The Subtracted-Kappa distribution and its properties

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We introduce a new particle distribution function in space plasma physics called the subtracted-kappa (S-K) distribution.This new distribution incorporates a loss-cone feature and an enhanced high-energy tail characterized by the spectral index kappa.The S-K distribution is a generalization of the well-known subtracted-Maxwellian and approaches the latter distribution in the limit as kappa tends to infinity.Further,the S-K distribution usefully includes the bi-kappa and kappa-loss-cone distributions as special cases. Two sources of free plasma energy are provided by the S-K distribution,namely the loss-cone property and the thermal anisotropy. Both free energy sources can excite wave growth.In this study we briefly consider the influence of the S-K distribution on three wave phenomena: (a) linear growth of whistler-mode waves generated by an injection of hot electrons into a cold plasma, (b) dispersion of R-mode and L-mode electromagnetic waves in a hot plasma,and (c) transition from linear to nonlinear growth of electromagnetic waves as determined by a critical boundary in the input-parameter space. There are many possibilities for future projects involving the S-K distribution. Charged particle distributions in space typically possess a pronounced high-energy tail that can be modelled approximately by a kappa distribution .and so the S-K distribution is an ideal tool for analyzing kinetic waves and micro-instabilities in space plasmas. Potential future projects related to this study include (i) incorporation of the S-K distribution in state-of-the-art particle simulations of whistler-mode chorus waves, (ii) influence of the S-K distribution on the nonlinear growth rates of whistler-mode emissions, (iii) use of the S-K distribution to analyze the instability of fast magnetosonic waves ("equatorial noise") by proton ring distributions, (iv) role of the S-K distribution in the resonant scattering of plasmasheet electrons by electrostatic electron cyclotron harmonic waves leading to diffuse auroral precipitation, and (v) employing the S-K distribution to investigate properties of particle precipitation induced by electromagnetic ion cyclotron waves in planetary magnetospheres. The S-K distribution involves five parameters comprising the spectral index kappa,the parallel and perpendicular thermal speeds,and two parameters that shape the loss-cone. We can readily adapt the distribution also to incorporate a parallel drift in the direction of the ambient magnetic field. In addition,we may formulate a composite distribution containing a finite sum of component S-K distributions. Such component distributions have the advantage of being set in a multi-dimensional parameter space,and so can be used to match complex experimentally measured phase-space density profiles in space plasmas.