3A01

Scaling astrophysical hydrodynamics to high energy density laboratory experiments

D.D. Ryutov[+]

Lawrence Livermore National Laboratory, Livermore, CA 94551, USA

Abstract

A broad range of astrophysical phenomena can be adequately described by hydrodynamic (magnetohydrodynamic) equations. In particular, astrophysical jets, photoevaporated molecular clouds, and certain stages of supernova explosions fall into this category. As was demonstrated during the past few years, properly designed laboratory experiments can provide important insights into the processes involved (e.g., [1-4]). Not only do they make possible benchmarking of codes used for simulating astrophysical phenomena but, in a number of cases, allow studying issues which are still outside the realm of computer simulations.

We discuss several phenomena that can be adequately simulated in high-energy-density laboratory experiments. After having summarized observational data and outlined the scaling issues, we describe existing and suggest new experiments. We consider the following specific problems: dynamics of photoevaporated molecular clouds (star nurseries), with an emphasis on possible role of tangled magnetic fields; momentum transfer to a core (future neutron star) in a non-spherically symmetric supernova explosion; implosion of rotating stars; and generation of magnetized jets.

We also describe a proposed experiment that allows one to make direct evaluation of the role of small-scale turbulence in high-energy-density experiments of relevance to astrophysics.

Work performed under the auspices of the U.S. Department of Energy by University of California Lawrence Livermore National Laboratory under contract W-7405-Eng-48.

[+] In collaboration with B.A. Remington.

1. Remington B A, Drake R P, Takabe H, Arnett D 1999 *Science* **284** 1488; Remington B A, Drake R P, Takabe H, Arnett D 2000 *Phys. Plasmas* **7** 1641
2. Robey H F, Kane J O, Remington B A, Drake R P, Hurricane O A, Louis H, Wallace R J, Knauer J, Keiter P, Arnett D, Ryutov D D 2001 *Phys. Plasmas* **8** 2446.
3. Lebedev S V, Chittenden J P, Beg F N, Bland S N, Ciardi A, Ampleford D, Hughes S, Haines M G, Frank A, Blackman E G, Gardiner T 2002 *ApJ* **564** 113.
4. Ryutov D D, Drake R P, Kane J O, Liang E, Remington B A, and Wood-Vasey W M 1999, *ApJ* **518** 821; Ryutov D D, Drake R P, and Remington B A 2000 *ApJ - Supplement* **127** 465; Ryutov D D, Remington B A, Robey H F, Drake R P 2001 *Phys. Plasmas* **8** 1804.