BULL. AUSTRAL. MATH. SOC.
VOL. 8 (1973), 479-480.

70F35

Inelastic collision processes in the Townsend-Huxley diffusion experiment

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The behaviour of electrons in the Townsend-Huxley diffusion experiment is examined theoretically with a view of gaining some further understanding of the way electrons interact with molecules, or atoms.

The discussion is centred around the Boltzmann transport equation. This equation is set up and solved for conditions which are characteristic of the Townsend-Huxley experiment. Density gradients, and some inelastic collision processes, are included in the analyses of the constant cross-section and constant collision frequency modes of electron-molecular interaction. Inelastic collisions in which the electrons do not lose much of their energy to the molecules are discussed. This assumption enables an inelastic parameter to propagate through the analysis.

In the consideration of the constant cross-section interaction, a two-term spherical harmonic expansion of the electron distribution function is used. The transport coefficients and the mean energy of the electrons are derived from the distribution function. A way of specifying a shape for the electron swarm is discussed. For the specific case of electrons moving in a hydrogen gas, the effects of inelastic collisions on the mean energy and lateral diffusion are discussed.

An analysis using a three-term spherical harmonic expansion is given for a constant collision frequency electron-molecular interaction. Again, expressions are obtained for the transport coefficients and mean energy. The validity of the drift velocity formula - resulting from a two-term analysis - is then examined.

Finally, an attempt is made to include a somewhat generalized

Received 27 February 1973. Thesis submitted to Monash University, June 1972. Degree approved, February 1973. Supervisor: Dr J.L.A. Francey.

electron-molecular interaction into the analysis. The interaction chosen is one in which the mean free path is directly proportional to the n-th power of the velocity. However, in order to carry out an analysis with such an interaction, some concessions have to be made. Among these is the neglect of inelastic phenomena. Although this leads to a departure from the main theme of the work, it does give some insight into the way electrons interact with argon atoms.

https://doi.org/10.1017/S0004972700042775 Published online by Cambridge University Press