Waves and Instabilities in Plasmas Containing Superthermal Particles

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In collisionless space and astrophysical plasmas, particle distributions in velocity space can depart considerably from being a Maxwellian. In particular, the observed velocity distributions have prominent high-energy power-law tails that can be better modeled by the generalized Lorenzian distributions, also known as the kappa distributions. The presence of a substantially larger number of superthermal particles, which distinguishes the kappa distribution from the Maxwellian, can significantly change the rate of resonant energy transfer between particles and plasma waves. Consequently, it can change the growth or damping rate and the excitation conditions for instability as well as the rate of anomalous transport processes that rely on wave-particle interactions. We have studied lower-hybrid modes [1] and temperature-anisotropy driven electromagnetic modes such as mirror modes [2], field-swelling modes [3], and fire-hose modes [2] for velocity distributions along the ambient magnetic field as kappa distributions and those in the perpendicular direction as Maxwellians. Supported in part by the U.S. DOE.

[1] B. Coppi, F. Pegoraro, *et al., Nucl. Fusion* **16**, 309, 1976.
[2] W.B. Thompson, *Rep. Prog. Phys*. **24**, 363, 1961.
[3] B. Basu and B. Coppi, *Phys. Rev. Lett*. **48**, 799, 1982.