Astrophysical simulations are severely constrained by limitations of space-time resolution and of computer memory. This is especially true in the presence of turbulent cascades which span many, many orders of magnitude. I describe a novel computational strategy pursued by our group at Johns Hopkins University to better understand turbulence in astrophysical plasmas, by exploiting modern database technology. We have created a public database of homogeneous MHD turbulence in space-time, consisting of 1024 frames of a 1024^3 pseudospectral simulation. Access to the data is facilitated by a Web services interface that permits numerical experiments to be run across the Internet.

Evaluation of velocity, pressure, magnetic fields, and vector potential at arbitrary points and time is supported using interpolations executed on the database nodes. This online database permits unique experiments on MHD turbulence, particularly regarding fluid Lagrangian aspects. As one example, we discuss the profound effects of turbulence on magnetic flux-conservation, which we show becomes intrinsically stochastic in the presence of a Kolmogorov-type inertial range. Turbulence allows fast magnetic reconnection by ideal, hydromagnetic mechanisms, as predicted by Lazarian & Vishniac (1999), without the need for kinetic plasma effects. Such Kolmogorov-type ranges of MHD turbulence are expected to occur widely in astrophysical systems down to scales of order the ion gyroradius, far below the numerical resolution capabilities of most large-scale, global simulations of solar flares, stellar dynamos, accretion disks, etc. Our database approach provides a “virtual microscope” of turbulence in such systems.