Observational aspects of electron scale turbulence

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The nature of the magnetic field fluctuations in the solar wind at plasma kinetic scales is still under debate. This kinetic scales turbulence starts around ion scales and goes up to sub-electron scales. It is now well established that at ion scales there is a superposition of the turbulent cascade and ion temperature anisotropy instabilities. Because of this superposition the turbulent spectrum is not-universal within the frequency range of $[0.1, 2]$ Hz. At higher frequencies in the satellite frame (i.e. at smaller scales), nearly universal spectrum of $f^{-2.8}$ is observed in the free solar wind. This spectrum goes up to the electron scales (observed around $30 - 60$ Hz in the satellite frame). The nature of this turbulent cascade between ion and electron scales is not completely clear: there are observational arguments in favor of the kinetic Alfvén waves cascade. There are also observations showing presence of coherent structures at these scales. I will discuss as well compressibility and wave vector anisotropy of magnetic fluctuations of this small scale cascade. At electron scales, the turbulent spectrum changes its shape following an exponential cut-off or a break as function of the presence of parallel propagated whistler waves in the signal. These waves, at $f \simeq 0.02 - 0.5 f_{ce}$ (f_{ce} being the electron cyclotron frequency), may appear very sporadically (lasting for a fraction of a second) or they may persist for minutes or hours as a function of the presence of the electron heat flux higher than a certain threshold. The role of these parallel propagating whistler waves in shaping of the solar wind electron distribution function will also be discussed.