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Skew-Kappa distribution functions & whistler-heat flux instability in the solar wind

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Electron velocity distributions in the solar wind are known to have field-aligned skewness, which has been observationally characterized by the presence of secondary populations such as the halo and strahl electron components. This non-thermal feature provides energy for the excitation of electromagnetic instabilities that may play a role in regulating the electron heat flux in the solar wind by wave-particle interactions. Among the wave modes excited in regulating the electron non-thermal features is the whistler-mode and its so-called whistler heat-flux instability (WHFI). In this work, we use kinetic linear theory to analyze the stability of the WHFI in a solar wind like plasma where the electrons are described as a single population modeled by a Kappa distribution to which an asymmetry term has been added. We solve the dispersion relation numerically for the parallel propagating whistler-mode and study its linear stability for different plasma parameters. We also show the marginal stability thresholds for this instability as a function of the electron beta and the parallel electron heat flux and present a threshold condition for instability that can be modeled to compare with observational data. The principal result is that the WHFI can develop in this system; however, the heat flux parameter is not a good predictor of how unstable this wave mode will be. This is because different plasma states, with different stability to WHFI, can have the same initial heat flux. Thus, systems with high $q_{\|e}/q_0$ can be stable enough to WHFI so that it cannot effectively modify the heat flux values through wave-particle interactions