



HAL
open science

**MEASUREMENTS OF INPLANE POLARIZATION
TRANSFER COEFFICIENT IN $^{24}\text{Mg}(p,p')$
REACTION AT $E_p=65$ MeV**

Y. Sakemi, H. Sakaguchi, M. Nakamura, T. Murakami, M. Yosoi, H. Togawa,
T. Nakano, S. Hirata, M. Iwaki, O. Kamigaito, et al.

► **To cite this version:**

Y. Sakemi, H. Sakaguchi, M. Nakamura, T. Murakami, M. Yosoi, et al.. MEASUREMENTS OF INPLANE POLARIZATION TRANSFER COEFFICIENT IN $^{24}\text{Mg}(p,p')$ REACTION AT $E_p=65$ MeV. Journal de Physique Colloques, 1990, 51 (C6), pp.C6-415-C6-418. 10.1051/jphyscol:1990641 . jpa-00230908

HAL Id: jpa-00230908

<https://hal.science/jpa-00230908v1>

Submitted on 4 Feb 2008

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

MEASUREMENTS OF INPLANE POLARIZATION TRANSFER COEFFICIENT IN $^{24}\text{Mg}(p,p')$
REACTION AT $E_p=65$ MeV

Y. SAKEMI, H. SAKAGUCHI, M. NAKAMURA, T. MURAKAMI, M. YOSOI*,
H. TOGAWA**, T. NAKANO, S. HIRATA, M. IWAKI, O. KAMIGAITO, Y. NAKAI,
H. KANEKO, F. HIEI and S. KOBAYASHI

Department of Physics, Kyoto University, Japan

**Department of Physics, Tokyo Institute of Technology, Japan*

***Research Center for Nuclear Physics, Osaka University, Japan*

Résumé

Nous avons mesuré les paramètres de rotation de spin $K_{xx'}$ pour les diffusions élastiques et inélastiques de protons de 65 MeV par le ^{24}Mg . L'analyse en phénoménologie de Dirac s'avère satisfaisante aussi à cette énergie et en diffusion inélastique. La valeur du moment Q_2 du potentiel de Dirac est différente de celle du potentiel de Schrödinger.

Abstract

Elastic and inelastic spin rotation parameters $K_{xx'}$ of protons scattered from ^{24}Mg were measured for incident energies of 65MeV. Dirac phenomenology has been applied to the elastic and inelastic scattering from ^{24}Mg . It was found that Dirac phenomenology succeeded at lower energy and for the inelastic scattering. The value of Q_2 moment of Dirac potential is different from that of Schrödinger potential.

1 - INTRODUCTION

Dirac phenomenology have succeeded in reproducing the spin rotation parameters in proton-nucleus elastic scattering/1/. Theoretically, a momentum space calculation pointed out that the incorporation of the virtual pair effects in the Dirac approach is the essential reason for the difference between the relativistic and the non relativistic approaches/2/. How is it in the case of inelastic scattering? For inelastic scattering, the validity of a Dirac treatment is less obvious than in elastic scattering. And only a few Dirac calculations have been made for deformed nuclei where multistep processes are important and therefore require proper coupled channel calculations/3/. With this motivation, we have measured spin rotation parameter of ^{24}Mg at 65MeV, and performed the Dirac coupled channel analysis and compared it with the Schroedinger coupled channel analysis.

2 - EXPERIMENTAL METHODS

The experiment was performed at RCNP using 65MeV polarized proton beam. With the use of a superconducting solenoid, the polarization axis of the beam is precessed by 90 deg from the vertical direction to the horizontal direction. The beam polarization are monitored by this polarimeter placed just after the superconducting solenoid. These transverse-horizontally polarized protons were scattered by the ^{24}Mg metal foil of 100mg/cm² thickness. The momenta of scattered particles were analyzed at the first focal plane(FP1) of the polarization spectrograph DUMAS/4/ and tagged by MWPC placed at FP1. The scattered particles are again focused achromatically at the second focal point(FP2) where the polarimeter MUSASHI/5/ are placed. The polarimeter MUSASHI can measure the transverse-horizontal components of the polarization of the scattered particle at the exit of DUMAS, using the large asymmetry of p-¹²C elastic scattering. The second scattering targets consist of 7 carbon sheets. By ray tracing the MWPC data, we obtain the position and angle of the scattering. Only the elastic scattering from the second scattering target was used for the analysis by using the energy signal from the plastic scintillators at the side walls.

