Derivation of Eq.(3) in Bell's historical paper fails?

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Abstract

Unfortunately the Bell's correlation formula violates the law of logic: it is not theoretically founded. Here is shown, that it hardly can be ever founded.

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See formula (3) of correlation in the John S. Bell, On the Einstein Podolski Rosen paradox, Physics, 1, 195-200 (1964). See "Bell's theorem" in Wikipedia, there is "free" file.

I argue, that polarizator's non-relativistic spin-operator is

$$S_a = \vec{\sigma}\,\vec{a}\,,$$

where $\vec{a} = (a_x,\, a_y,\, 0) = a(\cos\alpha, \sin\alpha, 0)$ is the axis of polarizator. The $\vec{\sigma}$ are the three Pauli matrices. The polarizator A. The incoming wave function Ψ turns to ψ, where $S_a\,\psi = s_a\psi$, where $s_a = +1,\, -1$ (please check). This wave ψ arrives at B. Then the measurement is s_b in $S_b\,\psi = s_b\psi$. Please check, that $s_b = +1, -1$. The vector ψ is the same in both A and B.

We could write then $S_b\,S_a\,\psi = s_a\,S_b\,\psi = s_a\,s_b\,\psi$. And very soon by averaging we would get the formula (3).

Let us check the assumptions. The axis of A has $\alpha = 0$

$$a\,\sigma_x\,\psi = s_a\,\psi\,.$$

Then $a\,\psi_y = s_a\,\psi_x$ and $a\,\psi_x = s_a\,\psi_y$. When $s_a = 1$, $a = 1$, $\psi_x = \psi_y$ is the solution ψ_1, also solution ψ_2 is $s_a = -1$, $a = 1$, $\psi_x = -\psi_y$.

Let us check the second assumption. The axis of B has $\alpha = \gamma$.

$$b\,(\sigma_x \cos\gamma + \sigma_y \sin\gamma)\,\psi_1 = s_b\,\psi_1$$

We have matrix

$$b\,(0,\, \cos\gamma - i\sin\gamma)$$

$$(\cos\gamma + i\sin\gamma, 0)$$

then $b\,(\cos\gamma - i\sin\gamma)\,\psi_y = s_b\,\psi_x$, where $\psi_x = \psi_y$. The b is complex valued, but $Re(b) > 0$ if $s_b = 1$. Another equation $b\,(\cos\gamma + i\sin\gamma)\,\psi_x = s_b\,\psi_y$. But this says, that by rotating the polarizator we must shrink its size. That is not true, thus, the formula (3) is still not derived.