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**Recent advances in the kinetic theory of hydrodynamic and non-hydrodynamic charged particle swarms in gases**[1]

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Recent developments in plasma processing technology using non-equilibrium plasma discharges have led to a resurgence of interest in the fundamental kinetic theory of charged particles in gases. In this work we outline the current status of both the hydrodynamic and non-hydrodynamic kinetic theory of charged particle swarms with the goal of reconciling the plasma and swarm literature. Three fundamental issues: (i) the temporal and spatial non-local behavior; (ii) the effects of magnetic fields and field orientations on the transport properties, and (iii) the duality in transport coefficients arising from non-conservative collisions (attachment/ionization), are discussed for electrons for certain model and real gases. Much research has been devoted to interpretation of transport data obtained under different experimental arrangements and their proper use in plasma models. Two complimentary techniques are employed: a multi term solution of Boltzmann's equation and Monte Carlo simulation technique, both adapted to consider the time-dependent hydrodynamic and steady state non-hydrodynamic conditions. New and significant numerical results are presented to highlight the rich and diverse range of kinetic phenomena observed in varying configurations of time-dependent electric and magnetic fields. We systematically study the origin and mechanisms for such phenomena, their sometimes paradoxical manifestations and possible physical implications which arise from their explicit inclusion into plasma models.

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