New Twist on Double Slit
That damn double slit

(Quote probably stolen from Feynman)

ABSTRACT. For those who appreciate this experiment for being the simplest demonstration of the essence of quantum mechanics, this is an enigma that has defied conventional logic. The math of QM properly describes the phenomena, and is well beyond reproach, but for those who view particles as solid objects having a definite momentum and location, though un-measurable, rather than the probability of existence at a point in time, rethinking may be necessary. This paper poses a thought experiment, the purpose of which is to provoke a thought or two on the subject, but will not have a lot of answers.

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To set the stage:

Paul Dirac, The Principles of Quantum Mechanics, Fourth Edition, Chapter 1

> Some time before the discovery of quantum mechanics people realized that the connection between light waves and photons must be of a statistical character. What they did not clearly realize, however, was that the wave function gives information about the probability of one photon being in a particular place and not the probable number of photons in that place. The importance of the distinction can be made clear in the following way. Suppose we have a beam of light consisting of a large number of photons split up into two components of equal intensity. On the assumption that the beam is connected with the probable number of photons in it, we should have half the total number going into each component. If the two components are now made to interfere, we should require a photon in one component to be able to interfere with one in the other. Sometimes these two photons would have to annihilate one another and other times they would have to produce four photons. This would contradict the conservation of energy. The new theory, which connects the wave function with probabilities for one photon gets over the difficulty by making each photon go partly into each of the two components. Each photon then interferes only with itself. Interference between two different photons never occurs.

As a thought experiment, let us consider not necessarily a slit but a pair of radio dipoles being driven by a signal generator at a frequency of say, 100 k hertz. The radio pattern generated at a distant point perpendicular to the dipole being the classical double slit.

So as per Dirac The photons generated in the signal generator:

> "The new theory, which connects the wave function with probabilities for one photon gets over the difficulty by making each photon go partly into each of the two components. Each photon then interferes only with itself. Interference between two different photons never occurs."

Now let us make a couple of modifications to this double dipole:

1) The signal 100 k hertz generator is being counted down from a cesium clock with a stability of 1 second in 20 million years so the phase is accurate and stable to one wave wavelength per 200 years.

2) The generator for second dipole is replaced with an identical generator with a cesium clock, that is in no way connected to, or coupled with the first.

We can all agree that there will still be a double slit pattern, rather than the simple single slit sum. One could disagree with this but I don't think it's really in question. Because of the time stability of the generators the pattern could be constant, at least for a period of many years.

The argument that a photon interferes with it self to create the pattern does not quite hold true in this system, since photons generated by the first generator have no opportunity or probability to exit through the second dipole. In no way are the photons correlated, but the double slit pattern exists. Photons going off at a particular angle from the first dipole cease going in that direction when the second transmitter is activated, yet the photons are not correlated.

This is contrary to Dirac's assertion and also brings into question the conservation of energy. If two photons can destructively interfere, energy is destroyed and energy is only conserved in the average, a concept flatly rejected by the founders of quantum mechanics. In addition it certainly complicates the two slit diffraction of massive particles. In this case the probability of the location of one particle interfere with the probability of another without a correlation of the source.

Since there are two sources it should be $\psi_1^*\psi_1 + \psi_2^*\psi_2$ not $\left(\psi_1^* + \psi_2^*\right)\left(\psi_2 + \psi_1\right)$ which is what it seems to be. The concept of a single particle coming from two sources seems strange.

Recent experiments Kaltenbaek et al. have verified two photon interference for interfering infrared radiation:

http://arxiv.org/abs/quant-ph/0603048

A little rethinking may be necessary here.