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NOTE

Inclusive Proton Energy Spectra from the Deuteron Induced Reaction on Carbon at Ed=9.0 MeV

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A large amount of effort has been devoted to the study of stripping reactions leading to unbound states. Concerning (d, p) reactions the analysis has been advanced comparing the result with the free neutron scattering data. While the total cross section of neutron scattering gives the on-shell amplitude, a (d, p) spectrum in the unbound region can be interpreted as given extending the amplitude into the off-the-energy-shell domain. So line shapes of underlying continuum and peaking resonant scattering, displaying an interference pattern between them, are expected to be observed in a way common to both the (d, p) spectrum and the total neutron cross section. It has been shown that the off shell effect appears as a strong l-dependence of the ratio of the stripping cross section to the total cross section.[1] So the (d, p) study has been giving an useful method to obtain not only the insight to the reaction mechanism but also spectroscopic information.

Experiments have been concentrated on the reactions on light nuclei which have rather large level spacing. In ^{12}C(d, p) ^{13}C case, at Ed=14.5 MeV Hosono *et al.*[2] and at Ed =15.0 MeV Darden *et al.*[3] have measured cross sections leading up to eleventh excited state. They have been emphasized that in order to explain almost unbound states, it should be esential to take account of two step processes accompanying the core excitation, but for the eighth excited state $\left(\frac{3^+}{2};\ 8.2\,\mathrm{MeV}\right)$ which is taken to be described as a single particle state in good approximation. On the other hand, at Ed=9.0 MeV, Takai *et al.*[4] have reported cross sections only up to seventh excited state $\left(\frac{3^+}{2};\ 7.68\,\mathrm{MeV}\right)$ so it is meaningful to extend the cross section measurement to the eighth state at this deuteron energy so as to reinforce the theoretical analysis, though practically it is rather difficult because the emitted protons can only gain very low energies. The experimental procedure and the result are descrived in this note.

The experiment was performed at Tandem van de Graaff laboratory of Kyoto

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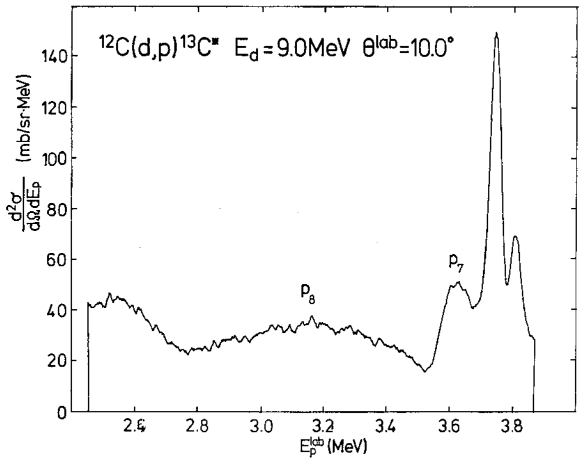

Fig. 1. A typical energy spectrum obtained. In the figure p_7 and p_8 point to peaks leading to the seventh and the eighth excitation states respectively.

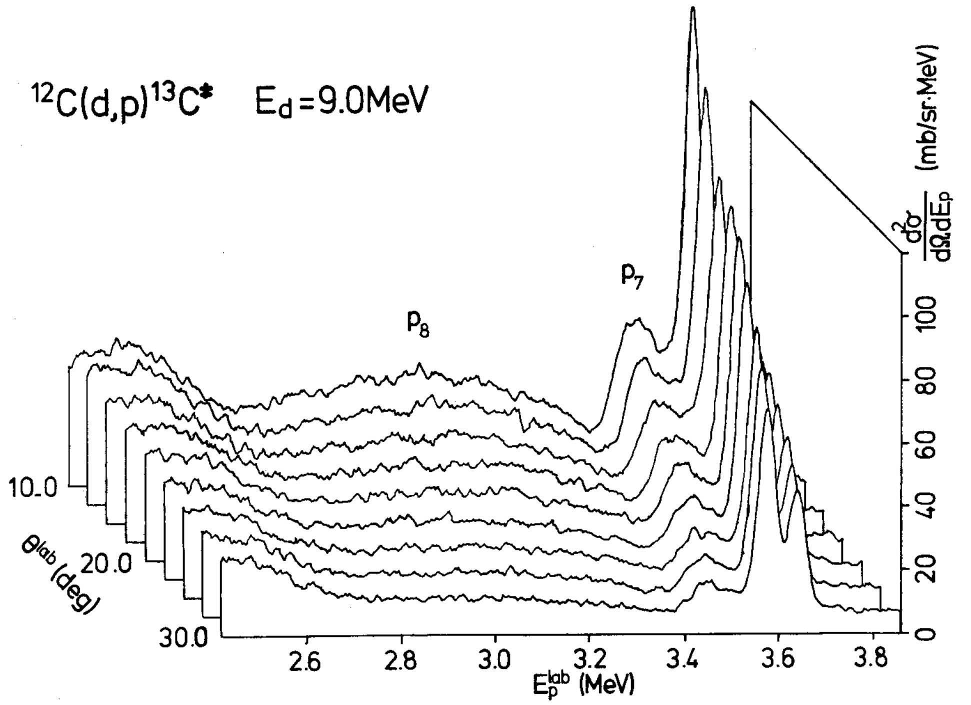

Fig. 2. Energy spectra obtained at angles from 10.0° to 30.0° are plotted together where p_7 and p_8 denote the same meaning as in Fig. 1.

University. A deuteron beam of 9.0 MeV bomberded a natural carbon foil and emitted protons were analysed energetically by the Particle Analyser (PA) magnet and then detected by a position sensitive detector located on the focal plane of PA. The position sensitive detector consisted of two parts; one a resistive wire gas counter which produced a pair of signals deciding a hit position by a charge division method, the other a usual single wire gas counter which was used to measure the energy loss of the hit. Coincidence technique among the signals of the detector satisfactorily removed background noises even in the forward angle region. All the signals were converted into a digital form and deduced into the position data by a minicomputer.

The energy of observed protons has ranged 2 to 4 MeV corresponding to 7 to 9 MeV of the excitation energy of ^{13}C. Proton energy spectra have been measured at the scattering angles from 10° to 30° with 2.5° step. A typical energy spectrum obtained is illustrated in Fig. 1 and its angular distribution in Fig. 2. There we can see a broad peak corresponding to the eighth excitation state (denoted as p_8 in the figures) growing up toward the forward angle. The line shape of the peak of the seventh (p_7 in the figures) exhibits a so-called "shark-fin" type resonance pattern interfering with p_8 in the forward angles and it becomes symmetric as the eithth peak lowers. Using the phase shift data of $^{12}C(n, n)$ scattering, the pattern of the line shape has been reproduced qualitatively[5] and recently, Tanifuji *et al.*[6] have succeeded in reproducing these line shapes quantitatively by a CCBA calculation.

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