Electron Transport in Dense Gases and more

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Electron transport in dielectric liquids has been investigated for several decades now and a large wealth of data is available. In simple high-mobility liquids the electric field dependence of the electron mobility closely resembles that in a dilute gas of hard-spheres and can be quite successfully described by means of the solution of the two-term expansion of the Boltzmann transport equation.

This approach, essentially due to Cohen and Lekner, retains the single scattering picture of kinetic theory, valid for dilute gases, because of the large electron mean free path in the liquid and introduces a suitable scattering cross section, which has to be considered as an adjustable parameter. Multiple-scattering corrections introduced by several authors have improved this approach and describe relatively well the density dependence of the electron mobility. A different route, directly based on multiple scattering, has been followed by Basak and Cohen, but it is not as satisfactory as the single-scattering picture to describe the density and electric field behavior of the electron mobility.

On the other hand, the equations of kinetic theory are correctly used in the realm of dilute gases in order to gather pieces of information on the electron-atom interaction potentials. However, for the same atomic species, there is no simple relationship between the cross section determined in the dilute gas and that in the liquid. Only at high electric fields, hence at high mean electron energy, the cross section in the liquid apparently approaches that of the single atom in the gas.

A way to bridge the gap between the description of the dilute gas and that of the liquid is to study the electron transport in a compressed gas as a function of density in order to see how multiple scattering effects develop and affect the dynamics and energetics of the electrons.

In this lecture the transport properties of electrons in the simplest gaseous systems, i.e. the noble gases, will be reviewed. It will be shown that from the experimental data a unified picture of the electron-atom scattering in the dense medium emerges, in which all multiple scattering effects cooperate with each other in a very predictable way in gases of very different polarizability so as to yield the apparently different experimental results. It will also be shown how the extrapolation of the dense gas results to even higher densities may suggest a way to interpret the experimental outcome in the simple dielectric liquids.

Other physical phenomena, some of which are not strictly related to electron transport, such as the self-trapping of electrons in bubbles, responsible of the low electron mobility in He and Ne, the resonant attachment of electrons to electronegative impurities like O_2, or even the density-dependent redshift of the infrared light emitted by noble gas excimers produced by electron impact excitation of noble gases will be presented and will find a coherent interpretation in terms of the unified picture of electron-atom scattering in a dense medium obtained from the analysis of the electron mobility.