Electron swarms and cross section data

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Once a physically proper set of electron collision cross sections is determined, we can uniquely obtain electron swarm properties, which are even difficult to be observed experimentally, e.g. the electron energy distribution function $F(\varepsilon)$, using the Boltzmann equation. Cross section values are determined by a *beam method* or *swarm method*. The former gives basically detailed structure with high-energy resolution in the cross section, however, for a set of them in a gas it is not so easy. In particular in low electron energies the cross section resolution degrades. The latter method was introduced for evaluation of H_2 and N_2 cross sections by Phelps [1]. After that, a set of the cross sections in a wide range of electron energies ε for various gases have been studied using a swarm method. In general, electron swarm properties in a gas are determined by binary collisions between an electron and a gas atom (or molecule). The energy gain of an electron in a free flight path λ (= $(NQ)^{-1}$) is determined by E/N value (E: electric field strength in V/cm, and N: the particle number density in cm^{-3}, $10^{-17}Vcm^2$=1 Td).

In the present talk, a several gases with distinctive featured cross sections are taken and the electron swarm properties brought by the cross sections are described, such as,

1) A set of electron collision cross sections for He and Ne: An interesting point is that the momentum transfer cross section Q_m of Ne in low energies is smaller than that of He, though the atomic mass of Ne is larger than the He [2]. For many applications of both gases to be a buffer gas, this property should be considered.
2) Gases with strong ionization and attachment: In a swarm system with strong ionization and/or attachment, the electron number density in the swarm varies with time and is not conserved at all. In a such system, $F(\varepsilon)$ depends on position x in the direction of the field, i.e. $F(\varepsilon,x)$. Consequently the electron drift velocity W_V defined in $\boldsymbol{v}$-space differs from the average velocity of electrons $W_\mathbf{r}$ in real space [3].
3) Effect of Ramusauer-Townsend (R-T) minimum: The Q_m with R-T minimum affects the W and diffusion constant ND_L in low E/N, significantly. Featured structures in W and ND_L in Ar and its mixtures are seen for E/N around 0.005 and 5 Td [4]. In the mixtures the W depends strongly on the mixture ratio in low E/N.
4) Effect of Penning ionization in gas mixtures[4], effective value of excitation cross section for rare gases[5], and others.

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