Marginal Stability Constraint on Runaway Electron Distribution

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High-frequency kinetic instabilities of the strongly anisotropic runaway electrons can enhance the pitch-angle scattering of the runaways significantly. This wave-induced scattering can easily prevail over runaway scattering on high-Z impurities.

In a steady state, collisional damping balances the kinetic drive of the unstable waves, keeping the RE distribution function at marginal stability. The marginal stability constraint limits the achievable RE densities and the shape of the RE distribution function.

In this study, we consider whistler waves as the primary source of enhanced elastic scuttering of the runaways. By balancing the anomalous Doppler resonance drive with the collisional wave damping, we find the runaway electron distribution function in the ultra-relativistic range of the phase space. We also derive an expression for the spectral energy density of the waves. We show that the power needed to compensate for the wave dissipation is negligible compared to the work of the electric field. The latter is in balance with the synchrotron losses of the runaway electrons.

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