A Proposed Experiment to Measure the Astrophysical S Factor of $^{12}C(\alpha,\gamma)^{16}O$ Reaction with an Internal Target in an Electron Storage Ring

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The reaction is one of the most important processes in nuclear astrophysics. It plays a major role in the He burning of massive stars and crucially affects the elements abundance in the Universe, the mechanism of Supernova explosion and even the final fate of the stars.

Despite numerous experimental efforts, the uncertainties in the cross-section of the reaction are very large, especially in the E2 channel, nowhere close to the requirements of astrophysics.

The proposed experiment investigates the inverse reaction, ^{16}O (e,e'α^{12}C). As theoretical analysis shows, the E2 part of the cross-section of $^{12}C(\alpha,\gamma)^{16}O$ reaction can be extracted from these measurements with very small theoretical and model uncertainties. Since the experiment requires detection of slow $\alpha\, and ^{12}$C particles, and high luminosity is needed, it can only be conducted with a superthin internal target in an electron storage ring.

The experiment is expected to be done at the MIT-Bates South Hall Ring. The oxygen target with a thickness of $2*10^{15}$ at/cm^2 is dense enough to produce a luminosity of 10^{33}cm^{-2}sec^{-1} at a beam current of 100 mA and it's thickness is still negligible for the passage of secondary particles. Scattered electrons will be registered with BLAST magnetic detector, and $\alpha\, and ^{12}$C particles will be detected with silicon strips. Triple coincidences effectively illuminate any possible background.

We expect to extend the measurements of S(E2) down to E(c.m.) of 0.6-0.8 MeV and improve significantly the accuracy of extrapolation of the S Factor to stellar energies.