

Skew-Kappa distribution functions & whistler-heat-flux instability in the solar wind: the core-strahlo model

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Abstract:

Electron velocity distributions in the solar wind are known to have field-aligned skewness, which has been characterized by the presence of secondary populations such as the halo and strahl. Skewness may provide energy for the excitation of electromagnetic instabilities, such as the whistler heat-flux instability (WHFI), that may play an important role in regulating the electron heat-flux in the solar wind. Here we use kinetic theory to analyze the stability of the WHFI in a solar-wind-like plasma where solar wind core, halo and strahl electrons are described as a superposition of two distributions: a Maxwellian core, and another population modeled by a Kappa distribution to which an asymmetry term has been added, representing the halo and also the strahl. Considering distributions with small skewness we solve the dispersion relation for the parallel propagating whistler-mode and study its linear stability for different plasma parameters. Our results show that the WHFI can develop in this system, and we provide stability thresholds for this instability, as a function of the electron beta and the parallel electron heat-flux, to be compared with observational data. However, since different plasma states, with different stability level to the WHFI, can have the same moment heat-flux value, it is the skewness (i.e. the asymmetry of the distribution along the magnetic field), and not the heat-flux, the best indicator of instabilities. Thus, systems with high heat-flux can be stable enough to WHFI, so that it is not clear if the instability can effectively regulate the heat-flux values through wave-particle interactions.

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