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Turbulent Equilibria for Charged Particles in Space

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The solar wind electron distribution function is apparently composed of several components including non-thermal tail population. The electron distribution that contains energetic tail feature is well fitted with the kappa distribution function. The solar wind protons also possess quasi power-law tail distribution function that is well fitted with an inverse power law model. The present paper discusses the latest theoretical development regarding the dynamical steady-state solution of electrons and Langmuir turbulence that are in turbulent equilibrium. According to such a theory, the Maxwellian and kappa distribution functions for the electrons emerge as the only two possible solution that satisfy the steady-state weak turbulence plasma kinetic equation. For the proton inverse power-law tail problem, a similar turbulent equilibrium solution can be conceived of, but instead of high-frequency Langmuir fluctuation, the theory involves low-frequency kinetic Alfvenic turbulence. The steady-state solution of the self-consistent proton kinetic equation and wave kinetic equation for Alfvenic waves can be found in order to obtain a self-consistent solution for the inverse power law tail distribution function.