SURVEY OF THE (α,^{2}He) REACTION ON 1p- AND 2s1d-SHELL NUCLEI

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A ^{2}He detection system has been developed and used to investigate the (α,^{2}He) reaction at bombarding energies of 55 and 65 MeV on targets of ^{12}C, ^{13}C, ^{14}N, ^{15}N, ^{16}O, ^{18}O, ^{20}Ne, ^{22}Ne, ^{24}Mg, ^{26}Mg, ^{28}Si, ^{29}Si, ^{32}S, ^{36}Ar, ^{38}Ar and ^{40}Ca. Preferential population of two-neutron states with dominant $(d_{5/2})^2_4$, $(d_{3/2}f_{7/2})_5$ and $(f_{7/2})^2_6$ character was observed. A linear A-dependence of the binding energies of the J = 5^- and 6^+ states was obtained. This systematic behavior is well described by the Bansal-French model.

Recently, it has been demonstrated[1,2] that the (α,^{2}He) reaction selectively populates levels that correspond to kinematically favored transitions in which the two transfered neutrons are simply captured in a singlet state about an undisturbed target core. At 65 MeV bombarding energy, the angular momentum mismatch for a surface reaction is about 4 $\hbar$ for 1p-shell targets and (5-6)$\cdot\hbar$ for 2s1d-shell targets. Therefore states formed by capturing the two stripped neutrons

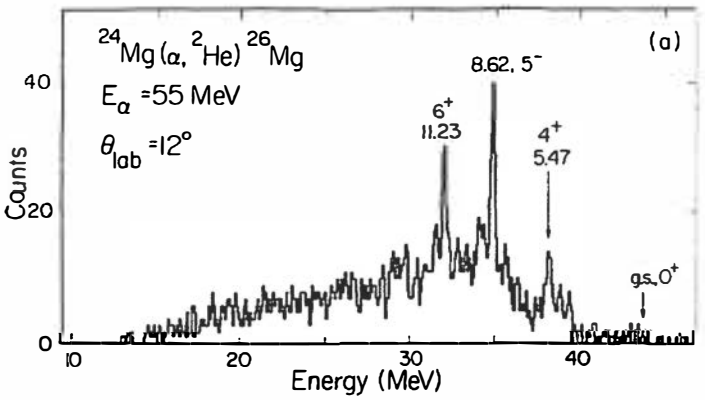

Fig. 1. Spectrum from the reaction ^{24}Mg(α,^{2}He)^{26}Mg at 12° lab. angle

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coupled to $(d_{5/2})^2_4$, $(d_{3/2}f_{7/2})_5$ and $(f_{7/2})^2_6$ are expected to be strongly populated in reactions on p- and sd-shell targets, respectively. In the present experiment targets of ^{12}C, ^{13}C, ^{14}N, ^{15}N, ^{16}O, ^{18}O, ^{20}Ne, ^{22}Ne, ^{24}Mg, ^{26}Mg, ^{28}Si, ^{29}Si, ^{32}S, ^{36}Ar, ^{38}Ar and ^{40}Ca have been bombarded with 55 and 65 MeV ^4He-beams from the Lawrence Berkeley Laboratory 88-inch cyclotron. The same ^2He detection system as described in Ref.1 has been utilized. The overall ^2He detection efficiency was about 1% for 20-50 MeV ^2He events. In Fig. 1 a spectrum from the reaction $^{24}Mg(\alpha,^2He)^{26}Mg$ is shown, which demonstrates the extreme selectivity of the $(\alpha,^2He)$ reaction for populating 2n states of high spin. Preferential population of $(d_{5/2})^2_4$ configurations was evident on all observed p-shell targets, whereas 2n configurations of $(d_{3/2}f_{7/2})_5$ and $(f_{7/2})^2_6$ character were preferentially populated on all observed sd-shell targets with A $\geq$ 22. In Fig. 2 the 2n binding energies B of the observed 5^- and 6^+ states are plotted versus A of the final nuclei. The solid lines represent B calculated with the Bansal-French method using the parameters a= - 0.30 MeV and b=2.6MeV. It can be clearly seen that the experimental 2n-binding energies display a linear dependence on A. These results demonstrate the utility of the $(\alpha,^2He)$ reaction as a new spectroscopic tool capable of locating many unobserved 2n-states of high spin.

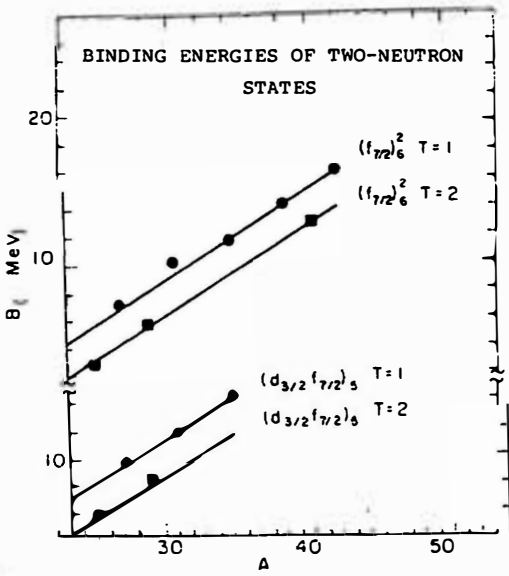

Fig. 2. Binding energies B of two-neutron states as a function of the mass of the final nucleus A.

REFERENCES

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2. R.J. de Meijer, R.Kamermans, J. van Driel and H.P.Morsch, Phys. Rev. C16, 2442 (1977)