3 - ANALYSIS AND RESULTS

Dirac coupled channel analysis and Schrödinger coupled channel analysis were performed for the 0^+ and 2^+ states of ^{24}Mg using the code ECIS79 and ECIS88 of RAYNAL/6/. The Dirac optical model consists of a Lorentz scalar potential and the time-like component of a Lorentz vector potential;

$$\{\alpha \cdot p + \beta(m + U_s) + (U_0 + V_v)\}\Psi = E\Psi \quad (1)$$

The deformed optical potential parameters of each model were searched to fit the differential cross sections and the analyzing powers for the 0^+ and 2^+ states. For the analysis, we adopted a macroscopic collective model, assuming that 0^+ and 2^+ states of ^{24}Mg are the members of ground state rotational band. 0^+ , 2^+ and 4^+ states are coupled in the coupled channel calculations. The deformation parameters were set equal for each parts of the potential.

The fitting results are shown in Fig.1. The χ^2 values of each approach are in the same order. It seems that both approaches can reproduce the experimental data equally well. The spin rotation parameter $K_{x,x'}$ was also calculated with this best fit potential, and we compared Dirac coupled channel analysis(D.C.C) with Schrödinger coupled channel analysis(S.C.C). The results of the calculation by D.C.C and S.C.C are shown with experimental data in Fig.2. The error bars of experimental data are statistical errors only. Both approaches reproduce the experimental data equally well. It seems that Dirac phenomenology succeeds at 65 MeV, and explains also the inelastic scattering.

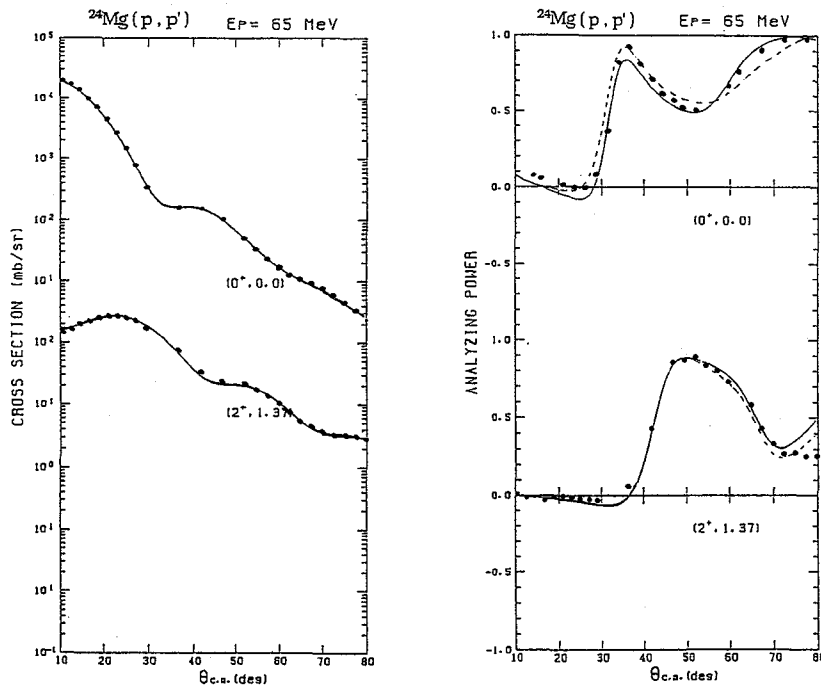


Fig. 1. The left figure shows the cross sections and the right figure shows the analyzing powers. The solid lines represent Dirac coupled channel calculations and the dashed lines represent Schrödinger coupled channel calculations.

