

Nuclear structure properties of neutron rich Ge-Br isotopes in the astrophysical r-process

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The astrophysical r-process is responsible for synthesis of roughly half of the elements heavier than iron. In spite of this significance, there are many uncertainties regarding the site of the r-process and the neutron-rich nuclei involved. Studying these nuclei presents a challenge, as they lie far from the valley of stability. Nuclear properties such as β decay half-lives and β -delayed neutron emission probabilities are critical inputs for r-process models. The neutron rich Ge-Br isotopes are in the region just after the N=50 bottle neck in the “classical” r-process, or may serve as seed material for the high entropy neutrino-wind r-process.

Neutron rich nuclei play an important role in both nuclear astrophysics and nuclear structure.¹ Central to the study of nuclear structure are the shape of a nucleus and how that shape changes from spherical to deformed. In some regions there is a smooth change in deformation as nucleons are either added or subtracted, and yet in other regions this transition is very rapid. The Ge-Br isotopes to be measured lie between the N=56 sub-shell closure and the onset of deformation at N=60, just below the Sr-Zr region, for which the most pronounced transition from spherical to deformed ground-state shapes have been observed.

Neutron rich Ge-Br isotopes will be studied at the NSCL at Michigan State University. Production will be by fragmentation of a 120 MeV/u ¹³⁶Xe beam on a Be target. The A1900 fragment separator will block unwanted species produced in this reaction. The transmitted nuclei will be implanted in a dual-sided silicon detector, which is part of the Beta Counting System detector. Implanted nuclei will be identified by the ΔE -time of flight method. Beta decays will then be detected by a single-sided silicon detector, which is also part of the Beta Counting System. Beta-delayed neutrons will be detected by the NERO neutron counter, which will surround the Beta Counting System. This will provide measurements of the β decay half-lives and β -delayed neutron emission probabilities. Then, SEGA germanium detector array will be used to detect gamma rays from decays of nuclei implanted in the Beta Counting System. The first 2^+ and 4^+ levels will be measured, determining the deformation of these nuclei.

1 A. Aprahamian, K.Langanke, and M. Wiescher. Prog. Part. Nucl. Phys., **54**:535 (2005).