MEASUREMENT OF ALPHA CAPTURE REACTIONS ON $^{17}$O AND $^{18}$O FOR
THE S PROCESS

Abstract

by

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The reaction $^{16}$O($n, \gamma$)$^{17}$O acts as a neutron poison in the weak slow neutron capture process (s process) by reducing the number of available neutrons in the stellar burning environment. The captured neutrons can be re-emitted into the stellar environment via the reaction $^{17}$O($\alpha, n$)$^{20}$Ne, weakening the poisoning effect of $^{16}$O. This branch competes with the reaction $^{17}$O($\alpha, \gamma$)$^{21}$Ne. Therefore in order to determine the strength of $^{16}$O as a neutron poison one needs to know the ratio of the two stellar reaction rates $\frac{^{17}$O($\alpha, \gamma$)$^{21}$Ne}{^{17}$O($\alpha, n$)$^{20}$Ne}.

As there is no published data on $^{17}$O($\alpha, \gamma$)$^{21}$Ne and only limited information is available on the $^{17}$O($\alpha, n$)$^{20}$Ne reaction both reactions have been measured. The total cross section of the ($\alpha, n$) reaction was measured using a high efficiency $4\pi$ neutron detector. To improve the accuracy of the results the ($\alpha, n_1$) channel has been investigated separately over the same energy range by detecting its characteristic gamma-rays with a germanium detector.

Besides a possible role in the weak s process $^{18}$O can be a strong source of beam-induced background in the measurement of ($\alpha, n$) reactions. Even a very small contamination of the target material with $^{18}$O can lead to spurious signals in both the $^{17}$O($\alpha, \gamma$)$^{21}$Ne and the $^{17}$O($\alpha, n$)$^{20}$Ne measurements.
reactions $^{18}\text{O}(\alpha, n)^{21}\text{Ne}$ and $^{18}\text{O}(\alpha, n_1)^{21}\text{Ne}$ were measured from the threshold up, covering the same energy range as the $^{17}\text{O}$ measurements.

In this work several resonances in $^{17}\text{O}(\alpha, \gamma)^{21}\text{Ne}$ have been found and their parameters have been determined. The uncertainty in both the $^{17}\text{O}(\alpha, n)^{20}\text{Ne}$ and the $^{18}\text{O}(\alpha, n)^{21}\text{Ne}$ reaction rates has been greatly reduced. The astrophysical implications of the new experimental results are discussed.