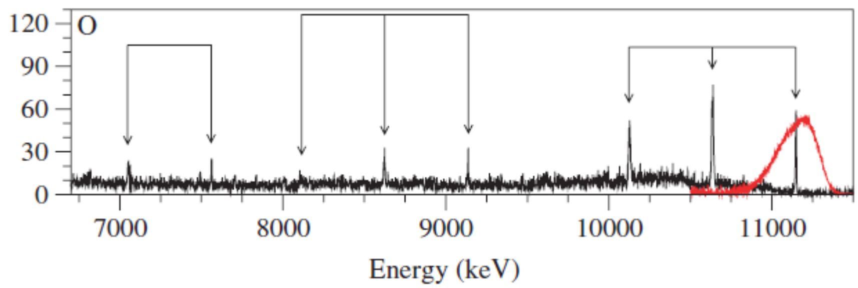
Nuclear Astrophysics at HIγS

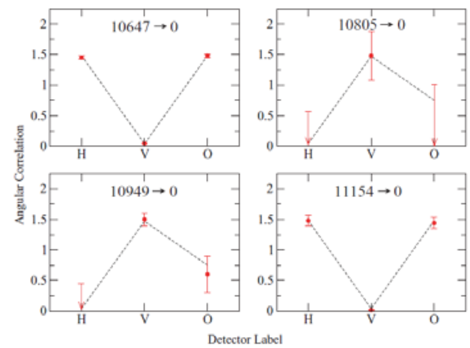


High energy portion of a spectrum from detector **O** at 11.2 MeV in the experimental setup figure. The primary de-excitation is seen at high energy followed by the first and second escape peaks. Two secondary de-excitations and their escape peaks were also seen. The beam energy distribution is shown in red.

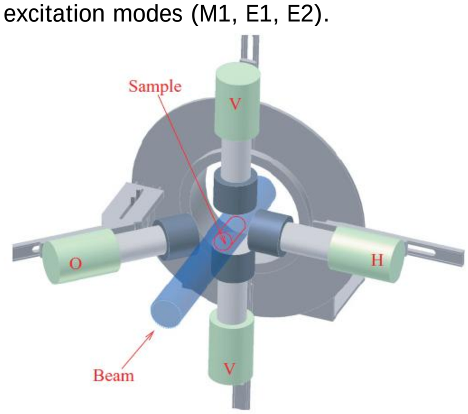
The High Intensity Gamma Source (HIγS) [1] at Duke University is a premier facility for the study of nuclei by gamma-ray induced reactions. The gamma-ray energies produced are perfect for the study of many nuclei important for critical nuclear reactions that occur in stars. One important goal is to identify the neutron source for the slow neutron capture (or s-process) ii stellar helium burning. Previous scientific studies have shown that one leading candidate is the ^{22}Ne(α,n)^{25}Mg reaction. Unfortunately this reaction is difficult to study by conventional means. At HIγS monochromatic gamma-rays can be used to study the reaction by inverse photo-dissociation techniques to provide important new nuclear structure information for deriving the reaction rate.

The experiment was performed in September 2008 and proved to be very successful. Five states were observed in the compound nucleus ^{26}Mg. Most importantly the spin-parity of these states could be unambiguously determined thanks to the ability of HIγS to produce linearly polarized gamma-rays. Greatly improved energy measurements were also obtained along with several never before observed modes of gamma-ray de-excitation. This study removed one of the main uncertainties, the possibility of near threshold resonances influencing the reaction rate. It suggests that the neutron production during stellar helium burning is substantially reduced [2].

[1] Weller et al. Prog in Part and Nuc Phys 62 257 (2009)
[2] Longland et al. Phys Rev C 80 055803 (2009)



Angular Correlation of four of the observed states. Gamma-ray excitation by a linearly polarized beam is one of the only definite methods of determining the spin-party of a state. The geometry of the detectors shown in the figure below maximize the differences in intensity seen for the different possible de-excitation modes (M1, E1, E2).



The experimental setup consisted of 4 60% High Purity Germanium (HPGe) detectors placed in a geometry conducive to the determination of the spin and parity of the observed states. The target was 16 grams of 99.5% enriched ^{26}MgO.

Researchers

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