Nature and origin of the electron distribution functions in the slow and fast solar wind at 1 AU: Wind observations

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The non equilibrium characteristics of the solar wind electron distribution functions (EDFs) at 1 AU are of great importance in many aspects, for instance in understanding heat conduction, plasma microinstabilities and transport in weakly collisional plasma, as well as in the scenario at the origin of the solar wind. It has been known for a long time that, in the free solar wind, EDFs display both thermal ("core") and suprathermal ("halo" and "strahl") populations; more recently a super-halo population has also been identified. The usual model used to characterize the observed solar wind EDF is a sum of two bi-Maxwellians, the core-halo model, with a core-halo drift velocity oriented along the interplanetary magnetic field. Other recent works have emphasized the Lorentzian nature of EDFs, i.e. the importance of their suprathermal tails, which should play a crucial role in the exospheric expansion of the slow and fast solar wind. Based on either the core-halo or the Lorentzian (or Kappa) models, kinetic instabilities in space plasma have been discussed in the literature and wave growth rates have been calculated. However both models are not appropriate to accurately characterize the solar wind EDFs because they do not account properly for some important features of the observed EDFs. It is therefore important to determine and characterize more precisely the nature of the EDFs, and in particular the nature of their suprathermal tails, in the two typical solar winds.

The 3DP experiment on the WIND spacecraft provides measurements of the full 3D electron distributions from energies of the order of few eV to above 100 keV, with a high-sensitivity, wide dynamic range, good energy and angular resolutions, and high time resolution (3s). Wind's in-ecliptic orbits cover prolongated periods in the ambient, slow and fast, solar wind near L1, during the last minimum of solar activity. New characteristics of EDF are established and their origins are discussed. Their consequences in different field of space plasma processes are also investigated.