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Polarization effects in the reactions $p + {}^3He \to \pi^+ + {}^4He$, $\pi^+ + {}^4He \to p + {}^3He$ and quantum character of spin correlations in the final $(p, {}^3He)$ system

The general consequences of T invariance for the direct
and inverse binary reactions $a + b \to c + d$,
$c + d \to a + b$ with spin-1/2 particles a, b
and unpolarized particles c, d are analyzed.
Using the formalism of helicity amplitudes, the theoretical study of polarization
effects in the reaction $p + {}^3He \to \pi^+ + {}^4He$ and in the inverse process
$\pi^+ + {}^4He \to p + {}^3He$ is performed. It is shown
that in the reaction $\pi^+ + {}^4He \to p + {}^3He$ the spins of the final proton and ${}^3He$ nucleus are strongly correlated. A structural
expression through helicity amplitudes, corresponding to arbitrary emission angles, is obtained for the correlation tensor. It is established that in the reaction $\pi^+ + {}^4He \to p + {}^3He$ one of the "classical" incoherence inequalities of the Bell type for
diagonal components of the correlation tensor is necessarily violated and, thus, the spin correlations in the final system $(p, {}^3He)$ have the strongly pronounced quantum character.

Experimental Collaboration

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