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Astrophysical problems for which high-energy-density physics can matter[1]

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The physical scope of astrophysics is vast, spanning all of physics and more. High-energy-density physics (HEDP), concerned with dense and/or high-pressure systems corresponding roughly to energy densities above 10^{12} ergs/cc, connects with a variety of problems in astrophysics. Astrophysical problems to which HEDP can contribute connect with either the physical properties or the nondimensional dynamics now accessible in the laboratory. In assembling a model of planetary structure one must know the relation of pressure and density in the HEDP range; this is being explored in ongoing experiments. In stellar structure the situation is similar with regard to x-ray opacities. Dynamic astrophysical systems are often approximately hydrodynamic, from clump destruction by shock waves to supernova remnant evolution to post-collapse stellar explosions. These systems typically are at high Reynolds number and involve very strong shock waves, which creates the ability to undertake very-well-scaled HEDP experiments aimed at specific problems. Such experiments are now beginning to show results that are not anticipated in computer simulations, and to prove useful in working with astrophysical data. Systems having a dynamically important magnetic field are more difficult. Understanding radiating systems in astrophysics poses substantial challenges, from the atomic physics involved in photoionization to the structure of radiative shocks in several regimes to the challenge of doing accurate simulations involving both radiation and hydrodynamics. Laboratory work in these areas is much less mature, but there is progress in the study of photoionized plasmas and radiative shocks, and in related simulations.

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