Experimental charged-particle (α,n) reaction studies relevant for the weak r-process

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Core-collapse Supernovae explosions are likely to produce at least some of the elements heavier than iron found in nature. Although the conditions are not adequate to produce the heaviest elements, those explosions powered by neutron-rich neutrino-driven winds can contribute to the galactic abundance of elements from iron all the way to silver and beyond. Charged-particle reactions in the wind, mainly (α,n) and (α,2n) play an important role to create heavier mass nuclei. In order to validate these explosions as viable scenarios to produce heavy nuclei, it is critical to reliably predict the charged-particle reaction rates that control the production of elements [1].
(α,n) and (α,2n) reaction rates used in nucleosynthesis calculations are calculated with statistical Hauser-Feshbach (HF) models as experimental information on (α,n) and (α,2n) reaction rates is limited to a few stable isotopes in the region of interest and, even in those few cases, the data do not cover the energy range of astrophysical interest. However, the theoretical reaction rates often vary by an order of magnitude (when employing different nuclear physics input) and their large uncertainties directly results in unacceptable uncertainty in the final elemental abundances calculated within the astrophysical environment [2].
In order to address these uncertainties, we have developed the neutron detector HABANERO (Heavy ion Accelerated Beam induced (Alpha,Neutron) Emission Ratio Observer) and started a program to constrain (α,n) and (α,2n) reaction rates of astrophysical interest. Preliminary results of the first experiment using HabaNERO, a measurement of the ^{75}Ga(α,n)^{78}As and ^{75}Ga(α,2n)^{77}As cross sections will be presented along with plans for future measurements.

References

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