KINETIC AND FLUID MODELLING OF NON-EQUILIBRIUM TRANSPORT OF CHARGED-PARTICLE SWARMS IN NEUTRAL GASES AND NON-POLAR LIQUIDS

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Abstract. This work contains two parts. The first part deals with the study of the third-order transport coefficients. The components of the third-order transport tensor are required for the conversion of the hydrodynamic transport coefficients into transport data that is measured in the arrival time spectra and the steady-state Townsend experiments. In this work, we have determined the structure of the third-order transport tensor in all configurations of the electric and magnetic fields, by using the group projector method, see Simonović et al. 2020. Moreover, we have carefully analyzed the physical interpretation of the individual components of this tensor, by examining their contribution to the flux gradient relation and to the approximate solution of the generalized diffusion equation. We have also examined the dependence of the third-order transport coefficients on the elementary scattering processes in a wide range of model and real gases, by using Monte Carlo simulations and multi term theory for solving the Boltzmann equation.The second part of this work deals with the electron transport in liquid argon, liquid krypton, and liquid xenon (the high mobility liquids), as well as with the transition of an electron avalanche into a negative streamer in these liquids. These three liquids represent the simplest systems in which quasi-free electrons exist in the liquid-phase medium, and they are an excellent starting point for the modeling of charged particle transport and electrical discharges in liquids. In this work, the transport of electrons in the high mobility liquids is investigated by employing Monte Carlo simulations, see Simonović et al. 2019. Our existing Monte Carlo code has been modified in order to enable a good representation of the coherent scattering effects. A special emphasis has been placed on studying the structure induced negative differential conductivity in liquid xenon, by employing the spatially resolved swarm data. Another point of interest was the influence of various representations, of the inelastic scattering in the liquid phase, on the ionization rate coefficient. The transport properties of electrons in the high mobility liquids, that were obtained by employing Monte Carlo simulations, were used as an input data in the 1.5D implementation of the first order fluid model. This fluid model was used to investigate the formation and propagation of negative streamers in these liquids. Among several important points, we have investigated the influence of various representations of the inelastic collisions on the dynamics of the formation and propagation of negative streamers in these liquids.

References

Simonović, I., et al.: 2020, *Phys. Rev. E*, **101**, 023203.
Simonović, I., et al.: 2019*, Plasma Sources Sci. Technol.*, **28**, 015006.