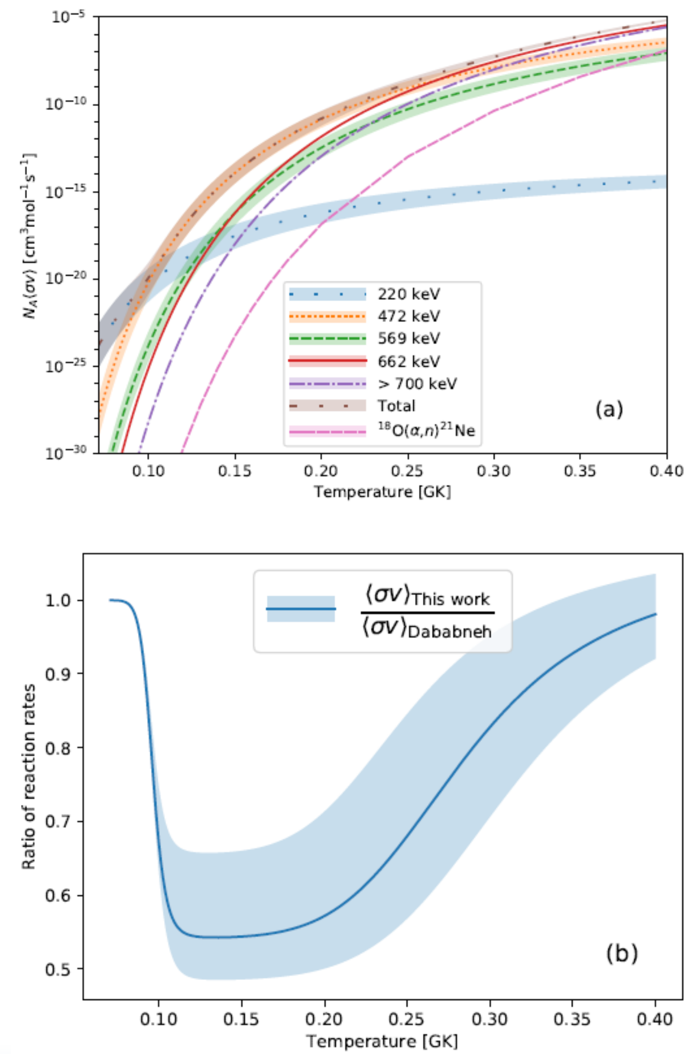
Measurement of Low-Energy Resonance Strengths in the $^{18}O(\alpha,\gamma)^{22}Ne$ Reaction

The $^{18}O(\alpha,\gamma)^{22}Ne$ reaction is an essential part of a reaction chain that produces the $^{22}Ne(\alpha,n)^{25}Mg$ neutron source for both the weak and main components of the slow neutron-capture process. At temperatures of stellar helium burning, the astrophysically relevant resonances in the $^{18}O(\alpha,\gamma)^{22}Ne$ reaction that dominate the reaction rate occur at α particle energies E_{lab} of 472 and 569 keV. However, previous experiments have shown the strengths of these two resonances to be very weak, and only upper limits or partial resonance strengths could be obtained.

This work reports the first direct measurement of the total resonance strength for the 472- and 569-keV resonances, 0.26±0.05 and 0.63±0.30 μeV, respectively. New resonance strengths for the resonances at α particle energies of 662.1, 749.9, and 767.6 keV are also provided.

These results were achieved in an experiment optimized for background suppression and detection efficiency. The experiment was performed at the Sanford Underground Research Facility, in the 4850-foot underground cavity dedicated to the Compact Accelerator System for Performing Astrophysical Research. The experimental end station used the γ-summing High EffiCiency TOtal absorption spectrometeR. Compared to previous works, the results decrease the stellar reaction rate by as much as ≈46+6−11% in the relevant temperature range of stellar helium burning.



A. Dombos et al., Phys. Rev. Lett. 128 (2022) 162701