Exploring the universe through Discovery Science on NIF: an overview and highlights

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New regimes of astrophysical and planetary science are being experimentally studied at high energy density facilities around the world, spanning drive energies from microjoules to megajoules, and time scales from femtoseconds to microseconds. In this presentation, we will provide an overview of recent research done on the NIF 192 beam, NIF-ARC, Omega 60 beam, and Omega EP lasers in the US. New results from pulsed power facilities and other laser facilities in the US, Europe, and Asia will be discussed in presentations by others at this conference. A selection of examples from the NIF, ARC, Omega, and EP lasers are: target normal sheath acceleration (TNSA) protons up to 20 MeV from ARC [1]; relativistically hot electrons with a slope temperature > ~1 MeV from planar experiments with ARC [2]; plasma - nuclear reactions relevant to stellar nucleosynthesis [3,4]; deep-nonlinear multi-mode Rayleigh-Taylor (RT) instability experiments relevant to supernovae [5]; radiative shock stabilized RT instability experiments relevant to supernova remnants [6]; dynamic diffraction of carbon (diamond) in the solid state at pressures of up to 20 Mbar relevant to exoplanet interiors [7]; collisional to collisionless shock transition on NIF relevant to astrophysical shocks [8]; Weibel instability induced magnetic field generation in scaled astrophysical flows on Omega [9]; and turbulent dynamo amplification of magnetic fields on Omega and NIF relevant to the magnetic field generation mechanism in the universe [10].

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[3] Dan Casey et al., “Thermonuclear reactions probed at stellar-core conditions with laser-based inertial-confinement fusion,” Nature Phys. 13, 1227 (Dec. 2017).
[4] Maria Gatu-Johnson, “High-yield, low-areal-density fusion product sources at NIF with applications in nucleosynthesis experiments,” PoP 25, 056303 (2018).
[5] Channing Huntington, Dov Shvarts et al., PRL, in preparation (2018).
[6] C.C. Kuranz, H.-S. Park et al., “Effect of high energy fluxes on RT instability growth in young supernova remnants,” Nature Commun., in press (2018).
[7] Amy Jenei, Daye Fratanduano, Jon Eggert et al., PRL, in preparation (2018).
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[10] P. Tzeferacos, G. Gregori et al., “Laboratory evidence of turbulent dynamo amplification of magnetic fields,” Nature Communications, in press (2018).