CONTRIBUTION OF THE $^4He(^4He,x)^6Li$ REACTION TO THE NATURAL ABUNDANCE OF LITHIUM*

L.W. Woo, K. Kwiatkowski, S. Zhou, T.E. Ward, M. Walker, and V.E. Viola, Jr.
Indiana University Cyclotron Facility, Bloomington, Indiana 47405

In the evaluation of galactic cosmic-ray models for light element nucleosynthesis,[1] the $\alpha + \alpha$ reaction has been previously studied[2] up to a bombarding energy of 160 MeV. The results indicate that above this energy, ^7Li and ^7Be are not produced to any significant extent. However, for ^6Li the situation is not clear. The existing excitation function for the $^4He(^4He,x)^6Li$ reaction suggests that the cross section for ^6Li decreases exponentially with increasing energy. If this is correct, then higher energy $\alpha + \alpha$ reactions are not important for ^6Li synthesis calculations. On the other hand, the possibility that the $^4He(^4He,pn)^6Li$ cross section ($\sim$ 10 mb at 160 MeV) may become independent of energy at high energies is suggested by the production of Li isotopes in studies of light-ion induced reactions on ^{12}C. In this case, the $\alpha + \alpha$ reaction would account for a major fraction of nature's ^6Li production, and would in fact lead to a major anomaly in light element abundance calculations.[1]

In order to extend the $^4He(^4He,x)$ excitation function to higher energies, we have studied this reaction at 200 MeV at IUCF. A gas target cell containing ^4He was bombarded with a 200-MeV ^4He beam and the A = 6 and 7 fragments were measured with a three-element solid-state detector telescope. Measurements were performed from 5 deg to the maximum angle allowed by kinematics (30 deg). The cross sections measured were as follows:

$$\sigma(^6Li) = 3.5 \pm 0.7 \text{ mb}$$

$$\sigma(^7Li) = 0.24 \pm 0.10 \text{ mb}$$

$$\sigma(^7Be) = 0.35 \pm 0.10 \text{ mb}$$

All of these values are in good agreement with excitation functions that are decreasing exponentially with energy. Hence, we conclude from these studies that the $\alpha + \alpha$ reaction at energies above 200 MeV is not a significant contributor to the natural abundance of lithium.

*Work supported in part by the U.S. Department of Energy.

1) Sam M. Austin, Prog. Part. and Nucl. Phys. 14, 40 (1980).

2) B.G. Glagola, et al., Phys. Rev. C 25, 34 (1982).