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SEARCH FOR CORE-EXCITED STATES IN N^{15}

Berkeley, California

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SEARCH FOR CORE-EXCITED STATES IN N^{15}

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ABSTRACT

Differential cross-sections for the scattering of 40.2-MeV alpha particles by N^{15} and O^{16} have been measured. The elastic cross section for N^{15} contains a deep minimum at about 88 degrees in the center of mass system, analogous to that previously reported for the scattering of 41-MeV alpha particles by O^{16}. Alpha groups which correspond to excitation of levels in N^{15} at 5.276, 6.328, 7.16, 7.31, and 7.57 MeV (as well as others) have been observed, and their angular distributions determined. Preliminary analysis of the data indicates that the levels at 5.276 and 7.57 MeV are formed by the coupling of the odd $p_{1/2}$ nucleon to a core excitation whose description is similar to that which gives rise to the 6.13-MeV level (3-) in O^{16}. Analogously, the 7.31-MeV level in N^{15} appears to be formed by the coupling of the $p_{1/2}$ nucleon to a core excitation whose description is similar to that which gives rise to the 7.12-MeV level (1-) in O^{16}.

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The interpretation of the level structures of odd-A nuclei in terms of the weak coupling of the odd nucleon to collective excitations of the even-even core has been the subject of a number of theoretical and experimental investigations. In order to test the ability of this model to interpret some of the levels in light nuclei, we have studied the scattering of 40.2-MeV alpha particles by N^{15} and O^{16}. N^{15} was chosen because 1) it might be considered as having one hole in a doubly closed shell, 2) it has a ground state spin of 1/2, and 3) with the exception of the two levels at 5.276 and 5.304 MeV, the energy spacings of the first few levels are comparable or greater than the energy resolution obtainable with our gas target system. In addition, previous investigators have suggested that the 6.13-MeV (3-) level in O^{16} can be described in collective terms. Hence, if the core excitation model is valid for N^{15}, one would expect to observe two states with spins and parities 5/2+ and 7/2+ whose "center of gravity" lies at an energy of about 6.13 MeV. The two levels in N^{15} at 5.276 MeV (5/2+) and 7.57 MeV (7/2+ probable) appeared as likely candidates.

Gaseous targets of nitrogen enriched to 99.7 per cent in N^{15} and natural oxygen, contained in a 7.6 cm diameter cell at a pressure of about 10 cm Hg, were bombarded with 40.2 MeV alpha particles from the Berkeley 224-cm variable energy cyclotron. A lithium-drifted silicon detector was used to measure angular distributions of the scattered

particles out to center of mass angles of about 105° and 70° for N^{15} and O^{16}, respectively. The overall resolution, including the angular resolution of the gas target system, varied from about 100 to 250 keV.

The angular distributions for excitation of the levels in N^{15} at energies of 5.276 (5/2+), 7.31 (3/2+), and 7.57 (7/2+) MeV are shown in Fig. 1. For comparison, the distributions for excitation of the levels in O^{16} at energies of 6.13 (3-) and 7.12 (1-) MeV are also shown. The deep minimum in the elastic distribution for N^{15} is similar to that reported by Yavin and Farwell [1] for the scattering of 41-MeV alpha particles by O^{16}. The angular distributions for excitation of the 5.276-MeV (5/2+) and 7.57-MeV (7/2+) levels in N^{15} are in phase with the elastic group, as well as that which leads to excitation of the 3- level in O^{16} at an energy of 6.13 MeV. Except for an as yet unexplained systematic error,‡ the sum of the differential cross sections for excitation of these two states in N^{15} is equal to that for excitation of the 6.13-MeV level in O^{16}. These results are indicative that the 5.276- and 7.57-MeV levels in N^{15} arise from the coupling of the odd $p_{1/2}$ nucleon to a core excitation whose description is similar to that which gives rise to the 6.13-MeV level in O^{16}.

It is interesting to note that the angular distribution for excitation of the 7.31-MeV level (3/2+) in N^{15} is similar to that for excitation of the 7.12-MeV (1-) level in O^{16}. In addition, the differential cross section (after being increased by 20 per cent‡) is about two-thirds that for exciting the 7.12-MeV level in O^{16}. Hence, it is tempting to consider the 7.31-MeV level in N^{15} as one member of a doublet which arises from the coupling of the odd $p_{1/2}$ nucleon to a 1- core excitation.

A more detailed discussion of these results will be presented elsewhere.

NOTES AND REFERENCES

† On leave from Laboratoire Joliot-Curie, ORSAY, FRANCE.

