Measurements of Gamow-Teller strength distributions via the (Hydrogen-3,Helium-3) reaction at the NSCL

The S800 magnetic spectrometer at the NSCL used in the measurement of the Gamow-Teller distributions via the (Hydrogen-3, Helium-3) creactions.

Researchers at the National Superconducting Cyclotron Laboratory have established that transition strengths that are important for understanding the late evolution of stars can be accurately extracted using the (Hydrogen-3, Helium-3) reaction.

In the experiments performed, a secondary beam of tritium particles traveling with a velocity of 45% of the speed of light was shot at two different target foils: one made of Magnesium-26 nuclei and one made of Nickel-58 nuclei. Helium-3 particles produced in the reaction were measured in the S800 magnetic spectrometer, leaving behind Sodium-26 and Cobalt-58, respectively. In these reactions, a proton inside the target nucleus is replaced by a neutron from the incoming Hydrogen-3 particle. A subset of such transitions, the so-called Gamow-Teller transitions, are closely related to those taking place in stars when they turn supernova and have s strong influence on how the star explodes and what the material ejected in the explosion is composed of.

The measurement on the Magnesium-26 target was used to make sure that the details of the reaction are well understood and that the Gamow-Teller transitions can be separated from other processes. For this purpose the data taken at the NSCL was combined with results from an experiment performed at the Research Center for Nuclear Physics (RCNP), located in Osaka, Japan. In that experiment, a target foil made of Magnesium-26 was bombarded with a beam of Helium-3 particles and detecting the Hydrogen-3 particles in the spectrometer Grand Raiden. It is, therefore, the mirror of the reaction studied at the NSCL.

Having established that the method of extracting the necessary information from the data is reliable and accurate, Nickel-58 was investigated. Nuclei in the Nickel-mass region are thought to be especially important for understanding the stellar evolution and measurement are important to test theoretical models used in the simulation of exploding stars. The results were used to solve a controversy between measurement using alternative nuclear reactions.
The research team at the NSCL is now planning experiments on other targets that are essential for understanding Gamow-Teller transitions and the role they play in supernovae explosions.

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