series which we believe to be the same as the series found in the liquid acid, but with every band characteristically shifted toward shorter wave-lengths. This matter is being investigated further. The records of the acid solutions of the nitrogen oxides show no trace of the fuming acid bands, a fact which indicates that these bands are not due to dissolved oxides of nitrogen. In regard to the anharmonic series found in the fuming acid, it is worth noting that the extrapolated fundamental at 2.85μ does not correspond to any fundamental yet observed by means of the Raman effect. Rao reports a band at 3.01μ, but even this has repeatedly failed to appear on plates taken by one of us.

It is hoped that a fuller discussion can be given during the autumn months after experiments, which have been interrupted, are completed.

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The Optical Excitation Function of Helium

I have just completed a study of the optical excitation function of helium under conditions which permitted, simultaneously, a study of the electrical conditions in the discharge tube and a determination of the intensities. A new variation of the photographic method has been used for the measurement of the intensities, and the discharge tube has been designed with a view to the elimination of secondary electron emission and of ionization affects. Due to this design, and to a thorough cleaning of the electrodes, the dependance of intensity on either current or pressure is linear indicating that there is no ion current. In earlier work, this linearity has been expected but not obtained.

The results for the singlet system are largely in accord with those obtained by Elenbaas[1] and Hanle.[2] For the triplets, double maxima as reported by Elenbaas, have been found, although the location of these maxima differs somewhat from that previously found. This disagreement is particularly pronounced in the case of the first maxima, which Elenbaas and Hanle both found in the region between 25 and 35 volts. With the present apparatus these maxima occur at approximately 28 volts and it has been possible to correct their position and shape in accordance with the experimentally determined velocity distribution curve of the electrons and the linear relation between current and intensity. This correction shows that the maxima are actually located at the excitation potentials and are of much greater height compared with the background than the experimental curves, without correction, would indicate.

A full report on the apparatus and results will be published in the near future.

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[1] Elenbaas, Zeits. f. Physik **59**, 289 (1930).
[2] Hanle, Zeits. f. Physik **56**, 94 (1929).

Metastable Atoms and Electrons Produced by Resonance Radiation in Neon

In studies of arcs in pure neon at a few millimeters pressure, we have observed some phenomena which indicate that the resonance radiation from the arc can travel through the un-ionized neon beyond the end of the arc for distances of 20 to 30 centimeters, or more, and the absorption of this radiation produces, by excitation of the gas and by subsequent collisions of the second kind, metastable atoms at the rate of at least 10^{13} cm^{-3} sec^{-1}. In these experiments the neon arc carrying currents of approximately one ampere was passed through a long tube between a hot cathode at one end of the tube and an anode placed near the center. One or more collecting electrodes were placed in the tube beyond the end of the arc, and, in some experiments, movable collectors were used whose distance from the end of the arc could be varied.

The metastable atoms thus produced beyond the end of the arc diffuse into contact with the walls or with metallic electrodes and liberate electrons from the glass or metal surfaces which have velocities of the order of 5 or 10 volts. The walls thus become positively charged and within the space there is a definite concentration of electrons. If a collector is maintained at, say, 70 volts negative with respect to the anode, the electrons emitted by it serve as a measure of the concentration of the metastable atoms. The concentration of metastable atoms diffusing out of the arc should fall to $1/e^{\text{th}}$ of its value every time the distance is increased by an amount equal to 0.4 of the radius of the tube. Within a few centimeters of the end of the arc this theoretical decrement is actually observed, but at greater distances the concentration of metastable atoms decreases far more slowly.

The width of the line corresponding to the resonance radiation in the arc is far greater than that of the absorption line in the unexcited neon, which is determined mainly by the Doppler effect. Assuming this cause of broadening of the absorption line, it can be calculated that between parallel planes the energy absorbed per unit volume in the gas is inversely proportional to the distance from the source and thus, as the end of the arc is approximately a point source of this radiation, the rate of production of metastable atoms should vary approximately inversely as the cube of the distance from the end of the arc. The observed values are in accord with this theory.

The electrons in the tube generated at the walls by the metastable atoms give to the neon a conductivity whose value can be measured, and from the known mobility of the electrons in neon gas, the concentration of electrons can be calculated. For low voltages on the collectors, the currents are determined solely by this mobility of the electrons, and the volt ampere characteristics for small currents are thus linear on both sides of the zero point. For larger negative voltages, the current becomes limited by the number of electrons that can escape from the collector. For sufficient positive voltages, the currents increase more rapidly than corresponds to the linear relationships, this being due to ions produced within the tube by the acceleration of the electrons. The experiments prove that these ions are produced by the ionization of metastable atoms rather than normal atoms, for the rate of production of ions varies approximately with the square of the light intensity. These conclusions are confirmed by experiments with a shutter placed beyond the end of the arc, which can cut off the radiation without interfering with the diffusion of atoms, ions, etc., past the shutter. It is thus proved that the production of metastable atoms is produced by light which travels only in straight lines. The fact that when the collector is positive the electron currents are also proportional to the light intensity proves that the electrons owe their origin not to photoelectric effect from the electrodes, but to the production of metastable atoms or excited atoms. Small disk-shaped collectors have also been used in which one side, which faces the source of resonance radiation, is covered with mica so that the exposed surface cannot receive radiation, and yet the electron current was nearly as great as if the mica were placed on the back side of the collector, proving that the electron currents are generated by metastable atoms which diffuse short distances to the electrode even when the resonance radiation does not reach the electrode itself.

Since the electrons emitted by the collectors possess considerable initial velocities, and since these electrons make elastic collisions with the neon atoms, it is impossible to obtain a saturation current from these electrodes at these gas pressures, for electrons which diffuse back to the electrodes have sufficient energy to be reabsorbed by it. A theoretical investigation shows that in this case the current i_x that flows between any two electrodes is given by the equation,

$$i_x = \frac{16\pi}{3} I_0 \lambda\, C(V/V_0) \frac{1}{\log(1+V/V_0)}$$

where V is the potential difference between the electrodes, V_0 is the volt equivalent of the velocity with which the electrons are emitted from the cathode, I_0 is the theoretical saturation current density of the electrons emitted from the cathode, λ is the mean free path of electrons, and C is the electrostatic capacitance between the two electrodes (expressed in centimeters). Experiments show that this equation expresses well the volt ampere characteristics of neighboring electrodes in neon exposed to resonance radiation.

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