Measurements and Analysis of Alpha-Induced Reactions of Importance for Nuclear Astrophysics

Abstract

By Richard J. DeBoer

Reactions during stellar helium burning are of primary importance for understanding nucleosynthesis. A detailed understanding of the critical reaction chain $4\text{He}(2\alpha, \gamma)12\text{C}(\alpha, \gamma)16\text{O}(\alpha, \gamma)20\text{Ne}$ is necessary both because it is the primary energy source and because it determines the ratio of $12\text{C}$ to $16\text{O}$ produced, which in turn significantly effects subsequent nucleosynthesis. Also during Helium burning, the reactions $22\text{Ne}(\alpha, n)25\text{Mg}$ and $22\text{Ne}(\alpha, \gamma)26\text{Mg}$ are crucial in determining the amount of neutrons available for the astrophysical s-process.

This thesis presents new experimental results concerning the $16\text{O}(\alpha, \gamma)20\text{Ne}$, $22\text{Ne}(\alpha, n)25\text{Mg}$, and $22\text{Ne}(\alpha, \gamma)26\text{Mg}$ reaction rates. These results are then applied to the calculation of the associated stellar reaction rates in order to achieve better accuracy.