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SEARCH FOR $T = \frac{1}{2}$ STATES IN ^{3}He BY ELASTIC SCATTERING OF PROTONS ON DEUTERIUM

D. DARONIAN †, J. C. FAIVRE, D. GARRETA, J. GOUDERGUES, J. JUNGERMAN ††, H. KRUG †††, B. MAYER, A. PAGES †, A. PAPINEAU and J. TESTONI ‡

Service de Physique Nucléaire à Moyenne Energie, Centre d'Études Nucléaires de Saclay

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Abstract: We have investigated previously found $T = \frac{1}{2}$ levels in ^{3}He by elastic scattering of protons on deuterium. Between 6.7 to 7.5 MeV and 10.3 to 11.3 MeV, no evidence of variation of the angular distribution is found.

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NUCLEAR REACTION ^{2}H(p, p), E = 6.7–7.5, 10.3–11.3 MeV; measured $\sigma(E, \theta)$. ^{3}He deduced no $T = \frac{1}{2}$ levels at $\approx$ 10.2, $\approx$ 12.6 MeV. Enriched target.

Evidence has been obtained [1]) for excited states in ^{3}He by inelastic scattering of 30.2 MeV protons from a ^{3}He target. The isospin ($T = \frac{1}{2}$ or $\frac{3}{2}$) was not determined.

A search for these states has been made using different reactions; in the reaction ^{6}Li(p, ^{4}He)^{3}He, evidence of these states has been found [2]).

On the other hand, these levels have not been found by inelastic scattering of 200 MeV electrons [3]), inelastic scattering of 42 MeV α-particles [4]), and inelastic scattering of 25 MeV protons [5]).

The tandem Van de Graaff at Saclay has been used to investigate the angular distribution of protons scattered by deuterium in the vicinity of two possible $T = \frac{1}{2}$ resonances in the ^{3}He system (E_x = 10.2 MeV and 12.6 MeV).

The experimental equipment was identical to that used in an experiment involving elastic scattering of polarized deuterons on protons [6]). The target was a deposit of deuterated paraffin (80 μg/cm^2) on a carbon foil (30 μg/cm^2). The scattered proton and the recoil deuteron were detected in fast coincidence (several ns) with surface barrier detectors. The kinematics of the d(p, p)d reaction permitted complete angular distribution measurements from 55° c.m. to 155° c.m. in three measurements at each energy; the deuteron detector covered the angular region 10°–65° lab, and the proton detector occupied successively three positions, 33° to 60° lab, 60° to 87° lab and 87° to 141° lab.

† SPNBE, CEN/Saclay.
†† University of California, Davis.
††† University of Bonn, Federal Republic of Germany.
‡ IAEA Fellow. On leave from CNEA, Laboratorio del Sincrociclotron, Buenos Aires, Argentina.

In order to avoid possible confusion with other reactions (elastic and inelastic scattering of protons on carbon, deuteron break-up, etc. . .), the pulse amplitudes from the proton and deuteron detectors as well as the coincidence time were registered on a 16-channel magnetic tape after analog to digital conversion.

In the analysis, the elastic scattered protons were separated from other events (break-up etc.) by accepting only those in coincidence with the recoil deuterons and requiring also that the sum of the energies of the proton and deuteron be equal to the incident proton energy.

For a given incident beam energy, the energy of the scattered proton corresponds to a well-determined c.m. angle. Therefore the function $dN/dE = f(E)$ can be easily transformed to

$$\frac{d\sigma}{d\Omega} = f(\theta_{c.m.}).$$

Two regions were examined in steps of 100 keV, one from 10.3 to 11.3 MeV and the other from 6.7 to 7.5 MeV.

The equipment required a considerable reduction in beam level (< 1 nA) in order to avoid an excessive counting rate in each of the detectors.

Despite the use of two monitors, one of which counted protons elastically scattered from a gold target and the second a Faraday cup, it is not possible to give a precise absolute cross section.

However, after normalization of all angular distributions to one point (105° c.m.) and taking into account the variation of the angular distribution with energy and statistical errors, the experiment showed that at all angles from 55° to 155° c.m., there is less than $\pm 12\,\%$ perturbation in the relative cross sections from 10.3 to 11.3 MeV and less than $\pm 6\,\%$ from 6.7 to 7.5 MeV from 90° to 155° c.m.

A similar investigation has been performed at Zürich [7]). It shows that at several given angles there is no detectable variation in the absolute cross section in the region of energies discussed here.

The complementary measurements seem to indicate that the states found at 10.2 and 12.6 MeV in ref. [1]), if they exist, are probably not of isospin $T = \frac{1}{2}$.

We would like to thank Dr. E. Cotton who placed the Tandem Van de Graaff at our disposal for this experiment, as well as the operators of the machine and in particular the personnel of the electronics laboratory of SPNBE since without their help this experiment could not have been performed.

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