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Polarization of Nuclei in Direct Interaction Processes

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The residual nuclei following a direct interaction process are left in a polarized state in general. The observation of an up-down asymmetry in the emission of beta-particles, the polarization of internal conversion electrons, the circular polarization of gamma rays emitted from the residual nucleus depend on the nuclear polarization moments. The experiment of CHASE and IGO [1] is an example of the first type of observation. The theories of the second and third type of measurement have been developed by BECKER and ROSE [2] and by SATCHLER [3] respectively. The angular correlation of an inelastically scattered particle or reaction product with a gamma ray emitted from the residual nucleus also depends on the polarization moments. An example is the $(\rho, \rho' \gamma)$ reaction which has been summarized by LEVINSON and BANERJEE [4].

In a (d, ρ) reaction, the distorted wave direct interaction (DWI) theory predicts the polarization of the residual nucleus $B(\theta)$ may reach 100% whereas the proton polarization cannot exceed $33\frac{1}{3}\%$. However the proton polarization in the $C^{12}(d, \rho)C^{13}$ reaction at MeV at a scattering angle of 70 degrees has been found to exceed $33\frac{1}{3}\%$ [5]. There is also evidence from the $Be^9(d, \rho)Be^{10}$ reaction [3] and the $C^{12}(d, \rho \gamma)C^{13}$ correlation [3] that the DWI theory is inadequate without at least the addition of spin orbit coupling.

A test of the DWI theory can be made by measuring the asymmetry $A(\theta)$ of the scattered deuterons in the $N^{14}(\rho, d)N^{13}$ when polarized protons are incident on N^{14} , and the polarization $B(\theta)$ of N^{13} in the $H^1(N^{14}, N^{13})H^2$ reaction at the same center of mass energy. The DWI theory predicts that $A(\theta)/B(\theta)$ is a constant independent of the scattering angle θ . A source of 10^6 sec. $^{-1}$ 100% polarized protons has been prepared at Berkeley to study the pick-up reaction.

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