

Lawrence Berkeley National Laboratory

Recent Work

Title

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

Permalink

<https://escholarship.org/uc/item/6ts1c6v2>

Author

Birchall, J.

Publication Date

1975-06-01

0 0 0 0 4 3 0 7 3 9 4

Presented at the 4th International
Symposium on Polarization Phenomena
in Nuclear Reactions, Zürich, Switzerland,
August 25 - 29, 1975

LBL-4054

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

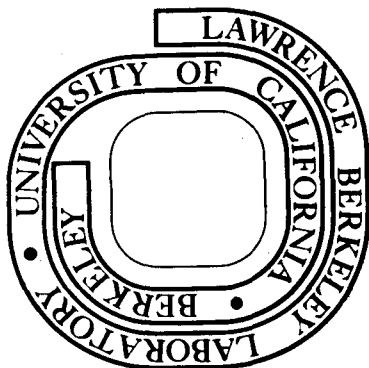
J. Birchall, H. E. Conzett, F. N. Rad,
S. Chintalapudi, and R. M. Larimer

June 1975

Prepared for the U. S. Energy Research and
Development Administration under Contract W-7405-ENG-48

For Reference

Not to be taken from this room



LBL-4054

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

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

J. Birchall⁺, H. E. Conzett, F. N. Rad, S. Chintalapudi⁺,
and R. M. Larimer

Sherif and Hussein¹ 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:

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

and a tensor term:

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

where $\underline{\sigma}$ and \underline{I} are the spins of the incident proton and the target nucleus, respectively, and $\underline{\hat{r}}$ 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 nucleus²). 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 data³). 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.

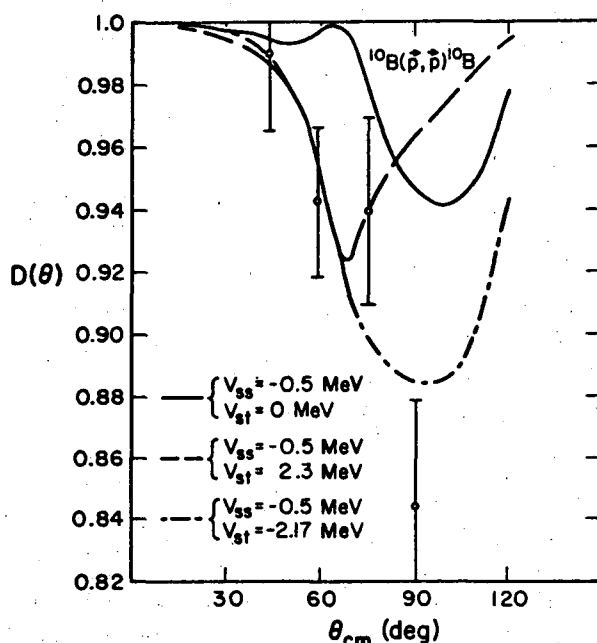
We have measured $D(\theta)$ at several angles in the elastic scattering of 26-MeV polarized protons from ${}^{10}\text{B}$. The polarization of the scattered protons is given by

$$p(\theta) = \{A(\theta) + D(\theta) p_0\} / \{1 + p_0 A(\theta)\},$$

where p_0 is the beam polarization and $A(\theta)$ is the target analyzing power. The polarization of the beam was continuously monitored by scattering from a ${}^4\text{He}$ gas target downstream from the ${}^{10}\text{B}$. The polarization of the elastically scattered protons was measured by a polarimeter with high figure of merit and good energy resolution⁴). The polarimeter used a 1-mm thick silicon solid state detector as polarization analyzer and two side detectors at $\pm 27^\circ$ 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 ${}^{12}\text{C}$ 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 Saclay⁵⁾ 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 effect⁶⁾. This effect can be present for nuclei that have ground-state quadrupole deformations, and, as such, ≥ 1 . Hence, further investigations are required to determine the separate effects from the explicit spin-spin interaction and from the quadrupole deformations.



XBL 743-2523

References

- * Work performed under the auspices of the U.S. Energy Research and Development Administration.
- + University of Basel, Switzerland.
- † Bhabha Atomic Research Centre, Trombay, India.
- 1) H. S. Sherif and A. H. Hussein, Phys. Lett. 41B, (1972) 465; Phys. Rev. C8 (1973) 518.
- 2) G. R. Satchler, Particles and Nuclei 1, (1971) 397.
- 3) J. Birchall et al., Phys. Lett. 53B (1974) 165, and references therein.
- 4) J. Birchall et al., Nucl. Instr. and Meth. 123 (1975) 105.
- 5) R. Beurtey, P. Cattillon and P. Schnabel, J. de Phys. 31, Supp. C2 (1970) 96; P. Schnabel, thesis, University of Paris, 1971 (unpublished).
- 6) J. S. Blair and H. S. Sherif, Bull. Amer. Phys. Soc. 19, (1974) 1010; J. S. Blair, M. P. Baker, and H. S. Sherif, to be published.

LEGAL NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research and Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

TECHNICAL INFORMATION DIVISION
LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720