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Exploring nuclear reactions relevant to Stellar and Big-Bang Nucleosynthesis using High-Energy-Density plasmas at OMEGA and the NIF

M. GATU JOHNSON, MIT

Thermonuclear reaction rates and nuclear processes have been explored traditionally by means of accelerator experiments, which are difficult to execute at conditions relevant to Stellar Nucleosynthesis (SN) and Big Bang Nucleosynthesis (BBN). High-Energy-Density (HED) plasmas closely mimic astrophysical environments and are an excellent complement to accelerator experiments in exploring SN and BBN-relevant nuclear reactions. To date, our work using HED plasmas at OMEGA and NIF has focused on the complementary ^{3}He+^{3}He, T+^{3}He and T+T reactions. First studies of the T+T reaction indicated the significance of the ^{5}He ground-state resonance in the T+T neutron spectrum. Subsequent T+T experiments showed that the strength of this resonance varies with center-of-mass (c-m) energy in the range of 16-50 keV, a variation that is not fundamentally understood. Studies of the ^{3}He+^{3}He and T+^{3}He reactions have also been conducted at OMEGA at c-m energies of 165 keV and 80 keV, respectively, and the results revealed three things. First, a large cross section for the T+^{3}He-γ branch can be ruled out as an explanation for the anomalously high abundance of ^{6}Li in primordial material. Second, the results contrasted to theoretical modeling indicate that the mirror-symmetry assumption is not enough to capture the differences between T+T and ^{3}He+^{3}He reactions. Third, the elliptical spectrum assumed in the analysis of ^{3}He+^{3}He data obtained in accelerator experiments is incorrect. Preliminary data from recent experiments at the NIF exploring the ^{3}He+^{3}He reaction at c-m energies of ˜60 keV and ˜100 keV also indicate that the underlying physics changes with c-m energy. In this talk, we describe these findings and future directions for exploring light-ion reactions at OMEGA and the NIF. The work was supported in part by the US DOE, LLE, and LLNL.