Finite Length Effects on Collisional Damping of Plasma Waves in Single-Species Plasmas

M.W. ANDERSON, T.M. O’NEIL, F. ANDEREGG, C.F. DRISCOLL, UCSD — A recent paper analyzed the collisional damping of a plasma wave propagating on a single-species plasma column of infinite length. For high-phase-velocity \( \omega/k_z \) and weak collisions \( \nu_{\perp \parallel} \), the predicted damping rate is \( \gamma \approx -\nu_{\perp \parallel}(k_z v_{th}/\omega)^2 \), where \( v_{th} \equiv \sqrt{T/m} \). Measurements of the \( k_z = \pi/L_p \) mode on Mg\(^+\) plasmas corroborate the temperature and density scaling implicit in this formula; however, the measured damping rates are about 40\( \times \) greater than predicted. Here we investigate finite-length effects as a possible source of this discrepancy. The ends of a plasma column couple higher \( k_z \) components to the fundamental mode; and these high-\( k_z \) components should enhance collisional damping. Motivated by this intuitive picture, we derive a generalized integral expression for the collisional damping rate that allows for arbitrary \( z \)-dependence in the waveform. We find that small amplitude high-\( k_z \) components can provide the dominant contribution to the mode damping, bringing theory and measurements into better accord.

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