CFA LECTURES

Richard James De Boer
University of Notre Dame

Complimentary measurements of Cross Sections for Nuclear Astrophysics: 14N(p,g)15O and others

The reaction rates needed for stellar models in nuclear astrophysics occur at temperatures which correspond to low particle accelerator energies, usually of the order of a few keV. At these energies the desired charged particle cross sections are also extremely small, usually sub-nanobarn. For this reason, experimental measurements are often made at higher energies where the cross sections are much larger, and then an extrapolation is made to the low energy region. This extrapolation can have a very large uncertainty if nuclear structure properties are poorly understood for the reaction of interest.
The LNGS has the world's premier facility, LUNA, for pushing cross section measurements to as low in energy as possible. Often even reaching the actual energy ranges of stellar burning. Even so, at these energies the experimental uncertainties can be quite large and some times only strong resonance transitions can be observed. Further, the LUNA accelerator currently has a maximum energy of 400 kV, limiting the ability to overlap with previous higher energy data which is critical in verifying the absolute scale of the measurements.
The University of Notre Dame has a long history of Nuclear Astrophysics research. Our facility has recently constructed a new high intensity accelerator which covers an energy range from 300 keV to 5 MeV. This allows for an overlap in energy with the LUNA accelerator and also allows us to easily cover the energy range of most previous higher energy measurements.
To compliment these experimental endeavors, we have developed a comprehensive R-matrix code to make more reliable extrapolates to low energies. The code models compound nucleus reactions for particle-particle reactions and can be extended to model direct reactions for particle-gamma reactions. The code also allows for large amounts of data to be analyzed simultaneously facilitating the analysis of reactions from different experiments. These kinds of large scale analysis are becoming critical in reach the level of uncertainties necessary for comparison with modern stellar models and neutrino measurements.
In this talk I will show examples of where our two laboratories have already collaborated on experimental measurements and how the combined data resulted in considerably improved understanding of the reactions. Specifically, I will discuss 14N(p,g)15O, a reaction which is critical for modeling the CNO cycle and which can be compared to solar neutrino flux measurements.

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