Experimental Study of \(^{3}\text{He}, \alpha\) Reactions on \(2s-1d\) and \(1f_{\frac{3}{2}}\) Nuclei.

I. \(^{3}\text{He}, \alpha\) Reaction on Silicon Isotopes (*)

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Summary. — Angular distribution for \(^{29}\text{Si}(^{3}\text{He}, \alpha)^{29}\text{Si}\) and \(^{30}\text{Si}(^{3}\text{He}, \alpha)^{30}\text{Si}\) reactions induced by 10 MeV \(^{3}\text{He}\) particles have been measured. We have found experimental evidence that the silicon isotopes contain in their ground state large core-excited components. Neutron occupation numbers for \(d_{\frac{5}{2}}, d_{\frac{3}{2}}, s_{\frac{1}{2}}\) and \(f_{\frac{3}{2}}\) orbits are obtained for the ground state of the silicon isotopes and compared with the shell-model prediction.

1. – Introduction.

In this and in the following papers \(^{(1,2)}\), experiments on \(^{3}\text{He}, \alpha\) reactions are presented at an \(^{3}\text{He}\) bombarding energy of 10 MeV.

There is experimental evidence \(^{(3,4)}\) that \(^{3}\text{He}, \alpha\) can be employed successfully as single-neutron transfer reactions on medium and light nuclei at bom-
barding energy as low as 10 MeV. The 2s-1d shell nuclear region is of particular interest. There are shell-model calculations (2-7) which had success in accounting for nuclear phenomena in the 2s\textsubscript{1/2}-1d\textsubscript{1/2} shell. One of the basic approximations made in these calculations was to treat the \textsuperscript{28}Si core as a closed 1d\textsubscript{1/2} shell, an assumption which is not in agreement with the experimental information about the \textsuperscript{28}Si nucleus (5,9). Recent experiments (5,9) performed using (\textsuperscript{3}He, \alpha) reactions on \textsuperscript{28}Si and \textsuperscript{30}Si nuclei have shown appreciable core excitation.

The experimental results indicate that the neutron orbits 1d\textsubscript{3/2}, 2s\textsubscript{1/2} and 1d\textsubscript{1/2} in the ground state of \textsuperscript{28}Si are filled to approximately 60\%, 35\% and 13\%, respectively, while in \textsuperscript{30}Si the experiments indicate that the 1d\textsubscript{3/2} neutron shell is nearly filled and the remaining neutrons are split about equally between the 2s\textsubscript{1/2} and 1d\textsubscript{1/2} shell with an admixture of a few percent of f-wave neutrons.

In order to complete the study of the nuclear structure of the ground state of the silicon isotopes the present experiment was performed on \textsuperscript{28}Si and \textsuperscript{30}Si nuclei at a bombarding energy of 10 MeV.

2. - Experimental procedure.

The doubly ionized \textsuperscript{3}He beam (11) from the CN Van de Graaff accelerator of Legnaro (Padova) was employed for the present measurements. The separation of the doubly ionized \textsuperscript{3}He beam from the single one was accomplished by the use of a magnetic triplet which is shown schematically in Fig. 1.

The principle of operation of such a magnetic lens is the following. By focusing the doubly ionized \textsuperscript{3}He beam on the diaphragm at the entrance of the ion tube accelerator, as indicated in Fig. 1, the singly ionized \textsuperscript{3}He beam is focused to infinity (11). In this way it is possible to have, in the ion tube accelerator, about equal amounts of current of singly and doubly ionized \textsuperscript{3}He beams, which can be easily separated by the analysing magnet. Typical beam

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