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3.29 The Proton-deuteron Elastic Scattering at E_d = 56 MeV with PEST Interaction

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In the recent years it turned out that various scattering observables, especially certain polarizations, in nucleon-deuteron scattering require rather refined nucleon-nucleon forces. At present the most elaborate models for the nucleon-nucleon interaction are derived from meson-exchange theory. It is our aim to introduce the properties of such models into calculations of the three-nucleon system. Starting from the meson-theoretical Paris potential[1], the Ernst-Shakin-Thaler (EST) method[2] has recently been used to make a separable representation of the potential which allows us to perform Faddeev three-body calculations with reliable on-shell as well as off-shell properties of the two-nucleon interaction[3].

In a previous paper[4], we reported a three-body calculation with a separable representation of the Paris potential of rank-3 in the $^1S_0$ state (PEST3) and of rank-4 in the $^3S_1$-$^3D_1$ state (PEST4). We have used a phenomenological Doleschall potential for higher partial waves (p waves and d waves other than $^3D_1$ wave). In order to keep the consistency in the three-body calculation, it was highly desired to supplement the p and d waves from the Paris potential.

In the present report, we show a three-body calculation with a rank 1 separable representation of the Paris potential in p and d waves (PEST1). The same interaction PEST3 ($^1S_0$) and PEST4 ($^3S_1$-$^3D_1$) was used as before. A separable potential obtained by the EST method can reproduce the properties of the Paris potential just in the neighbourhood of one fixed, preselected energy. To facilitate the selection we made two PEST1 interactions according to different approximation energies (10 and 50 MeV, respectively). We found that PEST1 with the approximation energy at 10 MeV gave a rather poor result in the three-body calculation even at lower energy. Therefore we used PEST1 interaction in p and d partial waves with the approximation energy of 50 MeV.

In fig. 1, we show the result of the three-body calculation of the proton-deuteron elastic scattering at the deuteron energy of 56 MeV. The first order Coulomb approximation is introduced into the calculation. At such relatively high energies, the Coulomb effect is expected to be small. In fact, the difference between the calculations with and without the first order Coulomb approximation was small. The experimental data are from ref. 5). Reasonable agreement is achieved for each observable. However, some discrepancies are found especially in A_{xz}. These discrepancies might be related to an unsufficient treatment of higher partial waves in the present calculation. Besides our simple approximation in p and d waves, we neglected the tensor coupling in the $^3P_2$-$^3F_2$ wave and contributions of partial waves with $\ell > 3$. More sophisticated three-body calculations without these shortcomings could resolve the situation.

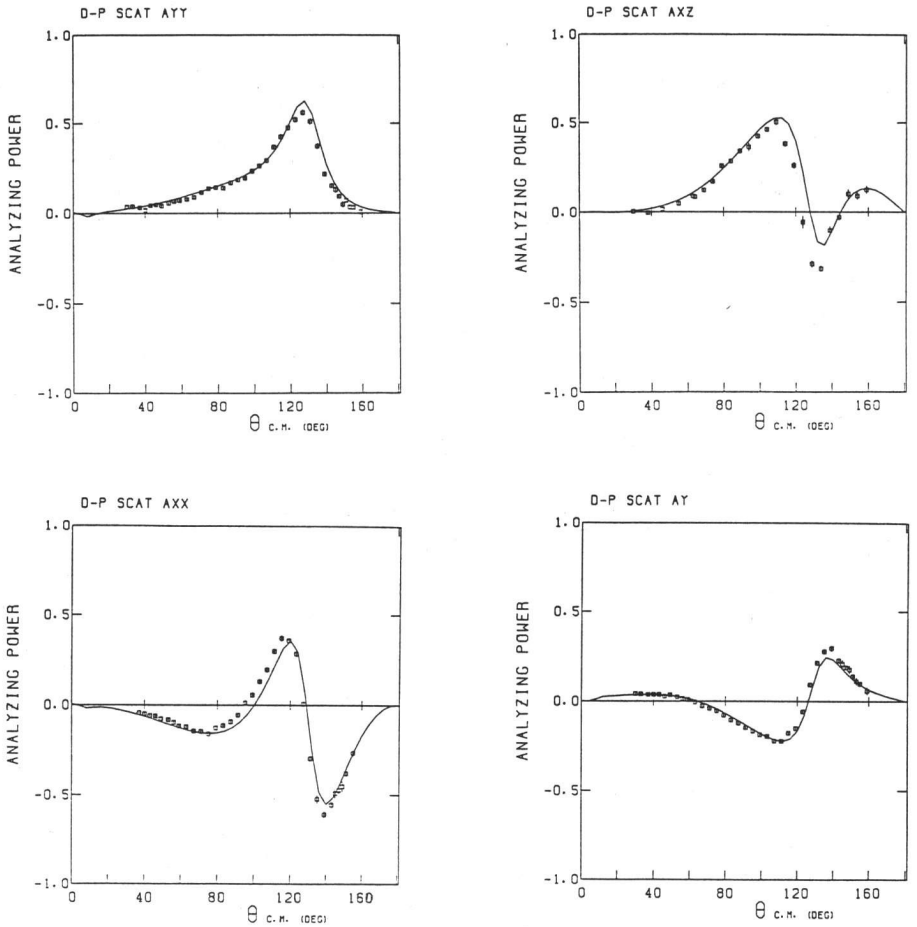

Fig. 1. Polarizations in the deuteron elastic scattering on the proton at 56 MeV. Data are from ref. 5). PEST interaction is used in the calculation.

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