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THE DEPOLARIZATION PARAMETER IN p-10B ELASTIC SCATTERING and THE SPIN-SPIN INTERACTION

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THE DEPOLARIZATION PARAMETER IN $\vec{p}$ - ^{10}B ELASTIC SCATTERING AND THE SPIN-SPIN INTERACTION*

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Sherif and Hussein[1] have pointed out that the depolarization parameter D is a sensitive probe of the spin-spin interaction in nucleon-nucleus elastic scattering. Other parameters, such as the cross-section and asymmetry, polarization and spin rotation parameters, are relatively insensitive.

Two types of spin-spin force have been considered. A spherical term:

$$U_{ss}(r) = V_{ss}F_0(r)\underline{\sigma}.\underline{I},$$

and a tensor term:

$$U_{st}(r) = -\tfrac{1}{2}V_{st}F_t(r)\{3(\underline{\sigma}.\hat{\underline{r}})(\underline{I}.\hat{\underline{r}}) - \underline{\sigma}.\underline{I}\},$$

where $\underline{\sigma}$ and $\underline{I}$ are the spins of the incident proton and the target nucleus, respectively, and $\hat{\underline{r}}$ is a unit vector in the direction of a line connecting the centers of the projectile and target. The depth V_{ss} and the form factor $F_0(r)$ of the spherical term can be estimated from the nucleon-nucleon spin-spin interaction and the single nucleon wave function in the target nucleus[2]). The form and strength of the tensor interaction have not yet been estimated, so a phenomenological Woods-Saxon form was taken for $F_t(r)$ and the strength V_{st} of the interaction was treated as a free parameter in the calculated fits to the available sparse depolarization data[3]). It is clear that more measurements of $D(\theta)$ to good accuracy over wider angular ranges are needed in a continuing study of the effects of the target spin in nucleon-nucleus elastic scattering.

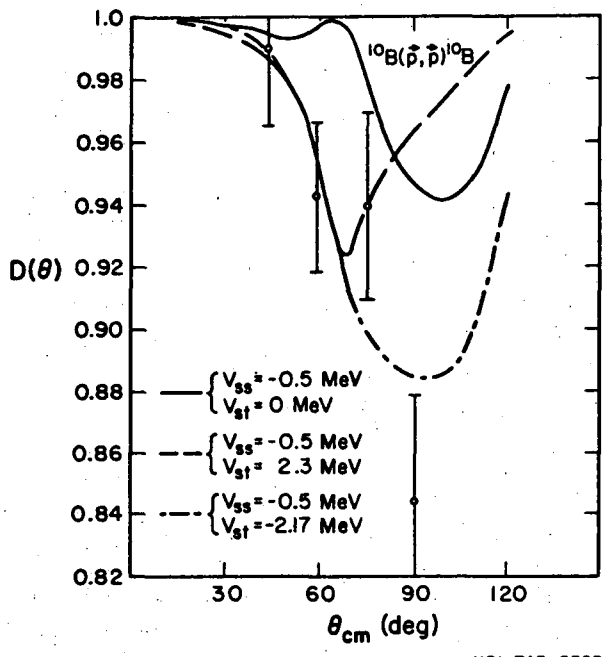
We have measured $D(\theta)$ at several angles in the elastic scattering of 26-MeV polarized protons from ^{10}B. The polarization of the scattered protons is given by

$$p(\theta) = \{A(\theta) + D(\theta)\, p_o\}/\{1 + p_o A(\theta)\},$$

where p_o is the beam polarization and $A(\theta)$ is the target analyzing power. The polarization of the beam was continuously monitored by scattering from a ^{4}He gas target downstream from the ^{10}B. The polarization of the elastically scattered protons was measured by a polarimeter with high figure of merit and good energy resolution[4]). The polarimeter used a 1-mm thick silicon solid state detector as polarization analyzer and two side detectors at $\pm 27^o$ to the polarimeter axis. Protons which passed unscattered through the analyzer detector were stopped in a "zero degree" detector. The zero degree collimation had the same angular width as the analyzer, with respect to the target center, but much reduced angular height. The analyzing power of the target was deduced from the spin up--spin down count ratio in the zero-degree detector.

Geometrical errors in the determination of D were minimized by careful monitoring and adjustment of beam alignment during the runs, by deducing D from spin-up/spin-down ratios in each side detector and by obtaining results with the silicon polarimeter placed on each side of the beam. As a check on these procedures the D-parameter of ^{12}C was measured at a number of angles (D for elastic scattering from a spin zero nucleus should be identically 1.0). Values of D consistent with 1.0 were found in each case.

Results of our D-parameter measurements are shown in fig. 1. The curves are not fits to our data. They are calculations from ref. 1, where the values of V_{st} were chosen to reproduce a data point from Saclay[5]) at 65°c.m. and 19.8 MeV. It was pointed out by Sherif and Hussein that the tensor strengths V_{st} extracted in their fits to the data were rather large. As a result, very recent theoretical effort has disclosed another contribution to deviations from unity of $D(\theta)$, which has been termed the quadrupole spin-flip effect[6]). This effect can be present for nuclei that have ground-state quadrupole deformations, and, as such, $I \geq 1$. Hence, further investigations are required to determine the separate effects from the explicit spin-spin interaction and from the quadrupole deformations.



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