PION ABSORPTION ON ^{3}He*

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Pion absorption in the π^+ ^{3}He $\rightarrow$ *ppp* reaction is investigated using the Faddeev formalism. As *preliminary* results, the differential cross sections for the two- and three-body absorption mechanics are shown.

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1. Introduction

In recent years it became possible to solve exactly the quantum mechanical three-nucleon ($3N$) problem with realistic two- and three-nucleon forces [1]. Powerful computer facilities allowed that important step forward. Except for a few observables the theoretical predictions perfectly agree with the experimental data. In the $3N$ continuum the strong rescattering among the three particles is thereby very important.

The Faddeev equations have been applied not only to the pure 3N system but also to electron scattering on ^{3}He [2–4]. The Faddeev formalism allowed to calculate any breakup process, exclusive [3] and inclusive [4] scattering. Now, in the same manner applying the Faddeev equations we can investigate the pion absorption phenomena.

Since the three body system itself is already quite complex one might think that the study of this subject should be started first of all restricted to the $2N$ + pion system. But there are good reasons to study the $3N$ + pion system. The deuteron has only the property of isospin 0, whereas ^{3}He or ^{3}H allow for pion absorption on 2 nucleons with isospin $t = 0$ and $t = 1$. The other point of physical interest is, in the case of the ^{3}He(π^+, ppp)

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reaction, the outgoing particles are three protons. This situation can not be realized in a pure 3N scattering system. Since the pion mass is 139 MeV relativity starts to get important. This is also another basic question, what is the influence of relativity? If the pion absorption is in the Δ resonance, it happens in the P_{33} partial wave. Therefore another question is, what are the contributions of the residual partial waves.

2. Formalism and preliminary results

In the first step let us include the most obvious dynamics. We follow the experience gained in the $2N$ system [5, 6]. This is the $\pi - N - \Delta$ vertex function in the P_{33} partial wave. Then the Δ deexcites by emitting a meson, which is reabsorbed by a second nucleon. Consequently the amplitude for that process is

$$A|\Psi_{^3\mathrm{He}}\rangle \equiv t_{NN-N\Delta} G F^+ |\Psi_{^3\mathrm{He}}\rangle\,, \tag{1}$$

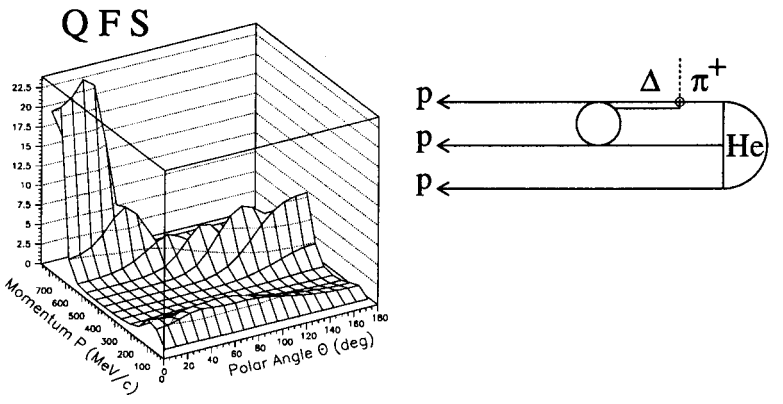
where G, $t_{NN-N\Delta}$, F^+ and $|\Psi_{^3\mathrm{He}}\rangle$ are the $NN\Delta$ propagator, the $NN-N\Delta$ transition matrix, the π^+ absorption vertex function and the ^{3}He ground state, respectively. The ^{3}He ground state is solved by the Faddeev equation.

Next final state interactions (FSI) among the three nucleons are treated via the Faddeev equation

$$T|\Psi_{^3\mathrm{He}}\rangle = tG_0PA|\Psi_{^3\mathrm{He}}\rangle + tG_0PT|\Psi_{^3\mathrm{He}}\rangle \tag{2}$$

where t, G_0 and P are the NN t-matrix, the free $3N$ propagator and the sum of a cyclical and anticyclical permutation of 3 objects, respectively.

Preliminary results given in Fig. 1 display the differential cross sections corresponding to the diagrams. First we notice that the FSI effects (shown



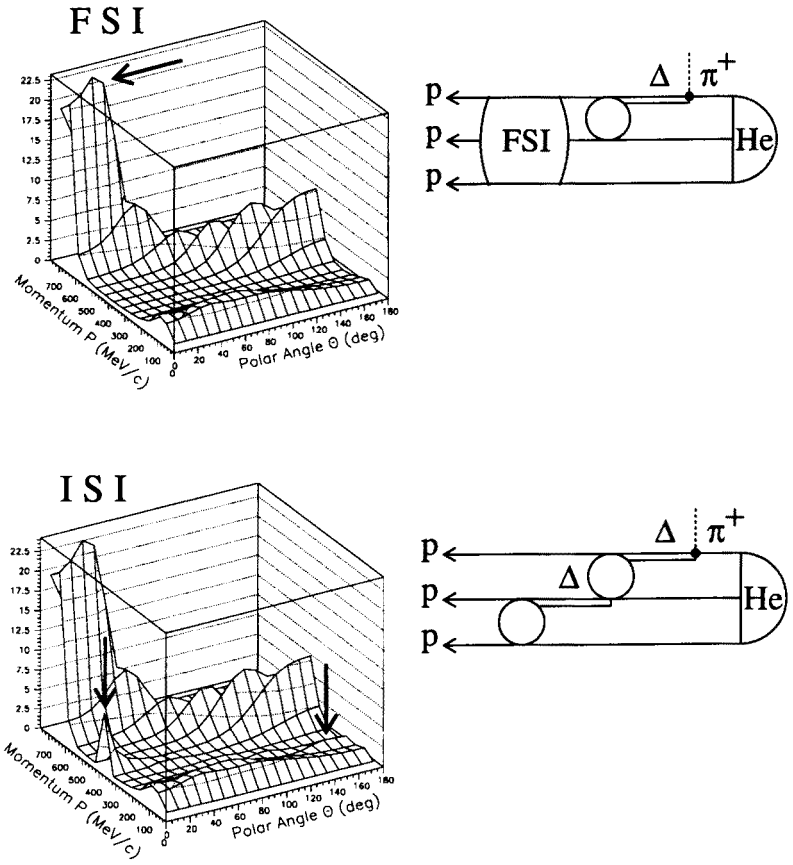


Fig. 1. 3D plots of $d\sigma/dp_1 d\Omega_1$ vs. proton momentum(lab.) and its angle (T_π = 239MeV).

by an arrow) are small in comparison to the process related to the first diagram (QFS). Recently the LADS group [7, 8] has established an enhancement in the region associated with free $\pi - p$ scattering. By kinematical arguments this is considered to be a signature of initial state interactions (ISI) in nuclear pion absorption. We also calculated that and found additional structures indicated in Fig. 1 by vertical arrows. They are well separated from the QFS and FSI contributions.

The calculations were done by SX4 at the CSCS of the ETH in Manno and by CRAY J90 in Zürich.

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