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S-process Nuclear Reaction Rates

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In stars the $^{13}C(\alpha,n)^{16}O$ and $^{22}Ne(\alpha,n)^{25}Mg$ reactions are the two main sources of neutrons for the so-called slow neutron capture process (s-process), which is the main mechanism for the stellar synthesis of heavy elements. About $^{13}C(\alpha,n)^{16}O$, in despite of many efforts in measuring its cross section at the lower energies, only high uncertainty data above the s-process Gamow window (140 keV < E_{cm} < 230 keV) were available, due mostly to the difficulties on suppress the natural background. Indeed, only recently the LUNA collaboration performed high precision underground measurements of the reaction cross section inside the Gamow window, improving the accuracy of its extrapolation at the lower energies. Again due to natural background, only upper limits for the $^{22}Ne(\alpha,n)^{25}Mg$ reaction cross section are currently known in the s-process Gamow window (450 keV < E_{cm} < 750 keV). For this, the ERC founded project SHADES (Unina/INFN) aims to perform high precision and high sensitivity measurements of the $^{22}Ne(\alpha,n)^{25}Mg$ reaction cross section down to neutron threshold. A sensitivity improvement of at least two orders of magnitude over the state of the art is expected thanks to the low natural background environment of INFN-LNGS laboratory in Italy, the high beam current of the new LUNA-MV accelerator and the Beam Induced Background events suppression performed by SHADES hybrid detectors array.
In this talk I will present the LUNA efforts to estimate nuclear reaction rates for $^{13}C(\alpha,n)^{16}O$, with a focus on R-Matrix analysis performed with the code AZURE2 to extrapolate the rates at stellar energies and the estimate of their uncertainty through Monte Carlo methods. I will also present an overview of the SHADES project to measure $^{22}Ne(\alpha,n)^{25}Mg$ in the Gamow window and the first results on the setup commissioning.

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