NEW MEASUREMENTS FOR THE ASTROPHYSICALLY IMPORTANT

$^{40}\text{Ca}(\alpha,\gamma)^{44}\text{Ti}$ Reaction

Abstract

by

Daniel Robertson

The short-lived $^{44}\text{Ti}$ radionuclide is an important signature of explosive nucleosynthesis in core-collapse supernovae. Direct detection in the supernova remnant Cassiopeia A, and the expected production in the innermost layers of a supernova event, allows the extraction of important information concerning explosive nucleosynthesis. A new measurement of the $^{40}\text{Ca}(\alpha,\gamma)^{44}\text{Ti}$ reaction has been performed through two different experimental approaches. An excitation curve measurement was performed over the energy range $E_\alpha = 4600 - 3000$ keV, using $\alpha$-particles incident on a $^{40}\text{Ca}$ target. This measurement was used to aid in the commissioning of a new accelerator mass spectrometry (AMS) facility developed during this work, at the University of Notre Dame. Using this facility, a series of $^{44}\text{Ti}$ activation measurements using a $^{40}\text{Ca}$ beam incident on a $^4\text{He}$ gas target, were performed and measured, all within the same $E_\alpha = 4600 - 3000$ keV energy range. A new reaction rate has been derived from the resultant excitation curve. This has increased the expected yield of $^{44}\text{Ti}$ in proposed supernova environments by 40% from previous prompt $\gamma$-ray measurements. The strong correlation between this experimental data and that collected from the newly formed AMS facility,
successfully commissions the facility for use in the measurement of reaction cross-sections of astrophysical interest.