OBSERVATION OF THE $^{27}Al(\alpha,{}^{8}B)^{23}Ne$ AND $^{66}Zn(\alpha,{}^{8}B)^{62}Co$ REACTIONS

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As a first step in a program to determine the masses of certain neutron-rich nuclides using multiple proton pickup reactions, we have investigated the $(\alpha,{}^{8}B)$ reaction on ^{27}Al and ^{66}Zn. Perhaps because this reaction is characterized by very large negative Q values, it has not previously been observed; hence, the yields to be expected were uncertain.

Spectra were obtained at $\theta_{lab} = 8^{o}$ and at E_{α} = 109 MeV using ^{27}Al and ^{66}Zn targets. In each case the Q-value range examined corresponded to approximately the first 4.5 MeV of excitation in the residual nuclei ^{23}Ne and ^{62}Co. The ^{8}B ions were momentum analyzed and identified using the QDDM spectrograph, with the gridded ionization chamber detector for heavy ions[1)] placed at the focal plane. This detector, in addition to measuring position along the focal plane, provides two sequential differential energy-loss measurements (ΔE_1 and ΔE_2), the total energy deposited in the detector (E), and a second position measurement which can be used to determine angle of incidence. The measured values of E and either of the two ΔE signals, together with knowledge of the spectrograph setting $B\rho$, were sufficient to clearly and unambiguously distinguish the ^{8}B ions from other species. A two dimensional display of ΔE_2 vs. E obtained with the ^{27}Al target is shown in Figure 1. The vertical scale is expanded by a factor of 100 in the region containing the relatively weak ^{8}B group, as indicated in the figure.

In Figure 2 a spectrum from the $^{27}Al(\alpha,{}^{8}B)^{23}Ne$ reaction is shown, with the Q value range indicated along the horizontal axis. The excitation energies of known states in ^{23}Ne are shown with arrows indicating their expected locations. The laboratory cross sections at 8° range from 35 nb/sr, for the first excited state at 1.02 MeV, to 384 nb/sr for the peak at 2.4 MeV.

A portion of the ΔE_2 vs. E display obtained during the run on the ^{66}Zn target is shown in Figure 3 where in the region with the expanded vertical scale the ^{8}B group appears clearly above the background. Since the level density in ^{62}Co is quite high and a relatively thick target was used, individual levels were not resolved. Hence it was not possible to

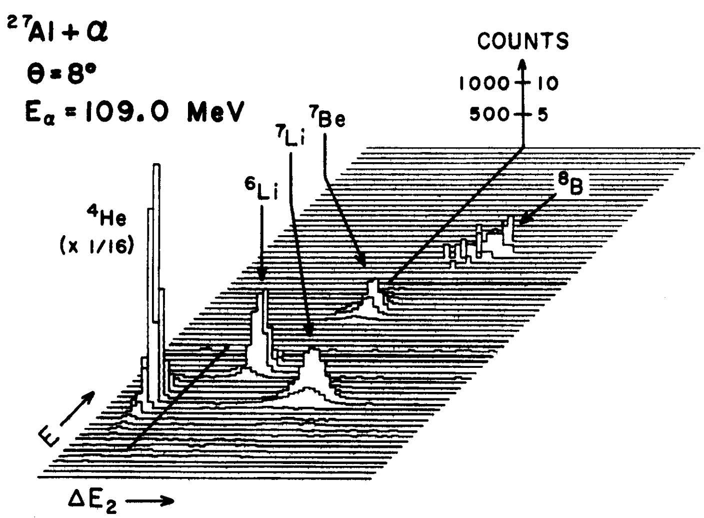

Figure 1.

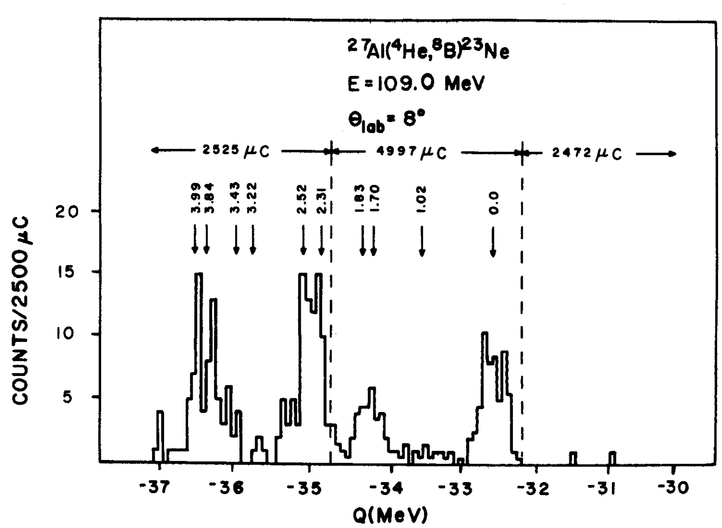

Figure 2.

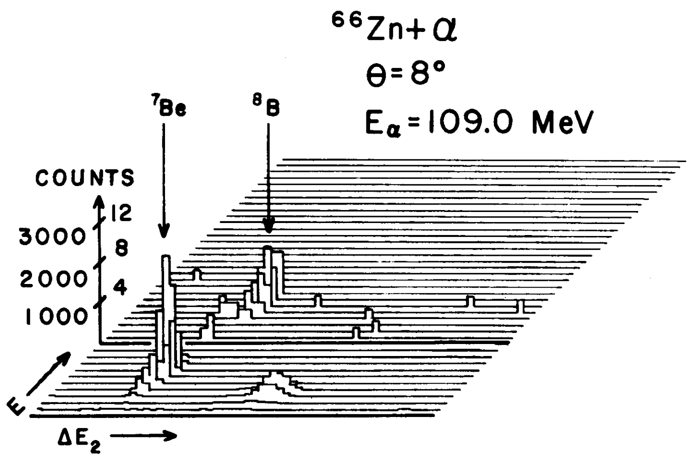

Figure 3.

identify specific levels in ^{62}Co. However, in the Q-value range examined (-27.8 to -32.4 MeV), all commonly encountered lighter target contaminants can be eliminated as a source of ^{8}B events because of larger negative Q values. Thus, we tentatively attribute the observed events to the ^{66}Zn(α,^{8}B)^{62}Co reaction. Over the range of Q values covered, corresponding to the first 4.5 MeV of excitation in ^{62}Co, the laboratory cross section would then be 540 nb/sr, or about 120 nb/sr-MeV. This would suggest an average cross section of 5-10 nb/sr for individual levels. This cross section is larger than has been reported in some cases for the (α,^{8}He) reaction,[2)] although it is less than the cross section for the latter reaction under comparable conditions of target mass and Q value.[3)]

In view of the observed yield, it appears that in some cases the (α,^{8}B) reaction may be a feasible, although difficult, means of reaching nuclides of interest. However, it suffers from the disadvantage that it is mainly suitable for studying odd-odd nuclides, whose level density would exacerbate target thickness problems due to the negative Q values and the high specific energy loss of ^{8}B ions. A mass measurement is presently planned using the (^{7}Li,^{10}C) reaction, which appears to be more promising.

These results have been submitted as a Communication to the Physical Review.

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3) R.E. Tribble, J.D. Cossairt, D.P. May, and R.A. Kenefick, Phys. Rev. C16, 1835 (1977).