VAGNER, S.D.; KAGAN, Yu.M.; PEREL', V.I.

Determination of plasma parameters by the double probe method. Vest. Len.un.11 no.22:75-78 '56. (MLRA 10:2)
(Electric discharges through gases) (Electrons)

KAGAN, YU.M.

CARD 1 / 2 PA - 1304

SUBJECT USSR / PHYSICS
AUTHOR KAGAN, JU.M., PEREL', V.I.
TITLE On the Mobility and the Space Charge of Ions in an Inhomogeneous Field.
PERIODICAL Dokl.Akad.Nauk, 108, fasc. 2, 222-225 (1956)
Issued: 7 / 1956 reviewed: 9 / 1956

The most important interaction process of ions with atoms of the same gas is the pure charge exchange without any important modification of the velocity of the particles concerned. In some cases of practical interest the fields in the layers are so strong that the average energy of the heat motion of atoms is small against the energy taken by the ion on a free path. Therefore the atoms may be considered to be at rest, and the product of the δ-functions of the velocity components v_x, v_y, v_z may be taken as velocity distribution function. At first, the kinetic equation is given for the case that the direction of the field (E(z) is at every point identical with the positive direction of the Z-axis. This kinetic equation is then transformed and adapted to initial conditions. The solution found is explicitly given and specialized for the limiting case of a constant field E = const.

Next, the expressions for the drive velocity and the concentration of the ions for inhomogeneous fields are given. The usual opinion that the drive velocity at a given point depends only on the field strength at this point is correct only if the modification of field strength along the free path is small as against the field strength itself. In this case the expression for the drive

KAGAN, Yu. M.
and
PEREL', V. I.

"On the Limited Movement of Ions in the Vicinity of a Sounding Balloon," pp 69-71, 5 ref

Abst: The article examines a sounding balloon located in a plasma at such a low pressure that it is possible to disregard collisions of charged particles with atoms of the gas. It is shown that a limitation of movement is possible under ordinary conditions if it is assumed that the potential changes gradually.

SOURCE: Uchenyye Zapiski Petrozavodskogo Gas. Un-ta (Scientific Notes of the Petrozavodskiy State University), Volume 4, No. 4 -- Physical-Mathematical Sciences, Petrozavodsk, State Publishing House of Karel'skaya, ASSR, 1957

Sum 1854

51-3-3/24

AUTHORS: Kagan, Yu. M. and Perel', V. I.

TITLE: On the motion of ions and the shape of their (spectral) lines in a positive-discharge column. I. The directed motion of ions in a low-pressure discharge. (O dvizhenii ionov i konture ikh liniy v polozhitel'nom stolbe razryada. I. Napravlennoye dvizheniye ponov v razryade nizkogo davleniya).

PERIODICAL: "Optika i Spektroskopiya" (Optics and Spectroscopy), 1957, Vol.2, No.3, pp.298-303 (U.S.S.R.)

ABSTRACT: Theoretical paper. It is usually assumed that ions move in an infinite homogeneous medium under the action of an electric field constant in magnitude and direction. In a real positive-discharge column, in addition to the applied longitudinal field, there is also a transverse electric field and ions escape towards the walls. This effect is more pronounced at low pressures. It shows up in the pressure dependence of the displacement and the width of ionic emission lines when observed along the axis of the discharge tube. A kinetic equation for the ionic motion is solved to find the velocity distribution function of the positive ions in a cylindrical discharge tube. It is assumed that the ions are formed inside the tube and that they perish at the tube walls. Collisions of the ions with atoms are neglected (this is

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51-3-3/24

On the motion of ions and the shape of their (spectral) lines in a positive-discharge column. I. The directed motion of ions in a low-pressure discharge. (Cont.)

T = gas temperature, M = the ionic mass, k = Boltzmann's constant. For a discharge tube filled with mercury at 3×10^{-4} mm Hg pressure, with a current of 0.3 A, $z = 7 \times 10^{4}$ sec^{-1}, $E = 0.1$ V.cm^{-1}, $kT/M = 1.2 \times 10^{8}$ cm^{2}sec^{-2}, we have, for Hg^{+} ions, $\overline{v_z} = 5 \times 10^{3}$ cm sec^{-1}, $\overline{v_z^2} = 1.6 \times 10^{8}$ cm^{2}. sec^{-2}.

