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Studying nuclear astrophysics with laser-generated high-energy-density plasmas

Wednesday, 23 May 2018 14:00 (30 minutes)

The ^{3}He+^{3}He, T+^{3}He, and p+D reactions directly relevant to either Stellar or Big-Bang Nucleosynthesis (BBN) have been studied at the OMEGA laser facility using inertially-confined plasmas. These high-temperature plasmas are created using shock-driven 'exploding pusher' implosions. The advantage of using these plasmas is that they better mimic astrophysical systems than cold-target accelerator experiments. A new measured S-factor for the T(^{3}He,γ)^{6}Li reaction rules out an anomalously-high ^{6}Li production during the Big Bang as an explanation to the high observed values in metal poor first generation stars. Our value is also inconsistent with values used in previous BBN calculations [1]. In a second experiment, proton spectra from the ^{3}He+^{3}He and T+^{3}He reactions are used to constrain nuclear R-matrix modeling. The spectral shapes disagree with R-matrix calculations using coefficients derived from fits to T+T data at higher or lower center-of-mass energy [2]. Finally, recent experiments have probed the p+D reaction for the first time in a plasma; this reaction is relevant to energy production in protostars, brown dwarfs, and at higher CM energies, to BBN. The first plasma data is consistent with previous accelerator experiments at $E_{cm} \sim 16$ keV, work is ongoing to further reduce our experimental uncertainties. Beyond these specific results, there are numerous applications of inertial fusion capabilities to nuclear astrophysics problems, which will be discussed.

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