reach-new-frontiers-of-dark-matter-130112/comment-page-6/#comments)

In that talkback and later on in the discussion developed and in several related discussions, Israel expressed his own idea, according to which the behavior of light as indicated by the second postulate of special relativity as well as the apparent non locality of quantum entanglement can result from the following suggested physics:

Electromagnetic radiation travels through space as waves in an "active ether" in all velocities from zero to infinity relative to a preferred frame of reference, that of the cosmic background radiation, but can be absorbed by matter only when their velocity respective of the CBR and the velocity of that matter, also respective of the CBR, differ exactly by ***C***. So, electromagnetic waves travel through space unnoticed by matter unless their velocity is greater exactly by ***C*** from the velocity of this matter.

Israel suggested that his assumption can be tested by a variety of experimental setups that can defer from one another in some technical details but are all based on the following type of experiment (see Fig. 1):

> Compare the time of arrival of a signal transmitted from a sufficiently remote source and received (i) by a detection system at rest relatively to the source (or approaching it in a predetermined velocity ***v***), and (ii) a detection system receding in a predetermined velocity from the source. The comparison between the times of arrival in the two systems will be performed in a system at rest by a recorder in short distance communication with both detection systems, with expectation to record a signal from the receding detection system prior to the recording of the same signal from the other detection system, thus affirming that the signal was carried by waves traveling through space at different velocities, some of which at ***C+v*** to catchup at ***C*** with the detection system receding at ***v*** and in violation of special relativity.

Meir, while being fascinated from the idea in its abstractness, disagreed with Israel about its actuality. Meir was unconvinced that the suggested phenomenon can be true, mainly due to seemingly apparent energy conservation violation (that can in principle be detected by a calorimeter) and due to the Sagnac effect that seemingly proves wrong the idea that the waves emitted from a source into the "active ether" suggested by Israel can catchup with a receding detector simultaneously with the very same waves that catchup with an approaching detector.

THE SPEED OF LIGHT AND THE QUANTUM MEASURMENT

In 5 September 2015, Micky came up with the following idea:

Delayed choice experiments hint that light somehow "knows" that it is being detected. What if light not only "knows" and materializes as a particle upon detection, but also automatically

adjusts its velocity to ***C*** upon detection? Can such peculiar behavior explain the second postulate of special relativity?

Micky's idea, that she published as a Facebook post on her home page somehow found its way into a Facebook group named "Sharp Thinking", and was laughed at by many of the group members, with Micky, that joined the group especially for defending her position, being rigorously criticized and publically shamed for her "courage" to "teach" the experts how physics can work.

Meir became aware of Micky's idea through that Facebook group, which he joined only several weeks before. Meir was among the grope members that argued against Micky's idea, but he treated her very gently, it should be mentioned, and with a lot of respect.

TRIPLE MERGER

Later on, and after Meir privately took a long and careful thought about Micky's idea, Meir and Israel occasionally engaged into another talkbackism about Israel's "active ether" idea in another internet forum, this time the one maintained and managed by the Open University, Israel (the state, not the person...)

Rethinking both nice yet peculiar ideas, it somehow popped up into Meir's mind to try and combine between them both: Micky argues that light not only "knows" that it is being detected as evident from quantum mechanics experiments, but also somehow "adjusts" its velocity to ***C*** upon detection, and from Israel's argument it follows that this "adjusting" is nothing more than simply approaching matter at ***C***, where ***C*** is a differential velocity between a specific photon's velocity ***C+v*** and the matter's velocity ***v***, both said velocities respective of the preferred CBR frame of reference.

The problem was that from the aforementioned reasoning Meir could not accept Israel's idea as a true description of the physical reality. So, in trying to improve the "match", another idea popped up into Meir's mind: maybe the light's "knowing" of being detected (as evident from quantum mechanics experiments), and its mysterious capability of "adjusting" its velocity to ***C*** upon measurement as suggested by Micky, are one: Israel's suggested divergence in light velocities is not due to divergence of velocities of different photons or divergence in velocities of "active ether" waves, rather a divergence of velocities of EACH and EVERY photon separately. The association of the idea that a single photon travels from source to destination in "all possible velocities" with Richard Feynman's "sum-over-paths" theory (known also as "path integral interpretation") of quantum mechanics according to which the single photon travels from source to destination in "all possible paths", emerged immediately in Meir's mind, remembering something that disturbed him in the past when he first became aware of Feynman's approach: the notion of traveling at a variety of velocities implicitly and inevitably emerges from the "sum-over-paths" interpretation, because paths of all sorts of different lengths end up simultaneously at the target. Since according to Feynman a photon behaves like taking all possible paths between the source and the destination, and since all but one path require it to travel at a velocity greater than ***C***, it can actually be assumed that a pre-materialized photon (or, equivalently, its wave function) travels in a whole spectrum of velocities ***v+C*** respective of the CBR (with v changing from infinity to ***–C***) through each and every individual path from the infinite number of paths, and

materializes immediately upon catching up with matter traveling at ***v*** respective of the CBR along the geodesic line connecting between the source and the target.

So, by combining Feynman's "sum-over-paths" theory with Israel's idea that the second postulate of SR can result from light traveling at a whole spectrum of velocities respective of the CBR but is interacting with matter only at a special velocity, i.e. ***C***, the idea of Micky that light adjusts its velocity to ***C***[1] upon measurement can be a true description of the physical reality.