The shape of the ionic emission lines observed along the tube axis is given in a diagram. It can be regarded as a Maxwellian distribution with ionic drift velocity (2×10^{4} cm.sec^{-1} under the above conditions) superimposed on it. There is one figure and ten references, 6 of which are Slavic.

Card 3/3

SUBMITTED: September 17, 1956.

AVAILABLE:

[illegible]

KAGAN, Yu.M.

Probe measurements in low pressure plasma [with summary in English, p.152]. Vest. Len. un. 12 no.4:63-78 '57. (MIRA 10:4)
(Electric discharges through gases)

Ya. M. [illegible], [illegible] Ya. Kal'[illegible], and [illegible]
[illegible] 12, No. 10, [illegible]

KAGAN, Yu. M.

66702

24(2)20
SOV/109-4-8-22/35

AUTHORS: Granovskiy, V.L., Luk'yanov, S.Yu., Spivak, G.V. and
Sirotenko, I.G.

TITLE: Report on the Second All-Union Conference on Gas
Electronics, Moscow 2-6 Oct. 1958

PERIODICAL: Radiotekhnika i elektronika, 1959, Vol 4, Nr 8,
pp 1339 - 1358 (USSR)

ABSTRACT: The conference was organised by the Ac.Sc.USSR, the
Ministry of Higher Education and Moscow State University.
A.A. Timofeyev - "Measurement of the Gas Density During
the Dynamic Operation of a Discharge" (see p 1306 of
the journal).A.V. Nedospasov - The Nature of a Striated
Positive Column".
V.I. Perel' and Yu.M. Kagan - "The Theory of Probes for
Arbitrary Pressures".
Yu.M. Kagan et al. - "The Positive Column of a Discharge
in a Diffusion Regime".
M.V. Konyukov - "Influence of the Processes of the
Annihilation of the Negative Ions on Their Concentration
in the Column".
M.D. Gabovich and L.L. Pasechnik - "Anomalous Scattering.
Excitation of Plasma Oscillations and Plasma Resonance"
Yu.L. Klimontovich - "Energy Lost by Charged Particles for
the Excitation of the Oscillations in Plasma (the Langmuir
paradox)" and "The Theory of Non-linear Plasma Oscillations".
Ye.G. Martinkov and I.G. Nekrashevich - "Dependence of
the Temperature in the Near-electrode Region of a Pulse
Discharge on the Material of the Electrodes".
N.A. Neretina and B.N. Klyarfel'd - "Formation of Light
Spots on the Anode of a Gas Discharge (see p 1301 of
the journal).
N.A. Matveyeva -"Distribution of Binary Mixtures of Inert
Gases in a d.c. Discharge".
V.G. Stepanov and V.P. Zakharchenko - "Some Phenomena
in Rarified Plasma".
V.G. Stepanov and V.S. Bezel' - "The Possibility of
Obtaining Highly Concentrated Plasmas".
G.V. Smirnitskaya and E.M. Reykhrudel' - "Some Character-
istics of the Discharge in an Ion Pump and in a Magnetic
Ionisation Vacuum Gauge".
Ye.T. Kucherenko and O.K. Nazarenko - "Properties of
a Discharge with Electron Oscillations in a Magnetic
Field" (see p 1253 of the journal).
The paper by L.M. Biberman and B.A. Veklenko considered
the approximate methods for determining the concentration
of atoms at the radiation levels.
I.I. Sobel'man and L.A. Vaynshteyn read a paper on
"A Non-stationary Theory of the Stark Broadening of the
Spectral Lines in Plasma".
M.A. Mazing and S.L. Mandel'shtam - "The Broadening
and the Shift of Spectral Lines in a Gas-discharge Plasma".
R. Lunt (England) - "The Kinetics of Electron Collisions
Leading to the Excitation of the Molecular Hydrogen in
a Hydrogen Discharge".
V.V. Kolesnikov et al. - "Some Properties of the Arc
Discharge in an Atmosphere of Inert Gases".
A.A. Mak and M.P. Vanyukov - "Production of High
Temperatures By Means of Spark Discharges".

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KAGAN, Yu. M.

66702

24,2120 SOV/109-4-8-22/35

AUTHORS: Granovskiy, V.L., Luk'yanov, S.Yu., Spivak, G.V. and Sirotenko, I.G.

