LETTER TO THE EDITOR

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IN my review article "Diffusion and Mobility of Ions in Gases (Usp. Fiz. Nauk 92, 75 (1967), Sov. Phys.-Usp. 10, 313 (1967)). I wish to add certain information in the course of the consideration of the mobility of ions in a gas of their own element.

The first to calculate the mobility of atomic ions in a gas of the same atoms and in weak fields were Massey and Mohr[1] for the case of helium ions in helium. They used for the resonance charge exchange cross section an expression related to the phase shifts of ion-atom scattering and previously derived by Massey and Smith[2]. The mobility of helium ions in helium gas under normal conditions, obtained on the basis of this rather crude calculation, turned out to be 12 cm^2/V-sec, in good agreement with modern data (~10). This figure played an important role in the determination of the type of ions produced in helium. The then-measured mobility of helium ions in helium[3] was higher (21 cm^2/V-sec). The cause of this discrepancy was subsequently[4] found to be connected with the formation of molecular helium ions in the gas under the prevailing experimental conditions.

The physical picture of the mobility of ions in their own gas, connected with the transfer of charge from one nucleus to another as a result of resonance charge exchange, was revealed in a 1946 paper by Sena[5], who obtained the ion velocity distribution function and the ion drift velocity at large electric field intensities, when the ion drift velocity greatly exceeds the atom thermal velocity. The results obtained in that paper have made it possible to describe the kinetics of ions in a positive gas-discharge column (cf., e.g.,[6]).

This problem was further developed by Kagan and Perel'[7-9]. In[7] they have derived a kinetic equation for the ion velocity distribution function under conditions when the resonance charge exchange cross section is much larger than the elastic scattering cross section, and the resonance charge exchange cross section is independent of the velocity, as is the case in practice. Solution of this equation at large field intensities[7] has made it possible to refine the numerical coefficient in the expression obtained by Sena[5] for the drift velocity. The ion drift velocity at arbitrary field intensities was found by Perel'[9] by solving the kinetic equation for the ion distribution function.

[1] H. S. W. Massey and C. B. O. Mohr. Proc. Roy. Soc. A144, 188 (1934).

[2] H. S. W. Massey and R. A. Smith, Proc. Roy. Soc. A142, 142 (1933).

[3] A. Tyndall, The Mobility of Positive Ions in Gases, Lnd.-N.Y., 1938.

[4] R. Meyrott, Phys. Rev. 70, 671 (1946).

[5] L. A. Sena, Zh. Eksp. Teor. Fiz. 16, 734 (1946).

[6] I. I. Popescu and N. P. Ionescu, Zh. Tekh Fiz. 29, 866 (1959) [Sov. Phys.-Tech. Phys. 2, 781 (1956)].

[7] Yu. M. Kagan and V. I. Perel', Dokl. Akad. Nauk SSSR 98, 575 (1954).

[8] Yu. M. Kagan and V. I. Perel', Zh. Eksp. Teor. Fiz. 29, 884 (1955) [Sov. Phys-JETP 2, 768 (1956)].

[9] V. I. Perel', ibid. 32, 526 (1957) [5, 440 (1957)].

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