Supersonic Plasma Turbulence in the Laboratory

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The properties of supersonic, compressible plasma turbulence determine the behavior of many terrestrial and astrophysical systems. In the interstellar medium (ISM) and molecular clouds (MCs), compressible turbulence plays a vital role in star formation and the evolution of our galaxy. Observations of both the density and velocity power spectra in the Orion B and Perseus molecular clouds show large deviations from those predicted for incompressible turbulence. Hydrodynamic simulations attribute this to the high Mach number in the ISM, although the exact details of this dependence are not well understood. Here we investigate experimentally the statistical behavior of boundary-free supersonic turbulence created by the collision of two laser-driven high-velocity turbulent plasma jets. We find a Mach number dependence in the slopes of both the density and velocity power spectra, which agrees with astrophysical observations of the Orion B and Perseus molecular clouds. Finally, we compare our results to existing 3-D hydrodynamic simulations of compressible turbulence.