

In-situ observations of solar wind electrons: Interplay between thermal core and suprathermals

C. Salem, M. Pulupa

Space Sciences Laboratory, University of California at Berkeley, USA

The non equilibrium characteristics of the solar wind electron velocity distribution functions (eVDFs) at 1 AU are of great importance 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. Solar wind eVDFs display a thermal Core and a suprathermal Halo populations present at all pitch angles, as well as a third antisunward field-aligned component, called Strahl. The usual model used to characterize the solar wind eVDFs has been a sum of two bi-Maxwellians, the core-halo model, with a core-halo drift velocity oriented along the interplanetary magnetic field. This model was used in the past to derive micro-instabilities and calculate wave growth rates.

Other works have emphasized the Lorentzian nature of eVDFs, 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. 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 slow and fast solar wind. The associated problem of the electron heat conduction has also attracted space plasma physicists for a long time. Yet, the mechanisms that determine the electron energy transport and dissipation in the solar wind are far from being understood. We present a review of our latest work based on statistical analysis of solar wind electrons at 1AU using a newly developed dataset of (several years of) accurate measurements of core, halo and strahl electron parameters from the 3D-Plasma experiment on NASAs Wind spacecraft. We investigate the properties of these different populations. We explore the physical processe(s) that likely act to control and regulate them. We review new results obtained on: electron temperature anisotropies and their variation with collisions and/or solar wind fluctuations and instabilities; properties of core and halo drifts in the solar wind frame; electron heat flux; and electron strahl. These new observations emphasize the non-negligible role of Coulomb collisions in shaping the eVDFs and regulating core and suprathermals, combined to that of electromagnetic fluctuations (turbulence/waves/instabilities).

[1] Salem et al., JGR, in preparation (2017).

[2] Pulupa et al., JGR **119**, issue 2 (2014).

[3] Salem et al., ESA SP-641 (2007).