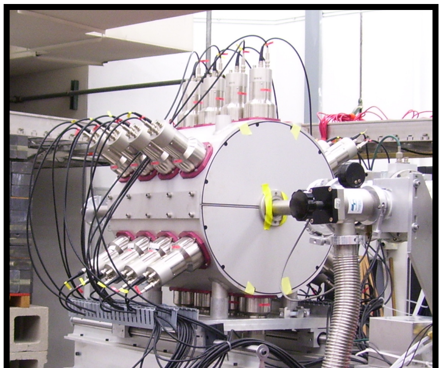
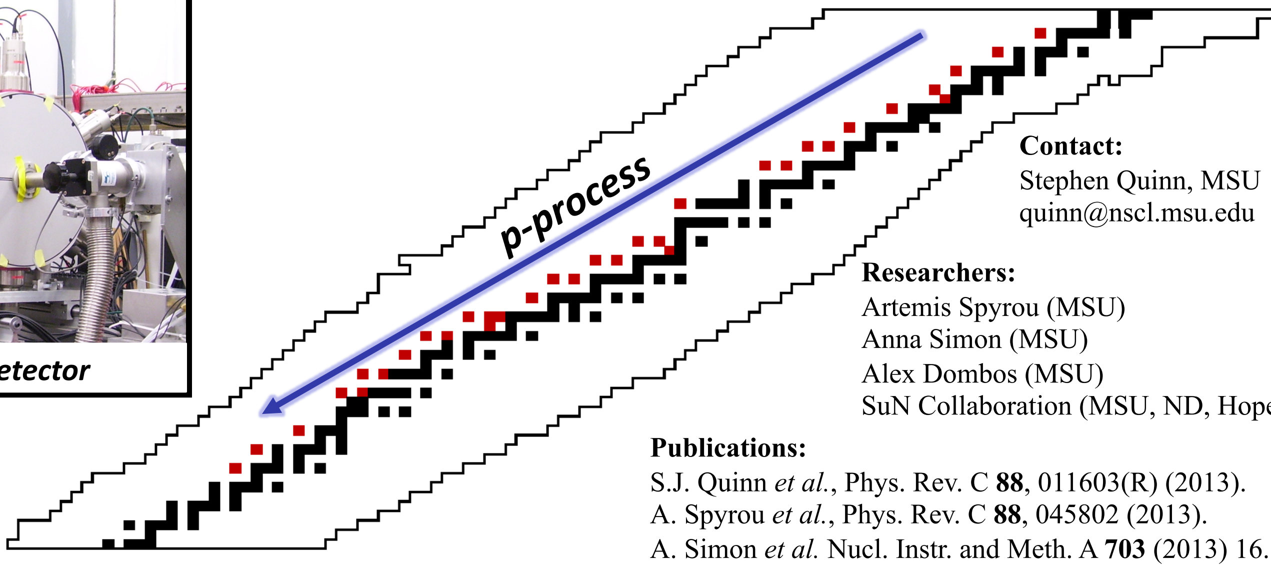
Joint Institute for Nuclear Astrophysics

Probing the production mechanism of the light p-nuclei



The SuN Detector



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Publications:
S.J. Quinn *et al.*, Phys. Rev. C **88**, 011603(R) (2013).
A. Spyrou *et al.*, Phys. Rev. C **88**, 045802 (2013).
A. Simon *et al.* Nucl. Instr. and Meth. A **703** (2013) 16.

A complete description of the origin of 35 isotopes (the p-nuclei) on the neutron-deficient side of the chart of nuclides has remained elusive to the nuclear astrophysics community. The favored scenario of photodisintegration reactions (the p-process) inside of type II supernovae has failed to reproduce the observed abundance pattern, especially for the light p-nuclei. In an effort to improve the nuclear physics inputs into p-process models, the Summing NaI(Tl) (SuN) detector was recently designed at the NSCL to measure (p,γ) and (α,γ) reactions at astrophysical energies. Cross section measurements of the ^{74}Ge(p,γ)^{75}As and ^{90,92}Zr(p,γ)^{91,93}Nb reactions were carried out at the University of Notre Dame and the results recently published. The measurements cover most of the relevant astrophysical energies (see Fig. 1) and experimental reaction rates were derived. The new and improved reaction rates were used in a p-process model of a type II supernova where they greatly reduce the nuclear physics uncertainty in the production of light p-nuclei (see Fig. 2) however the puzzle of the nucleosynthesis of the light p-nuclei remains.

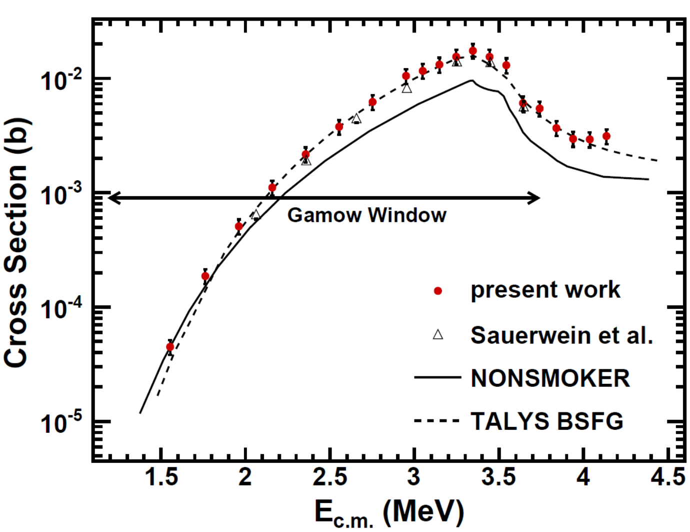

Figure 1: Cross section results for the ^{74}Ge(p,γ)^{75}As reaction covering the majority of the Gamow window and comparison to theory. New reaction rates were derived using the TALYS back-shifted Fermi gas model.

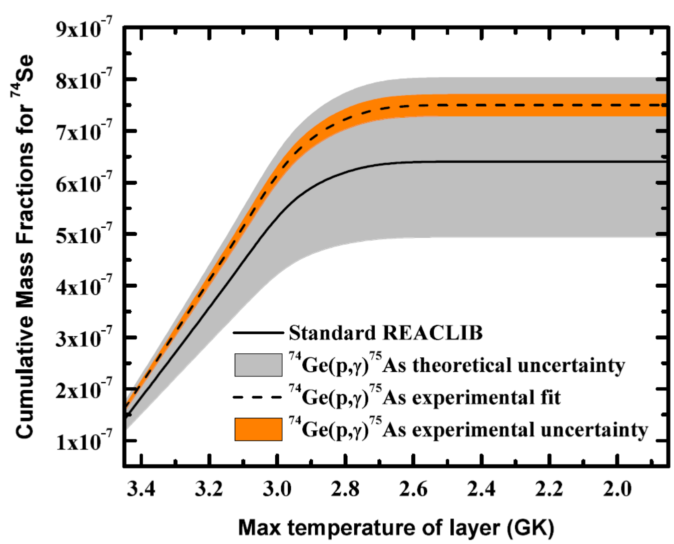

Figure 2: Result of using the new ^{74}Ge(p,γ)^{75}As experimental reaction rates in a p-process model compared to the previous theoretical values. The production of the p-nucleus ^{74}Se is increased and the nuclear physics uncertainty greatly reduced.