Furthermore, Born's rule that requires squaring the summation of the probability magnitudes of the paths in order to get the probability density, hints that the probability magnitude received from the path integral is not the only probabilistic factor which determines the probability to detect the photon at a specific location at a specific time, i.e. hints that there is another probability magnitude transversely to the first that must be accounted for. Since to our modified view of the path integral interpretation an infinite number of systems (one system of all possible paths per every velocity from zero to infinity) must be superimposed altogether in order to define a photon's history before detection, we suggest that said 'another probability magnitude' to be accounted for, is that relating to the photon's probability of having exactly the velocity ***C*** relative to an elemental particle constituting the "detector", exactly at the detection location and along a path of least time.

SUGGESTED EXPERIMENT

We suggest that this new interpretation of the nature of light can be tested, e.g. by the following "Shapira" experimental set-up:

A remote laser capable of emitting short light pulses at a predetermined repetition rate is aligned to illuminate towards a rotating platform having two pairs of photodetectors, located remotely from one another on a diameter of the platform, the photodetectors of each pair are arranged back to back with lines of sight perpendicularly to the diameter. The photodetectors are in communication with an OR gate that combines the pulses generated by the photodetectors upon detection of light pulses emitted from the laser, and sends the combined signal to a counter or a frequency meter. The OR gate location is equidistant from the photodetectors, on some point along the platform's axis of rotation. A light shielding wall opaque to the laser light is located between the laser and the platform in front of the platform such that the photodetectors are exposed to the laser beam only when the diameter line on which they are positioned is substantially perpendicular to the laser line of sight, i.e. when the velocities of the photodetectors respective of the laser are maximal or nearly maximal upon rotation of the platform.

According SR, when the diameter line on which they are positioned is substantially perpendicular to the laser line, the two remote photodetectors are expected to detect laser light pulses simultaneously irrespective of their rotation, since the speed of light does not

[1] It is suggested that the "tuning" of matter to the special velocity ***C*** is tolerable to some small extent not greater than ±1m/s, and anyway well within the error boundaries associated with the most accurate measurements of light speed. The probability of a photon to catchup and interact "exactly" at ***C*** with a matter particle moving at a velocity ***v*** and happens to be present on a least time path sufficiently closely to the least time moment for ***C+v***, though not exactly at the least time moment, is thus reasonably high.

depend on the velocity of the observer. According to the MOPI (Modified Path Integral interpretation) herewith suggested, a photodetector receding from the laser at a velocity ***v*** is expected to detect photons at velocity ***C+v*** while the photodetector on the opposite end of the platform is approaching the laser at a velocity ***–v*** hence expected to detect photons at velocity ***C-v***. It follows that if the count of laser pulses per a unit of time when the platform is at rest is ***f***, it should remain ***f*** according to SR upon rotation of the platform, or change to ***2f*** in case MOPI is an adequate description of the physical reality.

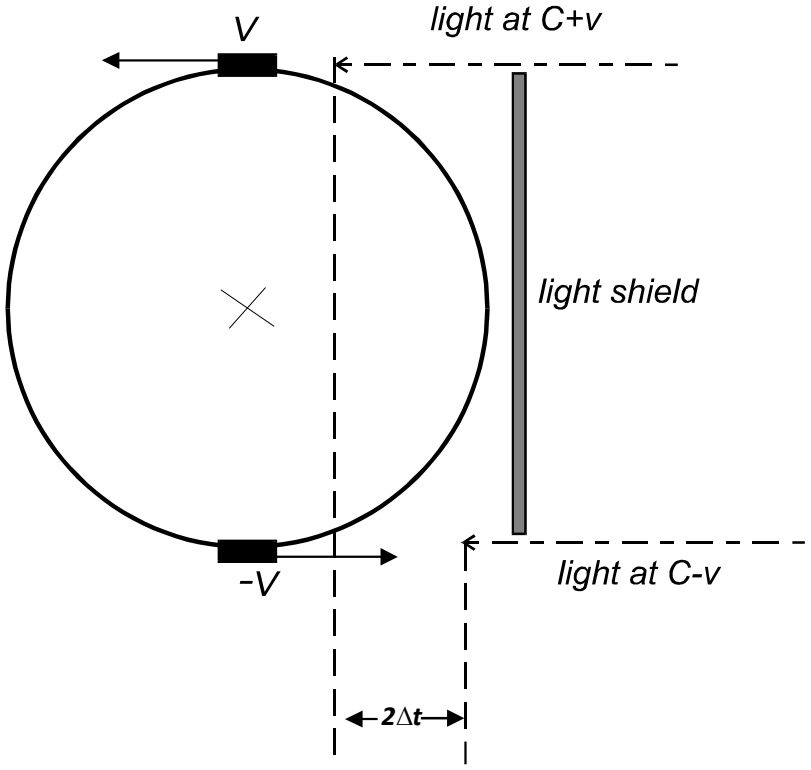

Fig. 1

A variation of the experimental setup is also suggested, in which the OR gate and the pulse counter are replaced by a time recordation system that comprises a photodetector at rest additionally to the two pairs of photodetectors on the platform, for recording and comparing time of arrival of the laser's light pulses. According to SR light pulses received by the photodetectors located on the platform are expected to have the same time of arrival as a light pulse received by the stationary photodetector. According to MOPI light pulses received by a photodetector receding from the laser are expected to be recorded with a time of arrival ~Δt prior to that of respective light pulses received by the stationary photodetector and $2\Delta t$ respective of light pulses received by the photodetector approaching the laser, where we define

$$\Delta \mathrm{t} = \frac{v * d}{C^2 - v^2}$$

(***v*** is the tangential velocity of platform mounted photodetectors
and ***d*** is the distance of the platform from the laser)

We urge to perform a "Shapira experiment" because special relativity has seemingly never been tested in an experiment that compares the times of arrival of a signal from a remote source as measured by observers in frames of reference having different velocities respective of the source.