Appeared in: **Squeezed States and Uncertainty Relations,**
H. Moya-Cessa, R. Jáuregui, S. Hacyan and Ocasaños, (eds.)
(Rinton Press, Princeton, 2003) pp. 200-202.

IS TWO-PARTICLE QUANTUM ENTANGLEMENT JUST CLASSICAL CORRELATION?

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Recently Lee and Thomas reported on an experimental technique that enabled them to *simulate* (emphasis added) "a four particle entangled state"[1] Their results conform precisely with those seen is similar experiments in which the observed correlations are those obtained in demonstrations of GHZ 4-fold 'photon' experiments, as reported elsewhere; e.g.:[2] These latter experiments are taken to demonstrate the quantum mechanical nature of EPR correlations, in particular the multi-particle GHZ correlations. The observation of the identical correlations among classical fields evokes the question: how can a "quantum" phenomena be rendered classically? This question is particularly acute in view of the conclusion of Bell's "Theorem," which states that such correlations are impossible in "local, realistic," circumstances, i.e., for *all* classical phenomena. Quoting Bell:

> In a *theory* in which parameters are added to quantum mechanics to determine the results of individual [EPR] measurements, without changing the statistical predictions, there must be a mechanism whereby the settings of one measuring device can influence the reading of another instrument, however remote. Moreover, the signal involved must propagate instantaneously, so that such a theory could not be Lorentz invariant. [3]

The premise of this comment is based on the proposition that nature does not *"simulate"* itself, and that the conceptual implications of the experiment by Lee and Thomas are, therefore, that it is an empirical counterexample to Bell's "Theorem," rigorously establishing its invalidity.

While this observation is in sharp contrast with much prevailing opinion regarding the significance of Bell's analysis, in fact it is supported by an ever increasing body of research which in various ways also leads to the conclusion that there is a fatal error in Bell's Theorem. This critical research falls into three categories: 1.) the logical deconstruction of Bell and Bell-Kochen-Specker Theorems, 2.) the construction of local realistic models and simulations of EPR correlations, i.e., theoretical counterexamples, and 3.) empirical counterexamples, of which that from Lee and Thomas is only the most recent. Additionally, there is much similar research which achieves only partial or specialized results, e.g., [4]. There is, however, only fragmented agreement on the logical interrelationships among these results. None of it, in any case, has been seriously refuted, as distinct from challenged, although all of it is oft rejected on the basis of conservative antipathy.

Apparently the first category was initiated by Jaynes.[5] He argued that Bell's fundamental premise, namely that "locality" demands that the coincident correlation for EPR situations factor according to: $P(a,b,\lambda) = P(a|\lambda)P(b|\lambda)P(\lambda)$, is a misconstrual of Bayes' formula, namely: $P(a,b,\lambda) = P(a|b,\lambda)P(b|\lambda)P(\lambda)$.[6] Bayes's formula does not imply instantaneous communication between the two space-like separated detectors as it also

accommodates “common-cause” correlation. This result has been rediscovered independently in various styles of argument at least five times.[7]-[11] Similarly, Barut seems to have been first to find the lacuna in Kochen-Specker type, inequality-free proofs of Bell’s Theorem.[12] The error there consists in failing to discern which spin operators are physically relevant *at the same time*. See also [8].

Model-making turns out to be rather simple so long as no effort is made to simultaneously satisfy Bell’s factorization. Utterly straightforward fully classical models exist for all the standard EPR-B (EPR-Bohm; i.e., polarization entangled) experiments.[13] Numerical, “Monte Carlo,” simulations devoid of ‘quantum structure’ for 2-fold EPR experiments also have violated Bell Inequalities.[14] Finally, and unambiguously, 2-fold EPR correlations have been simulated photoelectron by photoelectron solely on the basis of the definition of classical correlation.[15]

In addition to the Lee and Thomas 4-fold experiment, Evdokimov et al. reported on a 2-fold EPR “simulation.”[16] Again, the terminology employed respects sensibilities at the expense of precision; in fact any classical phenomena that exhibit EPR correlations, empirically contradict Bell’s premise.

Finally, note that rejecting the concept of “quantum nonlocal correlation” has scant effect on the discipline of physics, except to expunge paradoxical jargon. However, the larger issue brought up by EPR, i.e., the search for a deeper theory completing Quantum Mechanics, in accord with these conclusions, can not be considered a quixotic endeavor.

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