FTL by Down-converting

Horace Heffner   October, 2004

A method is proposed here to achieve faster than light (FTL) communication by the use of down-converters. A down-converter splits a photon into two photons each having half the energy of the original photon.

Suppose we have a sender Alice, a receiver Bob, and an intermediary facilitator Charlie. Charlie uses a beam splitter to create two beams of laser light: L the left beam and R, the right beam. Charlie then down-converts the L beam to create beams L1 and L2, and similarly creates beams R1 and R2 from the beam R. Fig. 2, below, is useful to follow this discussion. Beams R2 and L2 are normal path or "signal" photons through the down-converter, while beams R1 and L1 are called "idler" photons. "Beam" here means a flow of individually detectable photons sent in very short intervals so as to provide a useful rate of communication. Charlie directs beams L1 and R1 to Alice and beams R2 and L2 to Bob. The corresponding photons arrive at both Bob and Alice at nearly the same time, but here assume Alice receives hers first, but just barely before Bob.

Bob directs beams R2 and L2 such that they can create an interference pattern in a set of detectors arranged so it is feasible to rapidly and with high probability determine whether an interference pattern is present or not. The signal photon beams R2 and L2 can create such an interference pattern because they are the two paths from a beam splitter.

Alice can direct her idler beams L1 and R1 at will, in a co-linear fashion, to opposing sides of a half silvered mirror, but at an angle of 45 degrees. Fig. 1 shows this configuration. Half of L1 and half of R1 then goes to a detector DL. Similarly, half of L1 and half of R1 then goes to a detector DR. The beams emerging from both sides of the mirror are thus fully mixed, and the which-path information for all photons is lost. The history of the photons is scrambled. In this case Bob must see an interference pattern. If Alice then diverts her beams directly to detectors, the which-way information is then restored to 100 percent available, and Bob must see a bimodal distribution.

The design of this experiment is based on the Kim et al experiment. [1] A 1-1 photon-idler coincidence counting is vital to the Kim et al experiment because that experiment is set up so that the paths of only about 50 percent of the idlers is known. Bob, in the Kim et al experiment can not directly see an interference pattern at all, but when the photons are considered on an individual basis, the signal photons corresponding to the idlers (via recorded data) which are "observed" do not make an interference pattern, while those whose histories are "erased" by the configuration in Fig. 1 do make an interference pattern. It is expected that by knowing or not knowing the histories of 100 percent of the particles Bob must clearly see either a bimodal or interference pattern accordingly, without knowledge of the timing or the need for coincidence counting. If Bob dutifully records his distributions, and 100 percent of the photons are affected by a quantum wavefunction that generates interference, then he must be able to see that interference pattern because there are no photons left to mask it out. Whether Bob records his observations for later comparison or not should thus be irrelevant.

The significance of the Kim et al experiment is that *individual idler photon histories can be wiped out* by scrambling the idler's history with other histories by injecting the idler into the *beam* from the opposed path. (There doesn't even have to be a particle-particle interaction, it is merely the fact that the origin of the mother photon becomes uncertain that does the trick. Truly incredible!) Fig. 1 shows how an idler from one beam can be (was) mixed into another idler beam, scrambled, so as to lose its history.

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                     Full Mirror
R1--->-------------\
                   |
                   |  Half Mirror
L1---->------------\----------------------DL
                   |
                   |
                  DR

   Fig. 1 - Alice's which-path scrambler
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Note that ascii figures require a fixed font, like Courier, and Microsoft Outlook users may need to select "fixed" in the "textsize" submenu of the "view" menu.

Bob should in fact see such an interference pattern provided the which-path information is lost for idler beams R1 and L1. If Alice does place detectors directly in both her idler beams, then this is equivalent to knowing which path each of Bob's photons have traveled, and thus Bob can observe no interference pattern. This known-path-no-interference result has been characteristic of numerous versions of the two slit or two path interference experiments.[2] If Alice detects directly and sees an idler she then knows which path the corresponding signal photon took to Bob, and the interference wavefunction instantly collapses. Bob, when his photons arrive shortly after Alice's corresponding photons, knows the current state of Alice's detectors by whether he sees an interference pattern or not.

Assuming that beams adequate for fast communication can be generated and the resulting interference detected sufficiently fast, achieving high data rate FTL communication at short range then primarily boils down to how fast Alice can switch from a detecting mode to a non-detecting mode. This might be as simple as her redirecting beams R1 and/or L1. This experiment then, in addition to achieving FTL communication, may be useful for determining exactly of what an observation consists.

The fact that detector DR and DL can not determine whether an idler came from R1 or L1 in Fig. 1 *erases its history* and permits the corresponding signal photon to experience the quantum wavefunction for interference. DL detects half its particles from R1 and half from L1, as does detector DR. When the corresponding signal photon pattern is tallied for all the photons detected by DL and DR, an interference pattern is observed. The history of *every* photon passing through the scrambler thus must be erased, even those which pass straight through the half-mirror. The scrambler in Fig. 1 can be repeated if necessary to compensate for imperfect half-mirrors, beam overlap, and other problems.

