of experiments designed to measure the properties of levels in Ne^{20} have been undertaken at Chalk River.[9] In particular the 4.97-Mev level has been found to have $J\pi=2-$.[10] The astrophysical significance of this and a recent measurement of $J\pi=3-$ for the 5.63-Mev level[11] has been discussed.[12] Sufficient information on levels in Ne^{20} now exists to reveal the existence of several rotational bands.[13]

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Capture of 14.4-Mev Neutrons by Protons and Deuterons

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A counter telescope in connection with a two-dimensional analyzer has been applied to determine the ratio of the 14.4-Mev neutron capture and elastic scattering cross sections. The cross section for the capture by protons was determined to be 31.6 ± 3.1 μb. This value is in reasonable agreement with the theoretically predicted value. The cross section for the capture of neutrons by deuterons was found to be 29.4 ± 5.8 μb.

THE photodisintegration of deuterons and tritons and their inverse processes are among the simplest nuclear reactions and the study of these reactions can give informations about the deuteron and triton wave functions, the final continuum states, and the interaction mechanism.

It has been shown by De Swart and Marshak[1,2] that a successful fit to the experimental data on photodisintegration of deuterons in the medium energy region can be obtained if one uses for the deuteron the Gartenhaus wave function (6.7% D-state probability) and for the final-state interaction the Signell-Marshak potential.[3] Around 10 Mev the $E1$ transition is dominant, $M1$ contributing only $\sim 2\%$ and $E2\sim 0.15\%$. In this energy region accurate measurements of the total cross section and of the anisotropy are desirable for better understanding of the magnetic transitions. Hsieh[4] pointed out that the measurement of the total cross section around 10 Mev can provide additional information about the sign of the tensor potential in the triplet odd states.

For the capture of neutrons by deuterons, Burhop and Massey[5] in 1947 calculated the cross section using the wave functions constructed by a resonating-group structure method. Their cross section depends sensitively upon the type of nuclear forces; at 11.47 Mev it amounts to 45.8 μb for ordinary forces, and to 30.7 μb for exchange forces.

Accurate measurements of the fast neutron capture cross sections by light nuclei have been made possible through the development of counter telescopes.[6–8] This method permits precise determination of the ratio of capture and elastic scattering cross sections, as in either process charged particles are detected at the same counter and target setting. Although the fast neutron capture cross sections are very small, due to kinematics all particles formed by capture are emitted within a forward cone of a small aperture and have a narrow energy distribution. The counter telescope[8] in connection with a two-dimensional 100-channel analyzer[9] allowed a good discrimination between protons, deuterons, and tritons above 3 Mev. As the capture cross section can be related to the photodisintegration cross section by assuming the validity of the principle of detailed balance, measurements of the capture of fast neutrons by protons and deuterons seemed to be of some interest.

14.4-Mev neutrons were supplied by a 200-kev Cockcroft-Walton accelerator.[10] The targets were a 1×1 cm, 6.1 mg cm^{-2} polyethylene foil and a 1×1 cm, 8.4 mg cm^{-2} heavy paraffin mold, respectively, each

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mounted on a gold backing. The background was measured with a blank gold foil of the same size. The counting efficiency of the arrangement was 66% for deuterons and 48% for tritons. This was calculated by taking into account final size of the neutron source, target, and detector and the inherent angular distribution due to the emission of γ rays.

In the $H(n,\gamma)D$ experiment the spectra of particle energy losses in the dE/dx proportional counter were simultaneously displayed on the two-dimensional analyzer for four energy groups each 0.52-Mev wide. The spectra of three major energy groups are shown in Fig. 1(a), (b), and (c). The energy spectrum of deuterons is shown in Fig. 1(d).

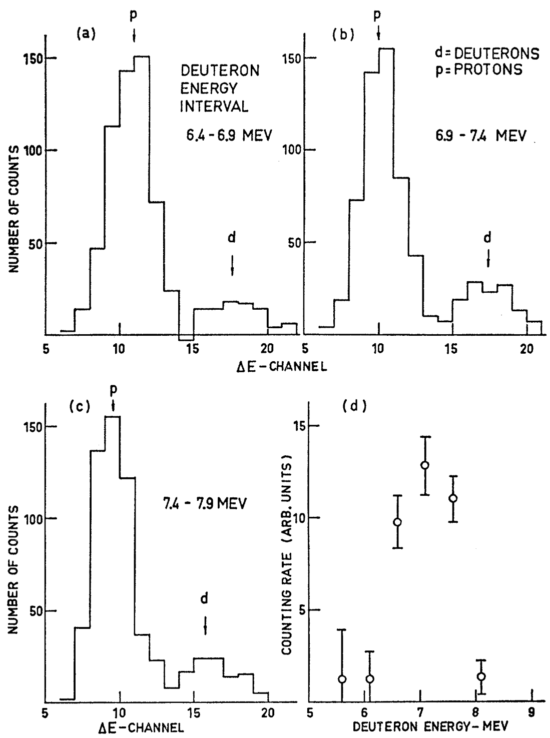

FIG. 1. (a)–(c) The spectra of proton and deuteron energy losses, ΔE, in the dE/dx counter for three energy intervals. (d) The energy spectrum of deuterons. The errors shown are statistical.

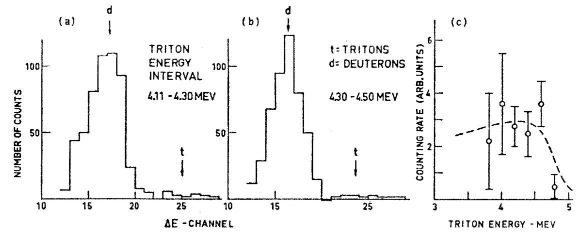

FIG. 2. (a), (b) The spectra of deuteron and triton energy losses, ΔE, in the dE/dx counter for two energy intervals. (c) The energy spectrum of tritons. The dashed curve is calculated taking into account the effective thickness of the thick target laminas, the inherent energy distribution due to the γ-ray emission and the resolution of the scintillation counter. The errors are statistical.

Assuming a total cross section for n-p scattering of[11] 689 mb with 7% anisotropy,[12] the total cross section for capture of (14.4 ± 0.2) Mev neutrons by protons was found to be

$$\sigma_{\text{capture}} = (31.6\pm3.1)\ \mu\text{b}.$$

The error is mainly due to statistics. The cross section is in reasonable agreement with the value of 28.9 μb derived from the paper by De Swart and Marshak.[1]

In the $D(n,\gamma)T$ experiment each energy group of the two-dimensional analyzer was 0.24-Mev wide and the heavy paraffin target was infinitely thick for tritons. Two typical dE/dx spectra are shown in Fig. 2(a), (b), and the energy spectrum of tritons is shown in Fig. 2(c). Following the same comparison procedure as in $H(n,\gamma)D$ experiment, the total cross section for capture of (14.4 ± 0.2)-Mev neutrons by deuterons was found to be

$$\sigma_{\text{capture}} = (29.4\pm5.8)\ \mu\text{b}.$$

Again the error is mainly due to statistics.

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