BOLTZMANN EQUATION ANALYSIS OF ELECTRON SWARMS IN COMBINED AC AND DC ELECTRIC AND MAGNETIC FIELDS IN GASES

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In recent years interest in charged particle transport processes in neutral gases under the conditions of combined ac and dc electric and magnetic fields has been revived. This interest was motivated by the desire to understand the physics underlying the operation of magnetically controlled/assisted ac plasma discharges in which magnetic field affects both the electron heating mechanisms and charged particle species transport. With these remarks as background, the groups at the James Cook University in Townsville (Australia) and Institute of Physics in Belgrade (Serbia) have undertaken a program to understand the kinetic behavior of charged particle swarms under the combined action of electric and magnetic fields in neutral gases. Two complementary techniques are developed and employed: a multi-term solution of Boltzmann's equation[1] and Monte Carlo simulation technique[2], both adapted to consider the time-dependent hydrodynamic and steady state non-hydrodynamic conditions. We systematically investigate the explicit effects associated with the electric and magnetic fields strengths, field frequency, field phases and field orientations on the electron transport properties under conditions which can be generally found in magnetically controlled/assisted rf discharges. In particular, we discuss the duality in transport coefficients arising from non-conservative collisions (ionization and attachment). Calculations of the transport properties revealed numerous interesting and sometimes unexpected kinetic phenomena, generally inexplicable through the use of dc steady-state results. Phenomena of significant note include the existence of transient negative diffusivity, time-resolved negative differential conductivity and anomalous behavior of certain diagonal elements of the diffusion tensor in ac electric and magnetic fields.

1. R. D. White, R. E. Robson, S. Dujko, P Nicoletopoulos and B Li, "Recent advances in the application of Boltzmann equation and fluid equation methods to charged particle trans port in non-equilibrium plasmas", J. Phys. D: Appl. Phys. **42** (2009) 194001.
2. S. Dujko, R. D. White, K. F. Ness, Z. Lj. Petrović and R. E. Robson, "Non-conservative electron transport in CF4 in electric and magnetic fields crossed at arbitrary angles", J. Phy s. D: Appl. Phys. **39** (2006) 4788.

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