The logic on this is a bit unusual, because, to achieve FTL communication, it is not actually suggested that use be made of an instantaneous wavefunction collapse, but rather that use be made of an instantaneous *wavefunction resurrection*. By erasing the history that destroyed a wavefunction, that wavefunction is instantly resurrected, and thus the interference is projected at faster than the speed of light to Bob's location. A wavefunction resurrection must be as instantaneous as a wavefunction collapse.

Since Alice and Bob could be light years away from each other, and since Alice thus might have years from the time Charlie released the photons to make the choice to detect or not detect her photons, faster than light communication from Alice to Bob is clearly a possible result. It might be said that the communication can not be verified for years, but such verification is in this case not necessary. Bob does not require verification or comparison to Alice's results to know the immediate state of Alice's detectors, or to immediately detect a change of state of those detectors. He can accomplish these things with sufficient speed and reliability to establish a practical communication channel. Further, a similar channel can be established from Bob to Alice, thus permitting immediate error detection and correction or retransmission.

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Figure 2 and the discussion following sums up the critical issue for the proposed experiment design in a nutshell:

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                                  DL
                                  |
                                  |  Alice in
                                  |  "erase history"
                                  ^  mode
                         R1       |
        /------------->----------//----->------->DR
        |                         |
        ^                         ^  L1
        |                         |
       ... to Alice              ... to Alice
        |                         |
        |                         |
     R1 |        laser            |
        |          |              |     Legend:
        ^          v              ^
        |          |              |       / - mirror
        |       R  |              |      // - splitter
   /----X----<----//  Charlie     |       X - down-shifter
   |              |               |       o - pattern detectors
   |              v L             |   DL,DR - photon detectors
   v              |         L1    |
R2 |              X------>--------/
   |              |
  ...to Bob      ... to Bob
   |              |
   |              |
   v              v
  o|              |  L2
   o              |
    o------<------/
     o
  Bob's Pattern
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Fig. 2 - Experiment with Alice in 100 % "erase history" mode.

The issue of whether the experiment can produce information transfer or not boils down to whether Bob sees an interference pattern in the arrangement diagramed in Fig. 2 or not (assuming path lengths are all adjusted properly). If he does, then the experiment must in fact be capable of transmitting information FTL, because it is well known that eliminating Alice's splitter, and thus directing R1 to DR and L1 to DL, eliminates Bob's interference pattern. Alice thus has numerous physical means available to switch from interference mode to bimodal mode. The (experimental) reason Bob should see the interference pattern is that every "history erased" photon entering Bob's detectors in the Kim et al experiment contributed to the interference pattern. Since 100 percent of the photons are "history erased" by Alice in Fig. 2, Bob should clearly see the interference pattern. This is a fundamental assumption of the design and the most likely conceptual error. The practical problem boils down to obtaining an interference pattern between beams R2 and L2, which may not be possible. [3]

An experiment requiring the simplest possible message would involve sending a data bit (actually only a change of state) via a one-way FTL communication channel and returning it via a second one-way return FTL communication channel, and repeating this process to establish an oscillation. A fiber pair from Charlie to Bob and Charlie to Alice could be used, if desired, to create a single FTL communication channel. A similar set of fiber pairs would be used for the return channel. To demonstrate FTL communication it is then necessary to transmit over a sufficient distance D that the oscillation frequency, f, is faster than the oscillation frequency $F = c/D$ that can be achieved by light. A 10 km communication link (each way) need only cycle faster than about 15 kHz to break the light speed barrier. Assuming a sample of 100 photons to be sufficient for determining interference, a photon transmission and detection rate of 1.5 million photons per second is required. However, it is not known what precisely constitutes an observation. It may be that individual photon detection is not even necessary, but rather mere beam intensity determination is sufficient.

Arguments based on causality and relativity that suggest the proposed experiment cannot achieve FTL communications, despite the fact they are likely correct, are not relevant to this experiment or valid because relativity and its related causality problems are the very things being brought into question by the proposed experiment.

References:

[1] Kim et al, "Delayed Quantum Eraser", Jan 19, 1999, Phys. Rev. Lett., Vol 84, no. 1, pp 1-5, <http://prola.aps.org/pdf/PRL/v84/i1/p1_1>
[2] Brian Green, *The Fabric of the Cosmos*, (New York: Alfred A Knopf, 2004), pp 193-197
[3] Chiao, Raymnd Y. and Kwait, Paul G., "Heisenberg’s Introduction of the ‘Collapse of the Wavepacket’ into QuantumMechanics" , Jan. 23, 2002, <http://arxiv.org/abs/quant-ph/0201036>