New Developments in the Theory of Incompressible MHD Turbulence with $Pr_m = 1$

J.J. Podesta, Los Alamos National Laboratory, Los Alamos, NM 87545 USA

For incompressible MHD turbulence, the correlation lengths along directions parallel and perpendicular to the local mean magnetic field may be defined by iso-energy surfaces derived from second order structure functions. The correlation time of the turbulence may be defined in a similar manner by means of a temporal second order structure function. Moreover, there is a natural correspondence between the lengthscales of fluctuations with a given energy and the timescale of fluctuations of the same energy so that each iso-energy surface is associated with a unique pair of parallel and perpendicular correlation lengths and a unique correlation time. In the case when the magnetic Prandtl number is unity, $Pr_m \equiv \nu/\eta = 1$, it is shown that the correlation time $\tau$ associated with an iso-energy contour of energy $E$ is equal to the energy cascade time of the turbulence in the sense that $E/\tau \sim \varepsilon$, where $\varepsilon$ is the energy cascade rate. For balanced MHD turbulence, both the Goldreich and Sridhar theory and the Boldyrev theory are shown to have this same property. I conjecture that the same property also holds for imbalanced MHD turbulence, that is, MHD turbulence with nonvanishing cross-helicity. These and other recent developments in the theory of incompressible MHD turbulence with $Pr_m = 1$ are discussed.

J. J. Podesta
Los Alamos National Laboratory, Los Alamos, NM 87545 USA

Date submitted: 12 Jul 2010

Electronic form version 1.4