On Bell's Inequality

Jonathan Tooker[1]

[1] *Occupy Academia, Atlanta, Georgia, USA, 30338*

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We show that when spin eigenfunctions are not fully orthogonal, Bell's inequality does allow local hidden variables. In the limit where spin eigenfunctions are Dirac orthonormal we recover a significant extremal case. The new calculation gives a possible accounting for $\alpha_{\text{MCM}} - \alpha_{\text{QED}}$.

As it has been understood, Bell's inequality rules out the new variable proposed in the MCM. No analytic form has been found for the eigenfunctions of the spin operator but they are assumed to be orthonormal. In this short paper we examine the case when spin eigenfunctions are not orthonormal [1]. Derivation of Bell's inequality often starts with a statement of the average value of the product of the spins when the detectors are aligned along spatial unit vectors $\mathbf{a}$ and $\mathbf{b}$ and θ is the angle between them [2].

$$P(\mathbf{a}, \mathbf{b}) = -\mathbf{a} \cdot \mathbf{b} = -\cos(\theta) \tag{1}$$

This is derived by taking the expectation value of the product of two spins in a singlet state. Moving directly to the end of that calculation we find the following.

$$\begin{aligned} P(\mathbf{a}, \mathbf{b}) \; &= \; \frac{\sin(\theta)}{\sqrt{2}} \langle 0\,0 | 1\; -1 \rangle \\ &- \; \cos(\theta) \langle 0\,0 | 0\,0 \rangle + \frac{\sin(\theta)}{\sqrt{2}} \langle 0\,0 | 1\,1 \rangle \end{aligned} \tag{2}$$

When spin states are orthogonal, equation (2) reduces to equation (1). Assume a uniform probability distribution on the hidden variable and let the magnetic quantum number distinguish $\delta_\pm$.

$$P(\mathbf{a}, \mathbf{b}) = \delta_- - \mathbf{a} \cdot \mathbf{b} + \delta_+ \tag{3}$$

To arrive at Bell's inequality each of the terms in equation (3) needs to be integrated [2]. The respective integrals of δ_- and δ_+ should be 2π and $(\Phi\pi)^3$ [1]. Before exploring the case when spin eigenvectors are Yang orthonormal, consider the case when they are Dirac orthonormal. Equation (3) can be integrated to give the following [2].

$$|P(\mathbf{a}, \mathbf{b}) - P(\mathbf{a}, \mathbf{c})| \leq 3 + P(\mathbf{b}, \mathbf{c}) \tag{4}$$

$$\max(LHS) = \min(RHS) \tag{5}$$

Dirac orthonormal spin eigenfunctions are the extremal case in which local hidden variables are always allowed. Now consider the case when $\delta_\pm$ are integrated according to the prescription in reference [1].

$$|P(\mathbf{a}, \mathbf{b}) - P(\mathbf{a}, \mathbf{c})| \leq 2\pi + P(\mathbf{b}, \mathbf{c}) + (\Phi\pi)^3 \tag{6}$$

$$\alpha_{\text{MCM}} - \alpha_{\text{QED}} = P(\mathbf{b}, \mathbf{c}) \tag{7}$$

The two axes $\mathbf{b}$ and $\mathbf{c}$ are not necesarily related to local orientation. It could be the angle of intersection between the worldlines that made this universe come into existence. This description of α_{MCM} both allows and tightly constrains a varying fine structure constant. Small fluctuations in the historical value for α_{QED} may be caused in part by orbital and other wobbles. Such cases are readily optimized against empirical studies of the shocking anomalies in the CMB [3].

[1] J. Tooker, viXra:1312.0168 (2013)

[2] D.J. Griffiths, *Introduction to Quantum Mechanics*, 2 Ed., Ch. 12 (2004)

[3] R.E. Schild and C.H. Gibson, arXiv/astro-ph: 0802.3229 (2008)