DPP14-2014-000988

Abstract for an Invited Paper
for the DPP14 Meeting of
the American Physical Society

Magnetohydrodynamic Turbulence: Observation and Experiment[1]

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Turbulence has been studied in laboratory plasmas for decades. Magnetic and electrostatic turbulence fluctuations have been implicated in degraded confinement in fusion devices so understanding turbulent transport is critical for those devices. Magnetic turbulence in laboratory plasmas has received less attention. Internal magnetic measurements in fusion plasmas are difficult. In addition, the externally applied magnetic field in most laboratory plasmas has a strong effect on the character of the turbulence (particularly parallel and perpendicular to the applied field). The solar wind is the best studied turbulent MHD plasma. There have been some recent advances in solar wind measurements using multiple satellites and high bandwidth instruments. We will review some recent observations in solar wind turbulence, as well as measurements of magnetic turbulence in laboratory plasmas. We will discuss the analysis techniques common to both, such as correlation functions, structure functions, and spectra. Finally, we will describe a new turbulent plasma source with several unique features called the MHD plasma wind tunnel. First, the MHD wind tunnel configuration has no applied magnetic field and has no net axial magnetic flux. Second, the plasma flow speed is on the order of the local sound speed ($M = 1$), so flow energy is comparable to thermal energy. Third, the plasma β (ratio of thermal to magnetic pressure) is of order unity so thermal energy is comparable to magnetic energy. We will present some initial results from the SSX MHD wind tunnel, including a recent observation of turbulent intermittency.

[1]Work supported by DOE OFES and NSF CMSO.