TITLE: Report on the Second All-Union Conference on Gas Electronics

PERIODICAL: Radiotekhnika i elektronika, 1959, Vol 4, Nr 8, pp 1339 - 1353 (USSR)

I.M. Podgornyy and N.G. Koval'skiy - "New Data on X-ray Radiation During Pulse Discharges"

V.A. Khrabrov and M.M. Sulkovskaya dealt with the investigation of the neutron radiation in powerful gas discharges in chambers with conducting walls.

N.A. Borzunov et al. - "Investigation of the Gas Discharge in a Conical Chamber".

S.M. Osovets et al. - "A Turn of Plasma in Transverse Magnetic Field".

I.G. Kesayev "Data on the Division of a Cathode Spot on Mercury in a Low-pressure Arc" (see p 1289 of the journal).

A.E. Robson (England) - "A New Theory of the Cathode Spot" (see p 1295 of the journal).

L.N. Brausova - "Positive Column in a Hydrogen Discharge With Stationary and Pulse Loads".

I.G. Nekrashevich and A.A. Labud - "Current Distribution on the Surface of Electrodes in Electric Pulse Discharges".

L.S. Kyg - "Some Properties of Gas Discharges in Low-voltage in Halogen Counters".

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G.I. Glotova and V.L. Granovskiy - "Comparison of the Initial De-ionisation in the Isotopes of Hydrogen (H and D)".

L.A. Akol'zina communicated some results on the pre-breakdown current pulses at low pressures.

M.Ya. Vasil'yeva and A.A. Zaytsev - "Charge-density oscillation Waves in Cylindrical Plasma".

L. Pekárek of Czechoslovakia communicated some information on the wave-like phenomena in gas-discharge plasma.

B.G. Brezhnev dealt with the problem of the determination of the energy of fast ions in pulse discharges.

B.B. Kadomtsev - "Convection Instability of a Plasma String".

S.I. Braginskiy and V.D. Shafranov - "Theory of a High-temperature Plasma String".

The fifth section was presided over by N.A. Kaptsov and dealt with high-frequency currents in gases. The following papers were read:

V.Ye. Golant - "Formation of Ultra-high Frequency Pulse Discharges in Inert Gases".

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G.I. Pateyuk - "Influence of the Boundary Conditions on the Formation and Maintenance of High-frequency Discharges".

P.S. Bulkin et al. - "Investigation of a Self-maintained Ultra-high Frequency Pulse Discharge and the Process of its Development".

M.M. Yastenker and G.S. Solntsev - "Some Results of the Investigation of the Formation of Low-pressure High-frequency Discharges".

G. Margenau (USA) - "Conductivity of Weakly Ionised Plasma".

A.A. Kuzovnikov - "The Conditions of Transition From High-frequency Corona Discharge at Atmospheric Pressures".

V.Ye. Golant - "The relationship Between the Characteristics of the Ultra-high Frequency Current and the Direct Current in Gas Discharges".

B.B. Lagov'yer analysed the conductivity of the disintegrating plasma in the window of a resonance discharge tube.

S.M. Levitskiy and I.P. Shashurin dealt with the applicability of the probe method to high-frequency discharges (see p 1238 of the journal).

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The paper by V. Ye. Mitsuk et al. was devoted to the investigation of the ultra-high frequency plasma by means of the Stark effect.

G.S. Solntsev et al. dealt with the problem of electric fields in a high-frequency discharge at low pressures.

Ye. Bedareu of Rumania read a paper entitled "High-frequency Discharges in Methane".

The work of the sixth section was devoted to the problems of plasma and its radiation; the section was presided over by V.A. Fabrikant. The following papers were read:

Yu.M. Kagan - "New Technique in the Probe Methods of Plasma Investigation"

V.I. Drozdov - "Oscillographic Measurements in Plasma".

V.A. Simonov and A.G. Mileshkin - "Investigation of the Movement of Plasma by Means of a Mass Spectrometer of the Transit Time".

A.V Rube[illegible]skiy - "Applic[illegible] the Oscillations on a [illegible] Vapour of Gas

SOV/48-22-6-16/28

AUTHOR: Kagan, Yu. M.

