through a gas in a uniform field and losing energy in elastic collisions with molecules. Although it is difficult to trace down the exact origin of any particular feature of a complicated discharge, it appears that conditions in our tubes have often been such as to make loss of energy in this way an important factor. Further, the ratio of random and drift currents has in many instances about the predicted value. With increase in electron concentration, the distribution function tends to the Maxwellian.

The second, less definite result, is the common occurrence of a fairly distinct group of electrons with a mean energy of the order of 5–10 electron volts, under conditions when much ionization was certainly due to fast primary electrons. If we suppose this group consists of electrons ejected from molecules by the primary electrons, its roughly constant energy receives an explanation on the quantum theory of ionization, which predicts that many of the ejected electrons should have an energy of this order, whatever the primary energy.[3]

It has been assumed in this investigation that the ideal conditions postulated in the usual theory of probes have been satisfied sufficiently well for the results to have meaning in relation to the undisturbed plasma. It would be very difficult to go into this theoretically for the complex discharges which have been studied, although the lines on which such calculations could be made have been laid down.[4] It is however at least certain that the main features of the results are independent of probe size over a wide range of this.[1, 5]

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Attempt to Observe the Spectrum of Doubly Excited Helium

According to the calculations of Massey and Mohr,[1] the excitation cross sections of the doubly excited states of helium by electron impact are very small for low electron energy and reach their maximum values for electron energy of the order 500–600 volts. Hence an attempt is made to excite the spectrum of doubly excited helium by electrons of these energies. Electrons emitted by a hot cathode consisting of an oxide coated spiral tungsten filament are accelerated through a glass tube to a hollow nickel anode at a distance of 2 cm from the cathode. The pressure of helium in the tube is kept within 0.07 and 0.12 mm of mercury so that the electron mean free path is of the order of 1 cm. The accelerating voltage is varied between 1100 and 1800 volts so that the electron energy on impact with the helium atoms would be of the order of 500–700 volts. A tube of 3 mm bore extends from the hollow anode and confines the excitation process within it in order to increase the intensity of the radiation which is observed end-on in the direction of accelerating field. The strongest lines of the spectrum $2s^2\,{}^1S-2s2p\,{}^1P$, $2s2p\,{}^1P-2s3s\,{}^1S$ and $2s2p\,{}^3P-2s3s\,{}^3S$, whose positions are calculated from the energy states obtained by the variational method[2] to be at 6320A, 5840A, and 2670A, respectively, are looked for. But prolonged exposures fail to reveal any faint lines at the expected positions.

In a way, this failure to observe the spectrum is understandable when one considers the widths of the levels of doubly excited helium. The lifetime of a doubly excited state is mainly determined by the process of autoionization, i.e., a radiationless transition in which one electron goes to $1s$ state while the other is ejected with the proper energy. The transition probabilities between a doubly excited state and the singly excited states and those between doubly excited states are small compared with that due to autoionization and hence can be neglected in estimating the lifetime of the doubly excited state. Calculation of the probability of autoionization has been carried out for $2s3s\,{}^3S$ by Kreisler[3] using for the ejected electron the continuous wave function of hydrogen. To ascertain the order of magnitude of Kreisler's result, we calculate the probability of autoionization using our variational wave function for $2s3s\,{}^3S$ and Wentzel's spherical wave[4] for the ejected electron and obtain a result agreeing with Kreisler's in the order of magnitude, namely, $P\sim 10^{14}$ sec.$^{-1}$. The lifetime is then $\sim 10^{-14}$ sec. and the width of the level is ~ 3000 cm^{-1}. The widths of other doubly excited levels would certainly be of the same order of magnitude. Thus transitions between two doubly excited states would give rise to a continuous band extending over hundreds of angstroms, if they are observed at all. This seems to show that the suggestion that the corona spectrum may be due to doubly excited helium is untenable.[5]

The lines observed by Compton and Boyce[6] and Kruger[7] in the region of 300A, if they arise from transitions between doubly and singly excited states, would according to these calculations have a width of 3A, or 1 mm at the dispersion employed by Kruger. This does not agree with the observation of Compton, Boyce and Kruger; for although the width of the line 320.4A is not explicitly mentioned, it appears to be quite sharp in the reproduction in their papers. Thus we may regard the question as to the origin of the lines at 320.4 and 357.5A still unsettled.

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