The role of waves and turbulence in the solar wind plasma

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Abstract

The solar wind is the background state of the heliosphere consisting of fast and slow components originating in various parts of the solar corona. However, the processes that lead to the solar wind heating and acceleration are not fully understood, and their study is one of the main goals of the near-future Parker's Solar Probe and Solar Orbiter missions. The main challenge in understanding the solar wind is connecting the large scale fluid-like to small scale kinetic processes. The ion composition of the solar wind is an important property that provides signatures of the solar wind formation, sources in the corona, and acceleration. In particular, the alpha particle can carry significant fraction of the solar wind momentum and energy flux. I will review briefly the current understanding of the solar wind acceleration and heating physical mechanism (focusing on the fast wind), and will present the observational evidence for waves, turbulence, and kinetic dissipation. I will discuss the results of numerical models of the multi-ion solar wind plasma, using 2.5D and 3D hybrid models, demonstrating the effects of kinetic dissipation of turbulent wave spectra and instabilities, and will discuss the role of alphas on the instabilities, and on the solar wind heating. The models provide the anticipated waves spectra, dispersion relation, and velocity distribution functions (VDFs) of protons and ions, that can be used as signatures of the kinetic heating processes in the solar wind in future observations in the inner heliosphere.