Re: Quantum entanglement and information transfer

Source: http://sci.tech−archive.net/Archive/sci.physics.research/2004−07/0544.html

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From: Caroline Thompson (*ch.thompson1_at_virgin.net*)
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Date: 25 Jul 2004 09:16:35 −0400

"Joe Rongen" <joe@alpha.to> wrote in message
news:a345818b.0407211703.4801f5f0@posting.google.com...
> "Caroline Thompson" <ch.thompson1@virgin.net> wrote in message
news:<3KZJc.104$wq5.31@newsfe3−gui.ntli.net>...
>
> >There are some very neat sources of "photons" around these
> >days that do seem to naturally support QM, but have they really
> >proved that they were initially of random direction? It's not easy
> >to tell the difference between a mixture of signals, some of one
> >polarisation, some orthogonal, and a genuinely random set.
>
> One can find a practical example here:
> http://xxx.lanl.gov/abs/quant−ph?0404115
>
> "We present an entangled−state quantum cryptography system ...

They don't tell us anything about how they generated the "entangled" pairs here, though they reference Kwiat's 1995 paper. This is the source with the overlapping cones of light, one polarised vertically, the other horizontally, if I remember rightly. The "photons" used are taken from the points A and B where cones intersect. The QM story is that you have either an H at A and a V at B or a V A and an H at B.

I'm rather sticking my neck out here, I know, but I've studied quite a lot of experiments that use this source and am fairly sure that what really happens is that each of the supposedly single photons is really a superposition of two signals, one H and one V. The difference between the emissions at A and B is not really a matter of them being of orthogonal polarisation directions but of the H and V components having related phase differences. I'd love to have more info on this!

There are a lot of questions I'd like to ask about just what the role of the various half−wave plates etc that are used is supposed to be. A half−wave plate changes the phase difference by 180 deg. It can change the polarisation of plane polarised light by 90 deg, or reverse the direction of

polarisation of circularly polarised light. What I suspect happens when Kwiat's source is used in QKD is that small frequency differences from one pair to the next cause difference in the phase difference between V and H components, so that some pairs are approximately circularly polarised, some approximately plane. The choice by Alice of whether to try and measure plane or circular polarisation (by inserting an extra half−wave plate or not) results, effectively, in selection of the pairs that are most nearly perfectly in the selected categories, pairs that otherwise polarised having much less chance of detection.

Much of the above is guesswork −− and I may have got some of the jargon wrong −− but I do know that Kwiat never proved conclusively that his photon pairs *were* entangled since he used the CHSH Bell inequality and so had to assume "fair sampling". There are real correlations between the emitted photons, and I think, for various reasons, that the correlation is in a combination of phase and frequency. If it really was a matter of getting either H or V then we would *not* have the rotational invariance that QM assumes, since the axes of the nonlinear crystal source would provide preferred directions. As it is, we may have rotational invariance (in that all phase differences may be almost equally possible) but nobody has proved that the results cannot be explained by ordinary correlations in the manner I've suggested: the pairs have identical phase differences. Or possibly, as I suggest in quant−ph/9912082 in relation to Weihs' Bell test experiment, about half have one phase difference, the other half another, differing by 180 deg. It all depends how accurately frequency is controlled.

In the QKD demonstration, it is possible that the method works by selecting one of four distinguishable subsets of the emitted signals: circular L or R and linear +45 deg or −45 deg. The signals received by Alice are always identical (or always conjugate?) to the ones received by Bob.

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