FIZIKA, Suppl. 1 (1969)

B. FEW NUCLEON PROBLEMS

B1 Few Body Problem in Nuclear Interaction Studies

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B2 Some Aspects of Reactions with Three Particles in Final State

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Processes responsible for most of the cross section for reactions

$$b + t \rightarrow 1 + 2 + 3 \tag{1}$$

are found to be

i) the interaction of two of the final state particles, and

ii) a quasi-free process. It is possible to find the kinematic regions where only one of the processes is dominant[1]. This separation is usually possible in kinematically complete experiments.

An investigation[2] of the reaction

$$p + d \rightarrow p + p + n \tag{2}$$

in the kinematic regions where the p-n final state interaction is a dominant process, gave a neutron-proton scattering length of $a_{np} = -23.90 \pm 0.37$ fm. The value of a_{np} determined from neutron-proton scattering experiment was $a_{np} = -23.678 \pm 0.028$ fm.[3] Excellent agreement between these two values promises that a more accurate value of a_{nn} can be obtained from kinematically complete measurements of the $n + d \rightarrow n + n + p$ reaction, now in progress in the Nuclear Reaction Laboratory of our Institute.

Simultaneous measurement of the quasi-free process and final state interaction contributions for reaction (2) (ref.[2]) showed that the quasi-free

process is much stronger. Figure 1 shows the measured differential cross sections over an energy range of 6.5 to 13 MeV for the n—p final state interaction and 9 to 11.5 MeV for the quasi-free process.

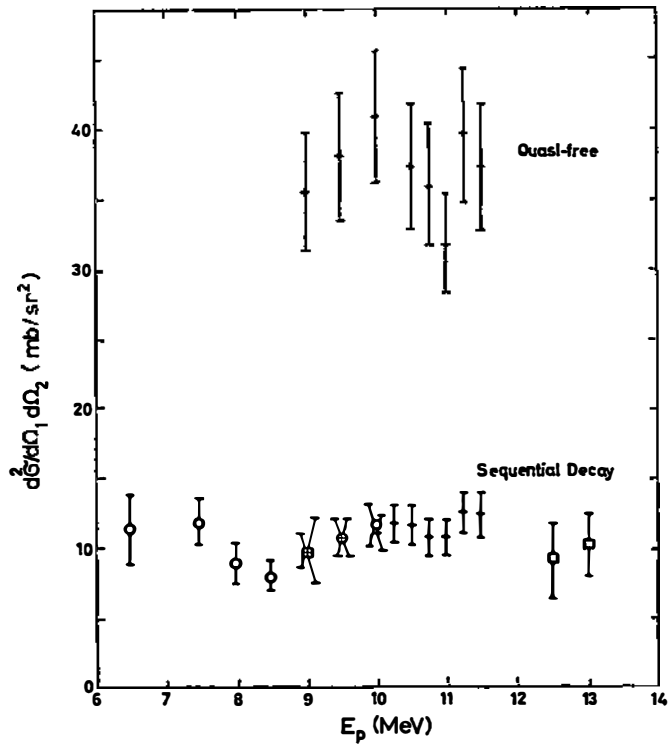

Fig. 1: The cross section for the sequential decay process at $\theta_1 = 30°$, θ_2 = recoil angle of d*, and the quasi-free process at $\theta_1 = 30°$, $\theta_2 = 30°$, as a function of bombarding energy (from ref.[2]).

Recently, a number of reactions with 3 particles in the final state, including a neutron and a proton (particles 1 and 2 in reaction (1)), have exhibited strong final state interaction between the neutron and proton in an $^1S_0$ configuration. The n-p system at low relative energy has some time-delay in decaying, giving rise to a broad peak in the "three-body" cross section. Such a system behaves like a short-lived particle which will be labelled d*. This offers an opportunity to study the (p, d*) (ref.[4]) and (n, d*) reactions. One of more interesting results obtainable from such reactions is information about particle cluster states, which consist of d* and the third emitted particle (particle 3 in reaction (1)). Whereas a cluster consisting of a regular ground state deuteron and particle 3 is capable of forming states of isospin T, the (d*—3) cluster can form states of isospin $1 \pm T$. As an example Fig. 2 shows the results of measurement of

the excitation function for the d(p, d*) p reaction[5] which indicates the existence of an excited state in ^{3}He at an excitation energy of 12.4 MeV and a width of 1 MeV, having the structure of d* + p and possibly at least an admixture of isospin $T = 3/2$.

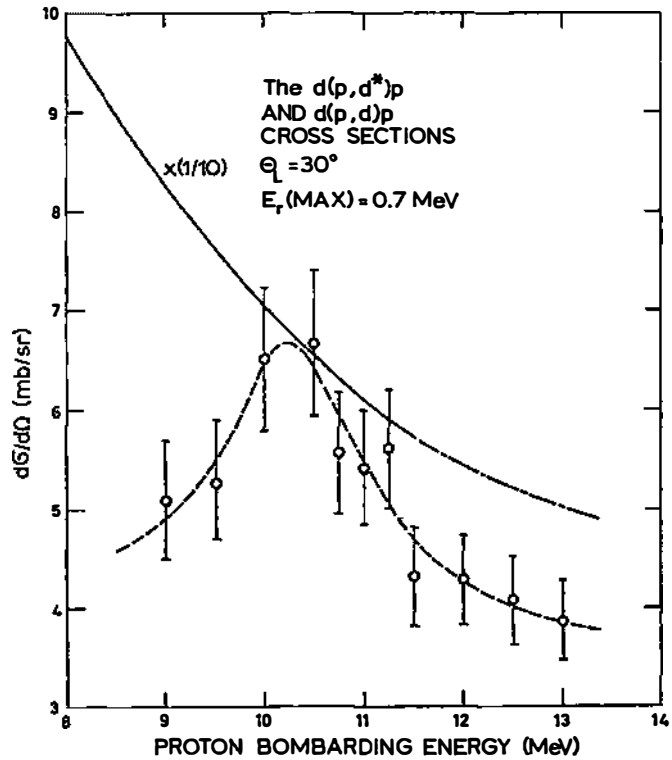

Fig. 2. The d(p, d) p and d(p, d*) p cross sections as a function of the proton bombarding energy. In the (p, d*) cross section n-p relative energies up to 0.7 MeV are included (from ref.[5]).

References

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