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Collisional Effects on Nonlinear Ion Drag Force for Small Grains[1]

I.H. HUTCHINSON, C.B. HAAKONSEN, MIT — Ion drag force arising from plasma flow past an embedded grain in a plasma is a vital part of dusty plasma dynamics. Ion-neutral collisions are often significant for experimental dusty plasmas. They are here included self-consistently in properly nonlinear comprehensive drag calculations, for the first time. The ion drag on a spherical grain is calculated using particle in cell codes SCEPTIC and COPTIC. Using ion velocity "drift" distribution appropriate for flow driven by a force field gives wake potential and force greatly different from a shifted Maxwellian distribution, regardless of collisionality level. The low-collisionality forces are shown to be consistent with estimates based upon cross-sections for scattering in a Yukawa (shielded) grain field, but only if nonlinear shielding length is used. Finite collisionality initially enhances the drag force, but only by up to a factor of 2. Larger collisionality eventually reduces the drag force. In the collisional regime, the drift distribution gives larger drag than the shift distribution even at velocities where their collisionless drags are equal. Comprehensive practical analytic formulas for force that fit the calculations are provided.

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Ian Hutchinson
MIT

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