Proc. Sixth Int. Symp. Polar. Phenom. in Nucl. Phys., Osaka, 1985
J. Phys. Soc. Jpn. 55 (1986) Suppl. p. 690-691

1.69 On the T_R-Type Tensor Potential in Deuteron Elastic Scattering at 56 MeV

N. Matsuoka, H. Sakai, T. Saito, K. Hosono, M. Kondo, H. Ito, K. Hatanaka*, T. Ichihara*, A. Okihana**, K. Imai*** and K. Nisimura****

Research Center for Nuclear Physics, Osaka University
Ibaraki, Osaka 567, Japan
* The Institute of Physical and Chemical Research, Wako, Saitama 351, Japan
** Department of Physics, Kyoto University of Education, Kyoto 612, Japan
*** Department of Physics, Kyoto University, Kyoto 606, Japan
**** Institute for Nuclear Study, University of Tokyo, Tanashi, Tokyo 188, Japan

Through the experiments on deuteron elastic scattering with vector and tensor polarized beams and their analyses in terms of an optical model, the T_R-type tensor potential has been investigated[1,2]. This type of tensor potential is correlated with the deuteron D-state, and its strength is predicted by a folding model[3]. Much attention has been concentrated on the point whether the strength of T_R tensor potential obtained from the optical model analysis is consistent with the folding model because the central and spin-orbit potentials are roughly in accordance with the folding model. Up to date, following results on the T_R tensor potential have been obtained from the optical model analyses of the experimental data at 10-13 MeV[1] and 20 MeV[2].

1) The imaginary T_R potential (W_{TR}) is consistent with the folding model[1,2].
2) The real T_R potential (V_{TR}) is smaller than the folding model. Very small values of V_{TR} are obtained in ref. 1) for A = 46 ~ 90 nuclei. In ref. 2), a mass number dependence of V_{TR} is reported: some strength of V_{TR} is needed for lighter nuclei than ^{65}Cu, but for ^{144}Sm and ^{208}Pb the experimental data are explained without V_{TR}.

The reason why the strength of V_{TR} is reduced compared with the folding model and with W_{TR} is not yet understood.

In order to see what strength of T_R tensor potential is needed at higher energy, we have measured the differential cross section σ, vector and tensor analyzing powers, A_y, A_{xx}, A_{yy} and A_{xz}, for elastic scattering of 56 MeV deuterons on several nuclei from ^{12}C to ^{208}Pb. The experiments were carried out at RCNP, Osaka University. The details of the experimental method is described elsewhere[4]. For the measurement of A_{xz}, a horizontally polarized deuteron beam was used.

Optical model analyses were carried out using the codes MAGALI[5] (without T_R potential) and DDTP[6] (with T_R potential). The form factor of the T_R tensor potential used in the DDTP code was of the form

$$V_{TR}(r) = -\lambda_\pi^2 V_{TR}\, r \frac{d}{dr} \{\frac{1}{r}\frac{d}{dr} f(x_{TR})\} ,$$

$$W_{TR}(r) = \lambda_\pi^2 W_{TR}\, r \frac{d}{dr} [\frac{1}{r}\frac{d}{dr} \{4 \frac{d}{dx_{TW}} f(x_{TW})\}],$$

which were suggested by a folding model[3]. Here $f(x_i) = (1+e^{x_i})^{-1}$ and $x_i = (r-r_i A^{1/3})/a_i$. The calculations without the T_R potential did not reproduce the tensor analyzing power A_{xz} and the quantity X_2 over the whole angular region. The quantity X_2 is $(2A_{xx} + A_{yy})/\sqrt{3}$. This quantity, as well as the tensor analyzing power A_{xz}, is derived as an observable which is sensitive to the tensor potential[7]. The inclusion of the T_R tensor potential in the optical model analyses greatly improved the fits to A_{xz} and X_2 data, and this fact clarified the necessity of the tensor potential.

The results of present optical model analyses are summarized as follows.

1) The central and spin-orbit potentials are roughly in accordance with the folding model.

