

Review of: "What connects entangled photons?"

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Potential competing interests: No potential competing interests to declare.

This paper purports to present a locally physically realist account of the correlations encountered in polarization entanglement experiments. This reviewer is very sympathetic with the general endeavour of giving a physically realist account of entanglement which is a welcome respite from the anti-physical realist conclusions which predominate in the literature. This reviewer is also sympathetic with the author's appeal to contextualist accounts of quantum mechanics whereby it is held that measurement results are not independent of the measurement setup and agrees that the need for this has been shown by experiments where entangled photons did not interact in the past.

However, this reviewer doubts that a local account of polarization entanglement is possible. He is also quite leary of the appeals which the author makes to both Niels Bohr's account of distinguishability and indistinguishability as being truly foundational for the occurrence interference and to the appeal to the conservation of spin angular momentum in this regard. Bohr's claims about distinguishability and indistinguishability introduce an element of subjectivity into the subject, at least if they are construed (as the author appears to) as constituting a causal explication of interference as opposed to an epistemic criterion for its occurrence. The causal claim has been refuted by the Afshar [1] experiment which uses extremely thin wires placed in between a focusing lens and where the light is detected to demonstrate both distinguishable and indistinguishable properties at the same time. Also, with respect to the author's appeal to the conservation of spin angular momentum as being a foundational principle it is not at all clear how this is supposed to serve as a causally efficacious (as opposed to a merely descriptive) criterion.

Bell [2] has shown that purported explanations of the statistics of entanglement in terms of random mixtures and using an ignorance interpretation of probabilities do not work. In fact, A dilemma has been posed by Chiao and Garrison [3] that the results of polarization entanglement can only be explained by giving up on either physical realism or by embracing action at a distance. The author attempts to go between the horns of the dilemma by claiming that entangled photons under a locally realist construal are mixtures of indistinguishable photon pairs (in spin singlet states). However, at least to this reviewer, it is extremely unclear as to how there can be a completely realist construal of photon pairs where the individual photons (assuming that they are traditionally conceived of as being indivisible wholes) making up the pairs do not themselves have definite polarization states.

This reviewer agrees with the author that a contextualist interpretation of quantum mechanics whereby the measurement process (which he construes as inherently involving the absorption process) is key for understanding entanglement processes. However, he also holds that a more radical solution to the dilemma posed by Chiao and Garrison is necessary. In particular in R. French [4] he shows that all four Bell states can be derived by postulating the occurrence of correlated two-photon absorption at the detectors together with the occurrence of advanced waves

operating in the present so as to link the detectors.

References

- [1] Afshar, S., "Violation of the Principle of Complementarity and its Implications," *Proceedings of SPIE Vol. 5866* (2005) 229.
- [2] Bell, J., "On the Einstein-Poldolsky-Rosen Paradox," *Physics*, 1 (1964), 195.
- [3] Chiao, R and Garrison, J., "Realism or Locality: Which should we Abandon?" *Foundations of Physics* 29 (1999) 553.
- [4] French, R., "Wave Particle Unity and a Physically Realist Interpretation of Light," *Physics Essays* 21 (2008) 196.