PHYSICS AND ASTRONOMY COLLOQUIUM

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Measuring cross-sections of astrophysical interest in a laser experiment

Measuring cross-sections of astrophysical interest at very low energy (1-100keV) is a rather difficult task. Since these cross-sections are extremely small, direct measurements using accelerated beams require very high beam intensity and very low signal to noise ratio. Results of direct measurements show that, at very low energies, target electrons partially screen the Coulomb barrier between the projectile and the target, resulting in an enhancement of the measured cross-section compared with the bare nucleus cross-section. This screening effect needs to be corrected in order to get the bare nucleus cross-section. Therefore, cross-sections of astrophysical interest are often extrapolated to the lowest energies or measured with indirect methods. We proposed a new experimental technique that utilizes the Coulomb explosion of molecular clusters induced by the interaction with an intense laser pulse to produce a plasma where the ions have enough energy to drive nuclear reactions. Since the reactions occur inside a low density plasma, the screening effects observed in low energy experiments with ion beams are expected to be strongly reduced so that no correction is required. In our first experiment we measured the astrophysical S factor for the 3He(d, p)4He fusion reaction, using the interaction of intense ultrafast laser pulses with molecular deuterium clusters mixed with 3He atoms. The experiment was performed at Center for High Energy Density Science at The University of Texas at Austin. The details of the experiment and the final results will be presented in this talk, as well as the possibility to use the same technique to investigate other reactions of astrophysical interest.

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