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July 31, 1985

Dr. Ram K. Varma
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Re: "Local realism and Bell's inequalities" LE3283

By: Ram K. Varma

Dear Dr. Varma:

The above manuscript was returned to you (at the Trieste address) on 26 June with two referee reports (enclosed in case the earlier communication has not yet reached you). On the basis of these reports, we declined to publish the paper.

Sincerely yours,

Stanley G. Brown

Stanley G. Brown
Editor
Physical Review Letters

Enc.
SGB/jaw

Referee's Report: "Local Realism and Bell's Inequalities"

Author: R. K. Varma

This paper should not be published because it does not accomplish what it claims: the class of hidden variable models analyzed does not satisfy local realism, since the distribution of hidden variables, $\rho(\alpha, \lambda)$ is allowed to depend on the orientation α of the faraway detector.

Allowing the distribution of hidden variables for a particle to depend on which observable is measured for that particle, evades the central difficulty of such exercises, which is to find a set of hidden variables and a distribution of those hidden variables which is <u>independent</u> of the choice of observables to be measured. (Simply requiring the distribution for one particle to be independent of which observable is measured for the other particle is not enough.) By endowing each particle with a distribution of hidden variables that depends on the choice of experiment to be performed at its detector, the author introduces precisely that element of non-locality he claims not to require.

It is not directly pertinent to the above criticism, but the author might be interested to note that Bell's 1964 paper <u>does</u> demonstrate that for a single spin it <u>is</u> possible to concoct a distribution $\rho(\lambda)$ (independent of α) that <u>does</u> reproduce the quantum theoretic correlations for spin-$\frac{1}{2}$, contrary to what is asserted on p. 6 of the current manuscript.

Referee Report:

Manuscript number: LE3283

Author: Ram K. Varma

Title: Local realism and Bell's inequalities

I recommend that this paper be rejected because it does not accomplish what the author claims it does. The claimed purpose is to describe a hidden variables model that is local and that gives the same probability distributions as quantum mechanics in the case of the Bohm Gedanken experiment. However, the model fails to reproduce the correlation function by a factor of 3.

In equation (6), a correlation function E_{QM} is defined as the probability to have parallel spins minus the probability to have opposite spins. The quantum theoretical prediction for E_{QM} is correctly computed as $-\vec{\alpha} \cdot \vec{\beta}$. In equation 11, another correlation function E_{HV} is defined. It is equal to E_{QM} divided by a normalization factor. The value of E_{HV} as predicted by the hidden variables model is also correctly computed and it is also $-\vec{\alpha} \cdot \vec{\beta}$. This would prove that the quantum theoretical and the hidden variable model predictions are equivalent if the normalization factor were 1. However, that factor is not 1. Therefore the goal claimed in the paper has not been reached.

The computation of the normalization factor is obscured by the fact that the author uses a probability distribution for a variable e normalized to 4π instead of 1. The author quotes a value of $4\pi/3$ for the normalization factor but 4π cancels out in the final computation of E_{HV}. Therefore, the actual ratio between the prediction of E_{QM} and E_{HV} for the author's hidden variable model is a factor 1/3. Therefore, the correlation function E_{QM} for the model is 1/3 the value of the quantum theoretical prediction. It is not the same.

The failure of the model to reproduce the quantum theoretical predictions comes as no surprise. In this paper, the author defines a vector e (direction of polarization) and other quantities λ (called hidden variables). In the model, the vector e is actually used like a hidden variable in the sense of the word used by references 1, 2, 4, 6, 7, 8 and 9. One can label the set of λ and e by the single symbol λ and show that the model of this paper is just a case of the models considered by all others. Since these others have shown that local hidden variables model cannot reproduce quantum theoretical

predictions, they also have shown that the model described in this paper cannot reproduce them either. However, the author does not seem to realize this point and his statements may lead to a lot of confusion if his paper is ever published anywhere.

In conclusion, my advice to the author is that he take a good look at the problem at hand before he proceeds to get into publication.