4 - DISCUSSION

Dirac real scalar potential has a large negative potential, and Dirac real vector potential has a large positive potential. In Fig.3 we show the shapes of Schrödinger equivalent and Schrödinger potential. The shapes of each potential part are very similar. So, the mean square radius of Schrödinger equivalent potential and Schrödinger potential are similar.

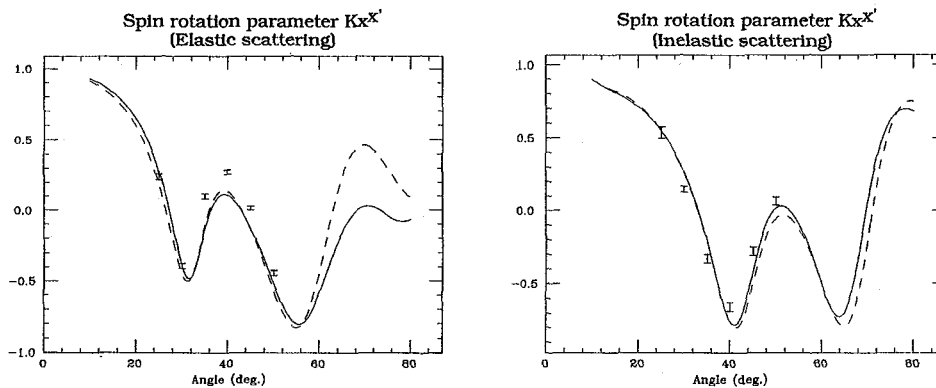


Fig. 2. Spin rotation parameter ($K_x^{x'}$). The left figure is that of elastic scattering and the right is that of inelastic scattering. The solid curves are results of Dirac coupled channel calculations. The dashed curves represent the Schrödinger coupled channel calculations.

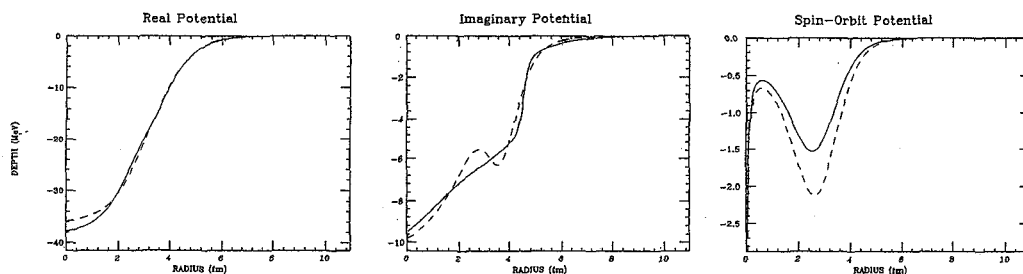


Fig. 3. The shapes of each parts of Schrödinger equivalent and Schrödinger potentials. The solid curves are the Schrödinger equivalent potentials and the dashed curves are the Schrödinger potentials.

The mean square radius of ^{24}Mg and other various nuclei are shown in Fig.4. The value for other nuclei were taken from our elastic scattering data/7/. The mean square radius of Dirac scalar and vector potentials are very similar. The deformed nuclei have a little larger mean square radii than spherical nuclei. We notice that the difference between the mean square radius of Dirac potential and that of charge density becomes larger as the target mass number increases. This means that the Dirac potential also has some kind of density dependence due to Pauli blocking.