2) The effect of W_{TR} potential is clearly seen on A_{xz} and X_2 data, and the strength of W_{TR} obtained is consistent with the folding model for all nuclei studied.
3) The folding V_{TR} potential overestimates A_{xz} and X_2 data, but V_{TR} potentials with following features are obtained. For lighter nuclei than ^{58}Ni, a V_{TR} potential is needed with a smaller diffuseness but with a comparable depth compared with the folding model. In these nuclei, the effect of V_{TR} potential is seen at forward and backward angles for A_{xz} and X_2. For heavier nuclei than ^{90}Zr, a V_{TR} potential is favoured with a strength of more than one half of the folding model. Fig. 1 shows examples of optical model calculations with a complex T_R potential and with only an imaginary T_R potential for ^{118}Sn and ^{208}Pb. The inclusion of V_{TR} potential improves the fits to A_{xz} and X_2 data: the 'phase' of the calculations to A_{xz} data, and the 'amplitude' to X_2 data are improved at forward angles.

References

1) R.P. Goddard and W. Haeberli, Nucl. Phys. A316 (1979) 116
2) R. Frick et al., Z. Phys. A-Atoms and Nuclei 319 (1984) 133
3) P.W. Keaton,Jr., and D.D. Armstrong, Phys. Rev. C8 (1973) 1692
4) K. Nisimura et al., Nucl. Phys. A432 (1985) 378
5) J. Raynal, Sacley, code MAGALI, unpublished
6) R.P. Goddard, Ph.D. Thesis, Univ. of Wisconsin (1978), unpublished
7) D.J. Hooton and R.C. Johnson, Nucl. Phys. A175 (1971) 583

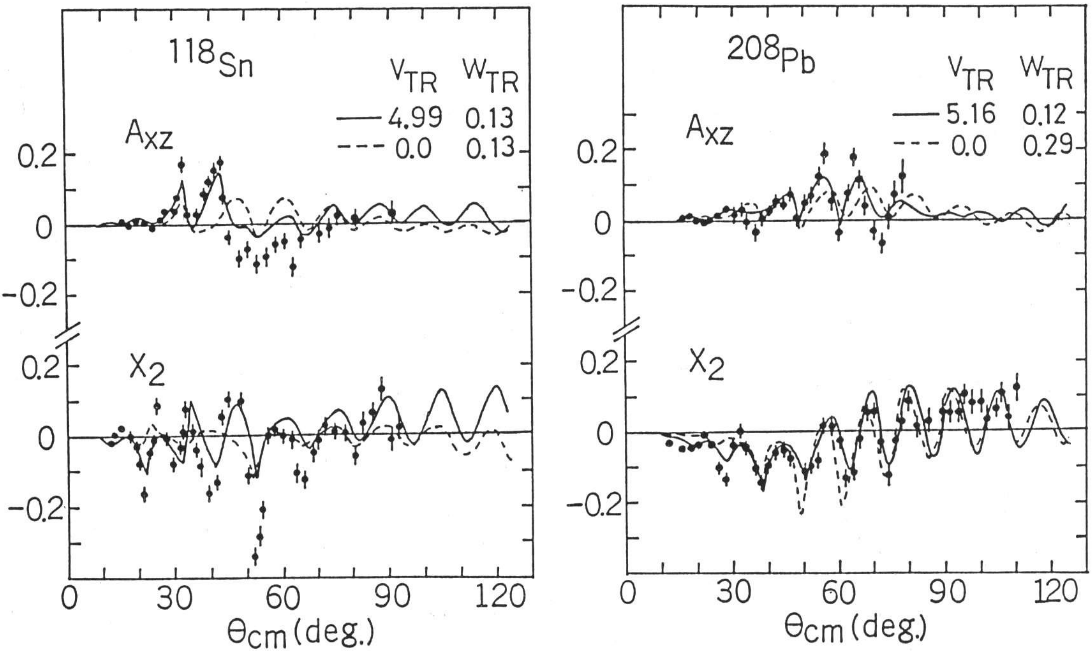

Fig. 1. Tensor analyzing power A_{xz} and the quantity X_2 for elastic scattering of 56 MeV deuterons on ^{118}Sn and ^{208}Pb. The solid and dashed curves are the results of best fit optical model calculations including complex T_R potential and only imaginary T_R potential, respectively.