TITLE: On the Motion of Ions in a Plasma (O dvizhenii ionov v plazme)

PERIODICAL: Izvestiya Akademii nauk SSSR, Seriya fizicheskaya, 1958, Vol. 22, Nr 6, pp. 702-707 (USSR)

ABSTRACT: It is said in the introduction that this problem is of great importance, but that it has hitherto not been possible to determine the velocity distribution of the ions in the plasma. A spectroscopic method was worked out (Refs 1-5) for the purpose of investigating the course of the traces of ions of a discharge tube as well as for the investigation of ion trace displacements along the discharge axis. The occurrence of a Doppler effect makes it possible to obtain data concerning the velocity of ion drifts, the distribution of ion energy, and also concerning the "temperature" of ions. In order to obtain the necessary conditions of discharges in the case of inert gases (0,1-3 torr and up to 50 A cm^{-2} current density), a discharge tube which is narrowed in the middle was used in this case. Diagrams show the dependence of ion drift velocity on pressure in the case of different amperages of the discharge current in argon, krypton, and xenon. Two further

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On the Motion of Ions in a Plasma SOV/48-22-6-16/28

diagrams illustrate the dependence of the "temperature" of the ion gas T_p on pressure along the tube and the dependence of atom "temperature" T and the "temperature" of ion gas T^* on pressure in the cross section of the tube. Further research work in this field was carried out with the discharge tube which was widened up to 4 mm in the middle, where probes were fastened by soldering. In this way it was possible to measure concentration of the electron N_e and the temperature T_e of the electron gas (Ref 8). The dependence of N_e and T_e on the amperage of the discharge at a pressure of $p = 1.75$ torr with respect to argon is here shown by a diagram. Two further diagrams illustrate the measured points of the drift velocity for helium-, neon- and argon ions in their own gas as well as in krypton and xenon. In conclusion it is pointed out that it has hitherto been possible to give only a qualitative explanation of the data obtained for interferometric measurements; quantitative comparison is, however, still impossible because of the effect produced by the rarefication of the gas during interferometric measurement as well as because of the

Card 2/3

Kagan, Yu. M.

51- 4-1-1/26

AUTHORS: Kagan, Yu. M. and Perel', V. I.

TITLE: On the Motion of Ions and the Shape of Ionic Lines in the Positive Column of a Discharge. II. Radial Motion of Ions in a Low-Pressure Discharge.

(O dvizhenii ionov i konture liniy ionov v polozhitel'nom stolbe razryada. II. Radial'noye dvizheniye ionov v razryade nizkogo davleniya.)

PERIODICAL: Optika i Spektroskopiya, 1958, Vol. IV, Nr. 1, pp. 3-8. (USSR)

ABSTRACT: In Part I (Ref.1) the authors solved the kinetic equation for a distribution function for ions in a cylindrical low-pressure discharge tube, taking into account both the longitudinal and transverse fields, volume ionization and loss of ions at the walls. The present paper deals with radial motion of ions and with calculation of the effective temperature for motion of ions across the tube. An approximate method

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On the Motion of Ions and the Shape of Ionic Lines in the Positive Column of a Discharge. II.

is described and used for determination of the radial part of the velocity distribution function of ions in the positive column of a low-pressure discharge. It was assumed that at low pressures the radial part of the distribution function does not depend on the longitudinal field. By means of this approximate method, velocity of the radial drift of ions and the effective ionic temperature were found as functions of distance from the discharge-tube axis. An expression for the effective temperature was found in terms of the shape of ionic lines observed across the tube. The observed shape of ionic lines (under Doppler conditions) depends essentially on the nature and lifetime of the excited ionic state. There are two simple cases: (1) Formation of excited ions in atom-electron collisions and instantaneous radiation. In this case the shape of ionic lines does not differ from that of atomic lines. (2) Formation of excited ions occurs in ion-electron collisions, and radiation is instantaneous. In this case the shape of ionic lines will be determined by the velocity distribution function for ions, and this distribution can be obtained from spectroscopic observations. In case (2) the ionic line shape observed across the tube should be strongly broadened, compared with the atomic line shapes. Such a broadening was observed in argon (Ref.3), but not at low pressures. No low-

On the Motion of Ions and the Shape of Ionic Lines in the Positive Column of a Discharge. II.

pressure experimental data seems to exist. The results obtained in this paper, using the approximate method, could also, in principle, be obtained from the general expressions of Ref.1. The authors show that for (A) the distribution of potential across the tube, (B) the radial velocity distribution of ions, and (C) the mean and mean square values of the radial velocity of ions, the approximate method gives results which are very close to those given by the exact theory. The approximate method, besides being simpler to apply, has the advantage that it can be generalized to the case of high pressures. The present paper is entirely theoretical. There is

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On the Motion of Ions and the Shape of Ionic Lines in the Positive Column of a Discharge. II.

