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Studying the astrophysically crucial 12C(α, γ)16O reaction at high temperatures

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One of the major processes in stars is helium burning, which consists of two main parts that produce $^{12}\mathrm{C}$ and $^{16}\mathrm{O}$. Helium burning is the primary source of $^{12}\mathrm{C}$ and $^{16}\mathrm{O}$, the two most abundant elements after hydrogen and helium. The second part of helium burning is the process of an α particle being captured by a $^{12}\mathrm{C}$ nucleus ($^{12}\mathrm{C}(\alpha,\gamma)^{16}\mathrm{O}$), which produces $^{16}\mathrm{O}$ in an excited state. The excited $^{16}\mathrm{O}$ can then γ decay to the stable ground state of $^{16}\mathrm{O}$. As $^{12}\mathrm{C}$ and $^{16}\mathrm{O}$ also take part in other processes in stars, the total amount of both elements, and the ratio between them, are important factors in how a star evolves. Thus the $^{12}\mathrm{C}(\alpha,\gamma)^{16}\mathrm{O}$ reaction is important in understanding stellar evolution. A new state of the art experiment of the $^{12}\mathrm{C}(\alpha,\gamma)^{16}\mathrm{O}$ reaction will be performed at iThemba LABS. A beam of α particles will be used on a stationary enriched $^{12}\mathrm{C}$ target. The resulting γ rays will be measured using 12 large volume $\mathrm{LaBr_3}$ detectors. The reaction will be measured at α energies of 4-9 MeV. Additionally a pulse shape discrimination (PSD) algorithm will be developed at the Oslo Cyclotron Laboratory. The PSD will mitigate the neutron background resulting from the $^{13}\mathrm{C}(\alpha,n)^{16}\mathrm{O}$ reaction on the $^{13}\mathrm{C}$ contaminant in the target. The data will then be analyzed using the R-matrix code AZURE2 to extrapolate the reaction cross section down to the experimentally inaccessible stellar energy region.

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