Magnetotail turbulence

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Abstract

"TURBULENCE" traditionally was a generic word for an ensemble of perturbations with random, erratic phases, i.e. meaning something disorganized and unpredictable. Conditions in the Earth's magnetotail as in an open system filled by high beta plasma are favorable for selforganization to the hierarchy of multiscale structures. Modern view on magnetotail is much more complex-low frequency 'turbulence' may, in fact, consists of well correlated regions, forming multiscale clots, permanently growing and decaying in magnetotail plasma. Particle dynamics in high – beta magnetotail plasma is usually nonadiabatic and often chaotic even in a simplest models of magnetotail magnetic field. Especially entangled particle orbits become in a "turbulent" magnetic geometry. This complicates usual eigen mode analysis because standard instabilities expected to develop in magnetotail (tearing, drift-kink, low –hybrid) appears to be strongly coupled. Scale invariance of magnetic structures very well manifested in experimental data (although only in a limited interval of scales) allows to use methods of fractal geometry for description of processes in the magnetotail. This approach appears to be especially productive when magnetotail state is close to so called non-equilibrium steady state (NESS). One could view such state as a result of nonlinear interactions and final saturation of numerous low frequency plasma sheet instabilities. Very often analysis of a higher order moments of probability distribution function shows that "turbulence" is intermittent and could be better described as a multifractal. "Turbulent" sheets have more chances to be observed far downstream in the tail where the stabilizing influence of the remnants of the Earth's magnetic field almost vanishes. In this region "turbulence" become the principal ingredient of a global distant tail structure which allows it to be stretched over hundreds of Re. Role of "turbulence" in the near-Earth tail and substorm initiation is more disputable. Low frequency hybrid type turbulence driven by cross-field current instability is often invoked to explain enhanced resistivity in a popular current disruption models. We will discuss available experimental data to reveal the role of "turbulence" both as a structural element of magnetotail quasi-equilibrium configuration and as a driving agent of magnetotail dynamical reconfigurations.