Phase-Shift Analyses of p-^{3}He Scattering at $T_L = 4.0 - 200$ MeV

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In 1996, ^{3}He(d,p) ^{4}He reaction experiment was performed at the incident kinetic energy of deuteron 270 MeV at RIKEN[1]. This reaction was theoretically investigated by Oryu *et al.*[2] using a multi-channel Fadeev equation. In their analysis, the n-p-^{3}He system plays an important role. However, the nucleon-^{3}He interaction is not well known in this energy region. It is necessary to carry out a phase-shift analysis(PSA) of nucleon-^{3}He scattering in the several hundreds of MeV region for the incident-proton energy (T_L), and to determine the scattering amplitudes.

Since 1950's, p-^{3}He scattering experiments in the low energy region $T_L \lesssim 20$ MeV and their resulting PSAs have been carried out with interest in nuclei of mass number 4. In their analyses, some assumptions were required because of the poor situation with regard to the experimental data. One of them is an assumption of the energy dependence in scattering amplitudes, which is refered to a energy dependent PSA.

A single energy PSA of experimental data is the method to determine the scattering amplitudes without any assumptions, and has higher quality than an energy dependent PSA. We carried out the single-energy PSA of p-^{3}He scattering at $T_L = 4.0$, 5.5, 6.8, 8.5, 9.5 and 19.5 MeV[3]. Our solutions show good agreement with the experimental data at all energy points of them. In the region $T_L \lesssim 10$ MeV, we carried out the PSA using reflection parameters $\eta_l = 1$, where no in! ! elastic channels are open. At 19.5 MeV, where the experiment al value of the inelastic cross section is $\sigma_r = 44 \pm 12$ mb, we carried out the PSA by taking the ηs as free parameters. The value of σ_r evaluated by our PSA is equal to 48 mb. This procedure made it possible to carry out a PSA of p-^{3}He scattering in the higher energy region.

We carried out the single energy PSA of p-^{3}He scattering at $T_L = 200$ MeV with the database including 151 real data, 10 pseudo data on $d\sigma/d\Omega$ and 1 pseudo datum on σ_r. The obtained solution of phase shifts, reflection parameters and mixing parameters for the lower partial waves than the orbital angular momentum 7 is reported.

A proposal for polarization experiments of p-^{3}He scattering and some comments for studying a few-body problem are given.

References

[1] T. Uesaka et al., Nucl. Instr. and Meth. **A402**, 212(1998).

[2] S. Oryu et al., Nucl. Instr. and Meth. **A402**, 402(1998).

[3] Y. Yoshino et al., Prog. Theor. Phys. **103**, 107(2000).