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Convergence of fluid and kinetic models in the high pressure limit
MILES M. TURNER, SEAN KELLY, Dublin City University, Ireland, ANN BOURDON, Ecole Polytechnique, France — Kinetic models (such as particle-in-cell simulations) are usually accepted as offering an fundamentally accurate description of low-temperature plasmas, albeit at high computational cost. Fluid models are far more economical, but less accurate. A common strategy for supplying electron transport and rate constants to a fluid model is to solve a fluid energy transport equation, and use the mean energy so computed to interpolate data obtained from a solution of the Boltzmann equation, often using the two-term spherical harmonic expansion. The fluid approach and the kinetic approach should then converge at sufficiently high pressure, where the local field approximation applies. In this work we compare the fluid and kinetic approaches for a capacitively-coupled discharge in helium over a wide range of pressures. We find that a regime of convergence is difficult to find, and perhaps does not exist under conditions where a uniform glow discharge occurs experimentally. We conclude that, in this case, the uncertainty introduced by the fluid model formulation is likely comparable with the uncertainty associated with basic data. Consequently, the basic fluid model formulation is a factor limiting the predictive capability of many present plasma simulations.

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