‡ Our measured N^{15} elastic cross section was about 20 per cent lower than that for O^{16}.

[1] A. I. Yavin and G. W. Farwell, Nucl. Phys. 12, 1 (1959).

FIGURE CAPTION

Fig. 1. Angular distributions for scattering of 40.2-MeV alpha particles which lead to excitation of levels in N^{15} at energies of 5.27 (5/2+), 7.31 (3/2+) and 7.57 (7/2+) MeV, and in O^{16} at energies of 6.13 (3-) and 7.12 (1-) MeV. The absolute cross sections for the N^{15} data are probably 20 per cent too low. (See footnote to text.)

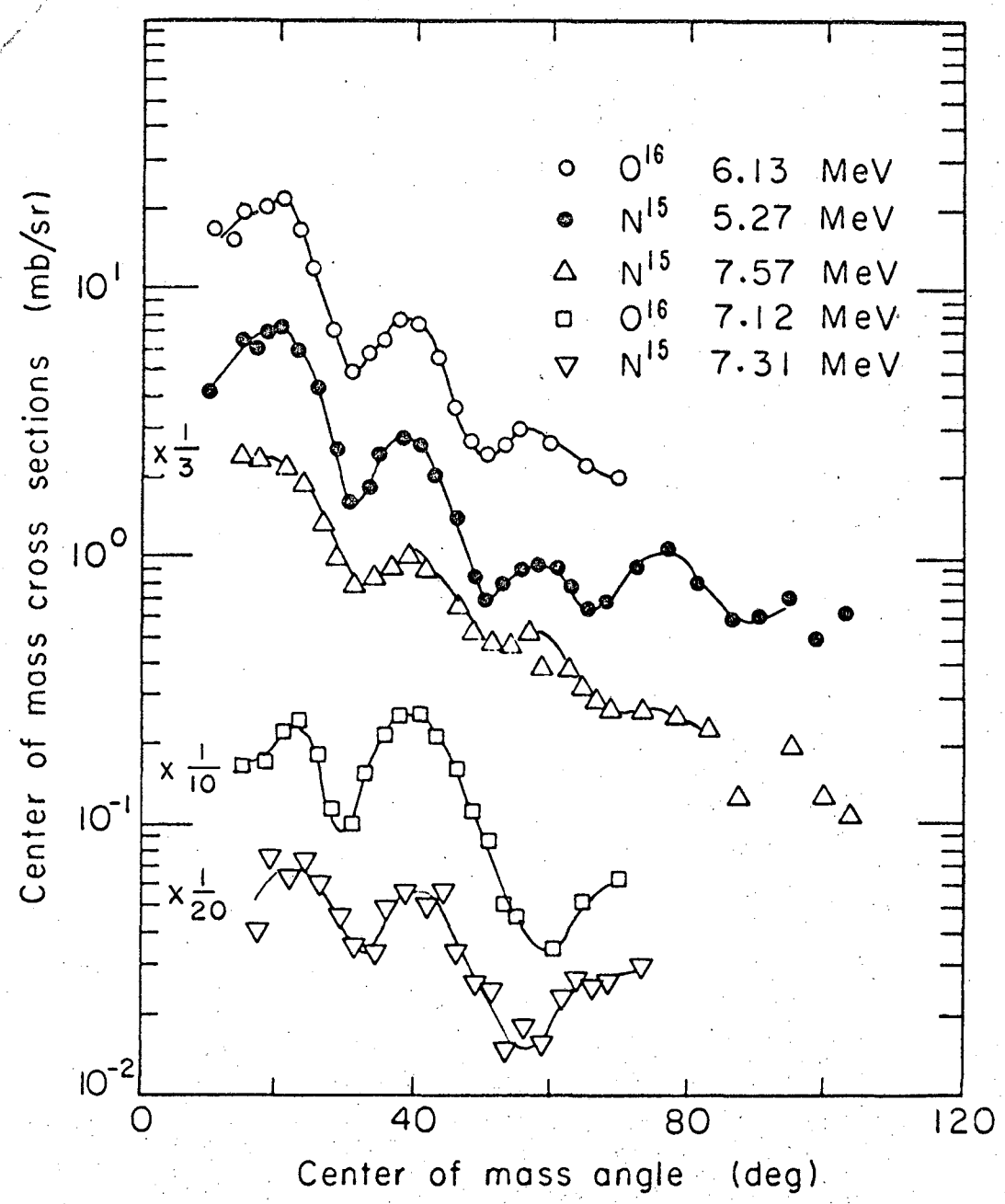

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Fig. 1.

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