Computer experiments for supersonic turbulent flows in high-energy density plasmas

Timothy A. Handy[1], Tomasz Plewa[1], R. Paul Drake[2], Frank Modica[1], and Andrey V. Zhiglo[3]

[1]Florida State University, Tallahassee, Florida
[2]University of Michigan, Ann Arbor, Michigan
[3]Kharkov Institute of Physics and Technology, Kharkov, Ukraine

March 22, 2012

Abstract

We investigate turbulent structure emerging in shocked high-energy density plasmas produced in laser experiments by means of computer simulations, with and without a pre-existing magnetic field. Such situations commonly occur in astrophysical environments. One particularly interesting astrophysically-relevant problem is the role turbulence plays in the generation and amplification of magnetic fields.

Our early analysis of laser-driven turbulent flows indicated that one can obtain plasmas characterized by Reynolds number on the order of Re∼1000 on the Omega laser. Using scaling laws one may expect that in a similar experiment executed at the National Ignition Facility one could produce flows with Re∼5000. This regime is close to where the transition to turbulence is expected to occur. One of our goals is to optimize experimental conditions to achieve Re∼10,000, enabling the study of transition to turbulence in HED plasmas. The scaling for magnetized HED flows shows that designing an experiment characterized by a high ($\approx 1\times10^4$) Re number and a least a moderate ($\approx$ 1) magnetic Prandtl number is quite challenging. To this end,

we investigate the sensitivity of the model experimental outcomes to experimental conditions such as the laser drive, material properties (plasma Z), and variations in target fabrication and target alignment. We also briefly discuss the suitability of such an experiment for model validation studies.