Joint Institute for Nuclear Astrophysics

The Coulomb Dissociation of ^{60}Fe

The nuclide ^{60}Fe has been of great interest to the nuclear astrophysics community for over a decade. It is one of several radioactive nuclei whose decay signature has been observed by orbiting γ-ray telescopes. Taken in conjunction with another radionuclide, ^{26}Al, the observed flux ratio is expected to yield important information concerning both the stellar production site of ^{26}Al as well as the conditions of convective burning shells in massive stars when compared to current stellar models.

The nucleosynthesis of ^{60}Fe occurs by neutron capture in massive stars during periods of high neutron flux. Due to the short half-life of ^{59}Fe, a direct determination for the cross section of the production reaction, $^{59}Fe(n,\gamma)^{60}Fe$, is not possible. The purpose of the present study was to experimentally constrain this capture reaction by studying the time-reversed $^{60}Fe(\gamma,n)^{59}Fe$ reaction using relativistic Coulomb dissociation. The experiment was performed in the Fall of 2010 at GSI in Darmstadt, Germany.

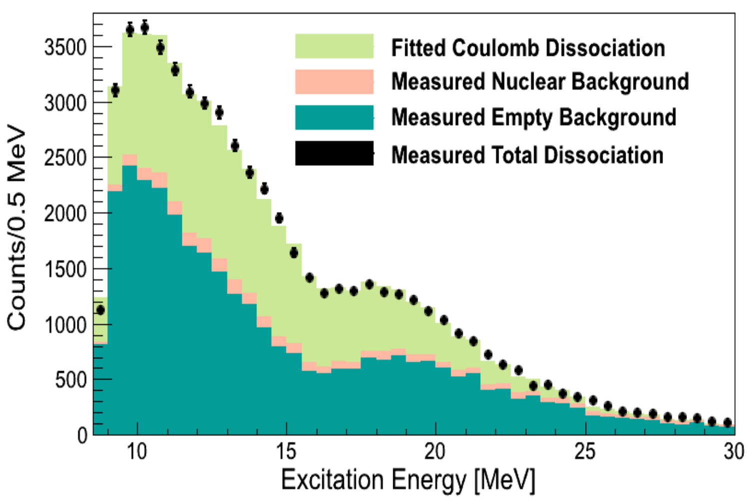

Fig. 1 – Fit of the γ-ray strength function to the reconstructed excitation energy distribution after the Coulomb dissociation of ^{60}Fe by a Pb target. The ambient background and contributions arising from nuclear interactions were quantified in separate runs.

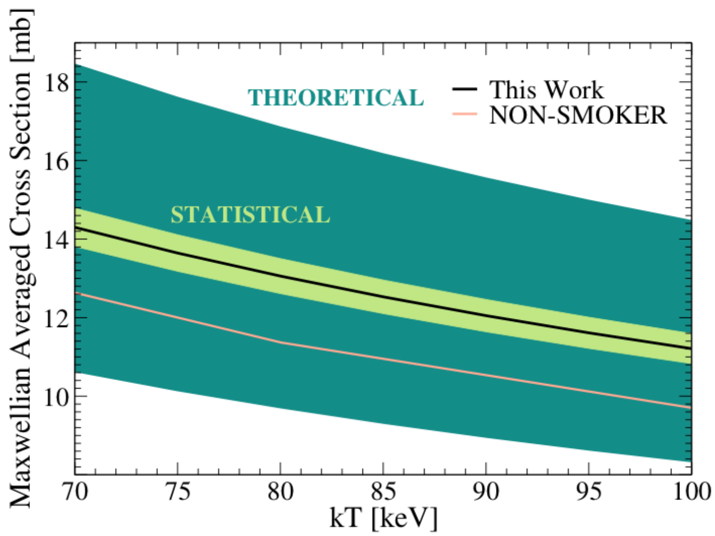

Fig. 2 – Calculated Maxwellian averaged cross sections for $^{59}Fe(n,\gamma)^{60}Fe$ utilizing the γ–ray strength function fitted to the Coulomb dissociation data. The shaded areas indicate the estimated uncertainty arising from the statistics of the experiment as well as the theoretical uncertainties inherent in the method. The present determination is in good agreement with the most current purely theoretical predictions.

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