Study of the ^{2}H$(d,p)^3$H Reaction at E_d = 30 - 90keV by the Four-Body Faddeev-Yakubovsky Equation

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In this decade we have investigated the low energy ^{2}H$(d,p)^3$H reaction using the four-body Faddeev-Yakubovsky equation. This is a report for recent calculational results of the total cross section, differential cross section, and analyzing powers, at energies E_d = 30, 50, 70, and 90keV. As the N-N interaction, the PEST [1] potentials are adopted for the two-body states: ^{1}S$_0$ (3), ^{3}S$_1$-^{3}D$_1$ (4), ^{3}P$_0$ (2), ^{1}P$_1$ (2), ^{3}P$_1$ (2), and ^{3}P$_2$ (3). The numbers in the braces are ranks for each states. The [3+1] and [2+2] subamplitudes are expanded separable form by EDPE [2] method. In the [3+1] sub-amplitude, the three-body total spin and parity j^π considered are within the range $1/2^\pm$ to $7/2^\pm$. For the [2+2] sub-amplitude, all possible quantum states, which are automatically driven by two-body states, are taken into account. As for the four-body total spin and parity states J^π these are taken from $0^\pm$ to $4^\pm$ and the convergence is confirmed. As for the Coulomb force, this has not been included in the calculations directly. However, the Coulomb effects are taken into account in calculating the scattering amplitudes by using the phase shift corrections and the damping effects when the charged particles penetrate the Coulomb barrier.

First, the energy dependence of the total cross section is illustrated in Fig.1, and the differential cross sections for the energies in Fig.2. The solid line corresponds to the present result while the dots in Fig.1 and the shaded regions in Fig.2 are the experimental data of Ref. [3] in which the ranges of y axis present the error bar. The agreement of the total cross section between our Coulomb corrected results and experimental data is excellent, but angular distribution is rather unsatisfactory.

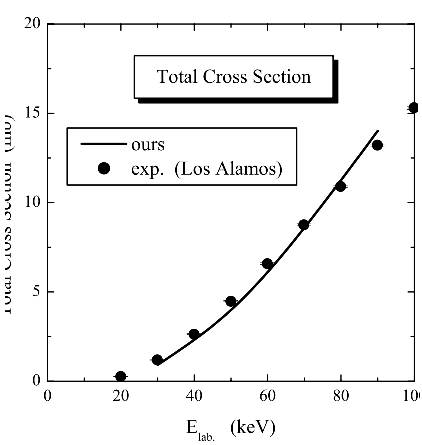

Figure 1: Energy dependence of the total cross section

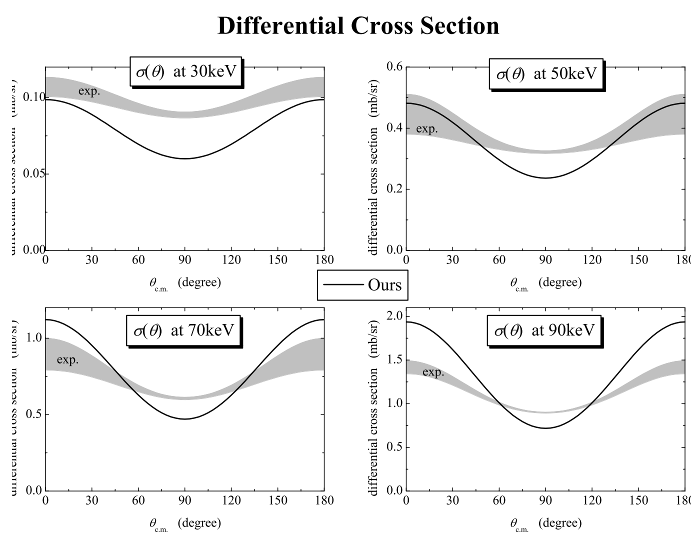

Figure 2: Differential cross section for the energies 30 - 90keV

Next we present, in Fig. 3, the vector and tensor analyzing powers for different energies. The solid lines are our results and black circles are the experimental data by Tukuba group

