HEDLA 2022
13th International Conference on High Energy Density Laboratory Astrophysics
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Exploring Stellar Nucleosynthesis and Basic Nuclear Science using High Energy Density plasmas at OMEGA and the NIF

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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. High-Energy-Density (HED) plasmas closely mimic astrophysical environments and are an excellent complement to accelerator experiments. This talk will focus on HED experiments to study the T+T reaction at the OMEGA laser facility [1], and the mirror 3He+3He reaction at OMEGA [2] and at the National Ignition Facility (NIF). The platform developed to undertake these experiments will be described [3,4], and first exciting results highlighted. We present neutron spectra from the T(t,2n)alpha (TT) reaction measured in HED experiments at ion temperatures from 4 to 18 keV, corresponding to center-of-mass energies (Ec.m.) from 16 to 50 keV. A clear difference in the shape of the TT-neutron spectrum is observed between the two Ec.m., providing the first conclusive evidence of a variant TT-neutron spectrum in this Ec.m. range [1]. Preliminary data from a recent discovery science experiment at the NIF exploring the solar 3He+3He reaction at Ec.m. from 60-120 keV will also be discussed. In addition, the talk will cover the potential of this new field of research, ongoing efforts, and future directions for studying nuclear astrophysics-relevant nuclear processes at OMEGA and the NIF. This work was supported in part by the U.S. DOE, the MIT/NNSA CoE, LLE and LLNL.

References

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