Futhermore, Q_2 moment of Dirac potential and Schrödinger potential were compared with that of charge distribution obtained by electron scattering. Q_2 moment of Schrödinger potential is about 10% larger than that of charge densities. A folding model calculation shows that the main part of this difference is attributed to the density dependence of the effective interaction/8/. On the other hand, Q_2 moment of Dirac real potential is a little smaller than that of the charge densities. In order to confirm these results, we have performed the Dirac coupled channel analysis for our old cross section and analyzing power data for 4 typical rare earth nuclei. The result is shown in Fig.4. The same tendency is found in all these rare earth nuclei. Namely, Q_2 moments of Dirac potential of ^{166}Er , ^{168}Er , ^{174}Yb , ^{176}Yb are also a little smaller than those of the charge distributions for these nuclei, and Q_2 moments of Schrödinger potential are larger than those of the charge distributions. If we assume the folding model, this means that the effective interaction in the Dirac formalism has almost no density dependence. But this result is different from the result deduced from the discussion on the mean

square radius. In order to investigate this difference, we are now performing the moment scaling search under the condition that multipole moments for each part of the potential are set to be the same.

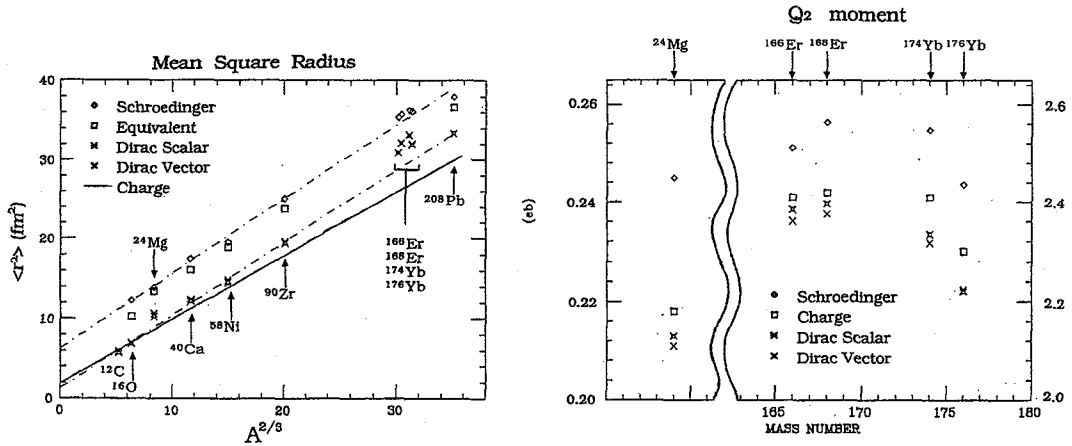


Fig. 4. The left figure shows the mean square radius. The right figure shows Q_2 moment of various nuclei.

5 - SUMMARY

We have measured the spin rotation parameter $K_{\alpha}^{\alpha'}$ in ²⁴Mg (p,p') reaction at 65 MeV. It is found that Dirac coupled channel method can reproduce the experimental data at lower energy and also explain the inelastic scattering. Dirac approach and Schrödinger approach can reproduce the experimental data equally well, but there is a difference between the value of Q_2 moment of Dirac potential and that of Schrödinger potential; Q_2 moment of Dirac potential is a little smaller than that of the charge distribution, and Q_2 moment of Schrödinger potential is larger than that of the charge distribution.

References

- 1) B.C.Clerk et al., Phys. Rev. Lett. 50(1983)1644
- 2) M.V.Hynes et al., Phys. Rev. C31(1985)1438
- 3) R.Deswiniarski et al., Phys. Lett. B213(1988)247;
J.Raynal et al., Phys. Lett. B218(1989)403
- 4) T.Noro et al., J. Phys. Soc. Jpn. Suppl. 55(1986)470
- 5) M.Ieiri et al., Nucl. Instr. and Meth. A257(1987)253
- 6) J.Raynal, Proc. Sixth Intern. Symp. on Polarization phenomena in nuclear physics (Osaka, 1985)
- 7) H.Sakaguchi et al., Phys. Rev. C26(1982)944
- 8) T.Ichihara et al., Phys. Rev. C29(1984)1228