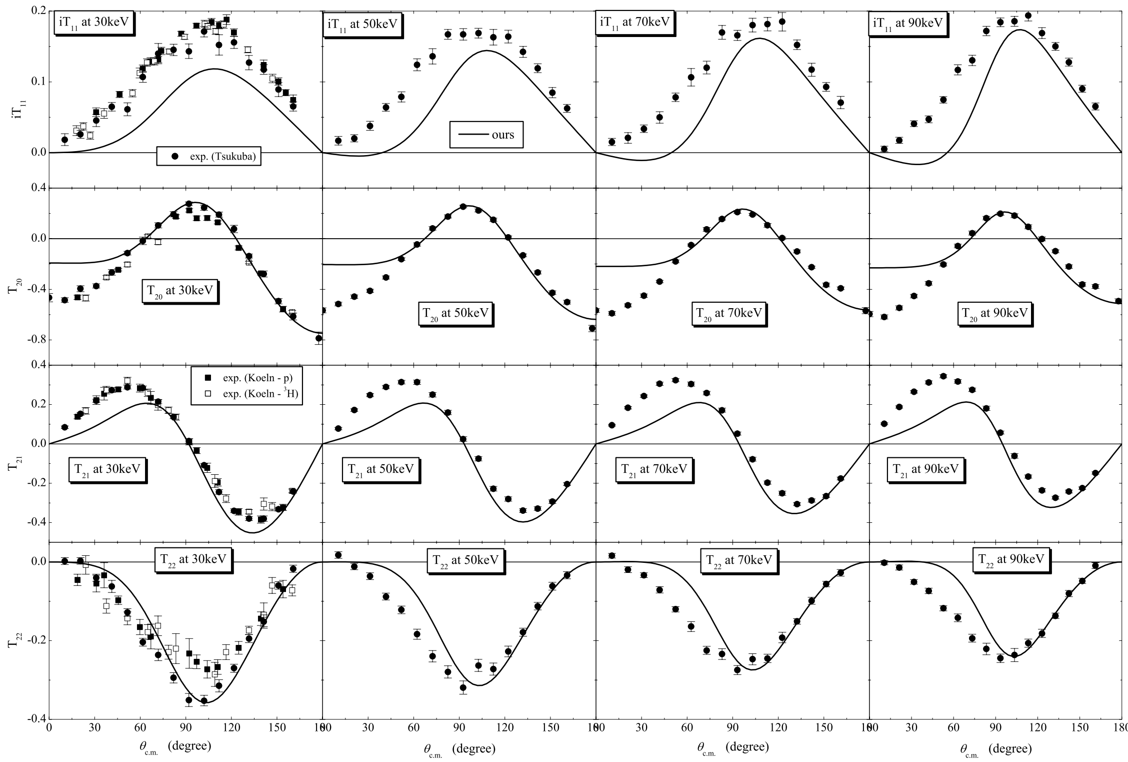

Figure 3: The analyzing power at the energies 30 - 90keV

[4], while the black and white square marks are those of Ref. [5]. In overall, the fit is very good. However, in the forward scattering regions for the tensor analyzing powers, there are discrepancies between our results and experimental data which in certain cases are quite large, but in the backward regions, more than 80°, the data are well fited. On the other hand, the peak value of the enhancement in $i\mathrm{T}_{11}$ at the energy $E_d = 30\,\mathrm{keV}$ is about 30% smaller than the experimental data, however, the discrepancy becomes smaller for higher energies. This can be seen in the $E_d = 90\,\mathrm{keV}$ results.

Our recent analysis by the invariant amplitude method [6] suggests that the differential cross section and tensor analyzing powers will be proved when the central and tensor force in this calculation are improved. Calculation including the ${}^1\mathrm{D}_2$ and ${}^3\mathrm{D}_2$ states and channel coupling of the ${}^3\mathrm{P}_2$-${}^3\mathrm{F}_2$, ${}^3\mathrm{D}_3$-${}^3\mathrm{G}_3$ states in the 2-body subsystem is in progress.

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