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

Abstract

by

Andreas Christian Best

The reaction $^{16}\mathrm{O}(n,\gamma)^{17}\mathrm{O}$ 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 $^{17}\mathrm{O}(\alpha,n)^{20}\mathrm{Ne}$, weakening the poisoning effect of ^{16}O. This branch competes with the reaction $^{17}\mathrm{O}(\alpha,\gamma)^{21}\mathrm{Ne}$. 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 $^{17}\mathrm{O}(\alpha,\gamma)^{21}\mathrm{Ne}$ and only limited information is available on the $^{17}\mathrm{O}(\alpha,n)^{20}\mathrm{Ne}$ reaction both reactions have been measured. The total cross section of the (α,n) reaction was measured using a high efficiency 4π neutron detector. To improve the accuracy of the results the (α,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 (α,n) reactions. Even a very small contamination of the target material with ^{18}O can lead to spurious signals in both the $^{17}\mathrm{O}(\alpha,\gamma)^{21}\mathrm{Ne}$ and the $^{17}\mathrm{O}(\alpha,n)^{20}\mathrm{Ne}$ measurements.The reactions $^{18}O(\alpha, n)^{21}Ne$ and $^{18}O(\alpha, n_1)^{21}Ne$ were measured from the threshold up, covering the same energy range as the ^{17}O measurements.

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