

Non-Local Behaviour of the Electron Component in Non-Equilibrium Plasmas

R. Winkler

Institute of Nonthermal Plasma-Physics, D-17489 Greifswald, Germany

In several regions of conventional discharge plasmas a special spatial structure of the plasma occurs and distinctly nonlocal properties of the electron component are of significant importance for the plasma behaviour. In this context it should be mentioned, for example, the discharge regions in front of electrodes, in the surrounding of enforced plasma constrictions or of inserted grids, in front of isolating walls which confine the plasma and in moving and standing striations.

Concerning the electron kinetics in electrode regions, which are generally characterized by large electric fields with rapid change in space, many investigations have already been performed. However with respect to the further mentioned spatially nonuniform plasma regions where smaller electric fields are present several tasks, with more or less success, have been undertaken in the past to reveal and to understand the electron kinetics and the global plasma behaviour.

It is the objective of this paper to contribute by theoretical studies on the spatially nonuniform electron kinetics to a better understanding of the behaviour of the electron component in nonuniform plasma regions at moderate fields acted upon the electrons. The non-local behaviour of the electrons in these plasma regions is mainly determined by their spatial relaxation properties.

To model plasmas in such regions, with respect to the appropriate electron kinetics often rough simplifications, as the local field approximation, have been adopted. This approximation lastly assumes that the action of the electric field on the electrons is largely compensated for by the collisions of electrons with atoms or molecules at each space position and thus a larger spatial delay with respect to the local field due to finite relaxation lengths is of less importance.

In order to illustrate the pronounced non-local behaviour of the electron component in such plasmas detailed results on their kinetics will be reported for following problems:

- Relaxation of plasma electrons injected into a uniform electric field
- Response of plasma electrons on spatial disturbances in the electric field
- Electron kinetics in case of space charge field confinement in a dc plasma column

By numerically solving the appropriate electron kinetic equation the non-local behaviour of the velocity distribution, of the significant macroscopic quantities and of the particle, energy and momentum balance of the electrons at moderate electric fields could be determined and analysed. Large relaxation lengths in some gases have been found which are responsible for a pronounced non-local behaviour of the electrons.