TEMPORAL RELAXATION OF ELECTRON SWARMS IN ELECTRIC AND MAGNETIC FIELDS CROSSED AT ARBITRARY ANGLES

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The theoretical investigations of electron swarms moving in an unbounded gas in electric and magnetic fields is a topic of great interest both as a problem in basic physics and for its potential for application to modern technology such as plasma processing. One of the major challenges in these investigations is an accurate representation of temporal and spatial relaxation of electrons. From a purely physical point of view, the knowledge of temporal relaxation is essential for a better understanding of electron-molecule interaction in short time intervals as well as a better understanding of transient transport phenomena in gases such as transient negative electron mobility [1]. The correct estimation of relaxation times for electron swarm transport parameters is important in experimental swarm physics, e.g., for design of the drift tubes. On the other hand, from an applied point of view, studies of temporal relaxation play a vitally important role in modeling of low-temperature, non-equilibrium plasmas. As an illistrative example, the relaxation times of the electron transport properties are necessary input data for fluid plasma models such as the relaxation continum model [2].

With these remarks as background, the groups at the Institute of Physics in Belgrade and James Cook University of Townsville have undertaken a program to understand the transient kinetic behavior of electron swarms under the combined action of electric and magnetic fields. The scope of this program covers a variety of hydrodynamic and non-hydrodynamic studies on the electron swarm relaxation by using a fully kinetic Monte Carlo simulation code [3] and multi-term theory for solving the Boltzmann equation [4]. In this work we study the temporal relaxation problem for the electron swarm in electric and magnetic fields crossed at arbitrary angles. Similar studies have been published previously for neon using the two-term approximation [5]. We extend these studies by (i) overcoming the inherent inaccuracies of the two-term approximation and (ii) addressing the temporal relaxation of spatial inhomogenities through a study of the diffusion tensor.

References

[1] J.M. Warman, U. Sowada and M.P. De Haas, *Phys. Rev. A* **31** (1985) 1974.
[2] N. Nakano, N. Shimura, Z.Lj. Petrović and T. Makabe, *Phys. Rev E.* **49** (1994) 4455.
[3] Z.Lj. Petrović, Z.M. Raspopović, S. Dujko and T. Makabe, *Appl. Surf. Sci.* **192** (2002) 1-25.
[4] R.D. White, R.E. Robson and K.F. Ness, *Appl. Surf. Sci.* **192** (2002) 26-49.
[5] D. Loffhagen and R. Winkler, *IEEE Trans. Plasma Sci.* **27** (1999) 1262.