1 figure, 1 table, and 3 references, 2 of which are Russian and 1 American.

ASSOCIATION: Leningrad Institute of Precision Mechanics and Optics. (Leningradskiy institut tochnoy mekhaniki i optiki.)

SUBMITTED: March 5, 1957.

AVAILABLE: Library of Congress.

1. Ions-Motion

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KAGAN, Yu. M.

51-4-3-1/30

AUTHORS: Kagan, Yu.M. and Perel', V.I.

TITLE: On the Motion of Ions and the Shape of their Lines in a Positive Discharge Column. III. A Directed Motion of Ions in a Discharge at an Arbitrary Pressure. (O dvizhenii ionov i konture ikh liniy v polozhitel'nom stolbe razryada.)

PERIODICAL: Optika i Spektroskopiya, 1958, Vol.IV, Nr.3, pp.285-288 (USSR).

ABSTRACT: In the preceding papers (Refs.1-2) the authors considered motion of ions in a positive column of a low-pressure discharge, taking into account longitudinal and transverse fields, bulk ionization and loss of ions at the walls. The present paper deals with directed motion of ions near the axis of a cylindrical discharge tube working at an arbitrary pressure. The method of dealing with the problem is the same as that in Ref.2. The authors obtain an expression for the velocity of directed motion of ions. From the expression the projection of the velocity on the discharge-tube axis v_z can be found. For low pressures the average value of v_z which follows

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51-4-3-1/30

On the Motion of Ions and the Shape of their Lines in a Positive Discharge Column. III.

from the expression obtained in this paper is given by $\bar{v}_z = a/z$, where a is the acceleration of ions in the longitudinal constant electric field, and z is the number of ionizations per unit time. The exact value of $\bar{v}_z$ for low pressures obtained in Ref.1-2 is given by $\bar{v}_z = 0.69\ a/z$. For high pressures the expression obtained in the present paper yields the value $\bar{v}_z = 3\sqrt{2\pi}\,a\lambda/16u_0$, where $u_0^2 = 2kT/M$, T is the gas temperature, M is the ionic mass, and λ is the mean free path of the ion. Because of lack of experimental data quantitative comparison of theory with experiment is not possible. The authors point out that the results obtained in the present paper hold only near the discharge-tube axis. In the approximate deduction of these results terms containing squares and higher powers of the acceleration a were included. It was assumed that

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On the Motion of Ions and the Shape of their Lines in a Positive Discharge Column. III.

either the longitudinal field was small or that $1/z \ll \lambda/u_0$ at any value of the longitudinal field.

The paper is entirely theoretical. There are 6 Soviet references.

ASSOCIATION: Institute of Precision Mechanics and Optics. (Institut tochnoy mekhaniki i optiki.)

SUBMITTED: July 11, 1957.

1. Ions--Motion

Card 3/3

AUTHORS: Vagner, S.D., Kagan, Yu.M., Romanova, Ye.V. 54-10-2-2/16

TITLE: The Influence of a Magnetic Field Upon a High Frequency Discharge (Vliyaniye magnitnogo polya na vysokochastotnyy razryad)

PERIODICAL: Vestnik Leningradskogo Universiteta, Seriya fiziki i khimii, 1958, Vol. 10 Nr 2, pp. 15-17 (USSR)

ABSTRACT: For the determination of the plasma parameters of a highfrequency discharge the two-probe method (Refs 1,2,3) was developed. This improved method was employed by the authors for measuring the plasma parameters of a highfrequency discharge in a weak magnetic field. The dependence of the temperature of the electron gas T_e and of the concentration of the charged particles n on the current in the solenoid is shown (table 1). T_e and n are average quantities obtained from a number of measurements and agree well with each other. The T_e values were determined by the methods described in former papers (Refs 1,2). The results obtained by the two methods are, practically, in agreement. The second method makes it possible to judge the presence of a Maxwell electron distribution according to velocities. The characteristics worked out

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The Influence of a Magnetic Field Upon a High Frequency Discharge 54-10-2-2/16

by this method showed that in the plasm of a highfrequency discharge the electrons retain Maxwell's velocity distribution also in the presence of a weak magnetic field. It may be seen from the table that the temperature of the electron gas T_e drops a little with an amplification of the magnetic field. The concentration of the charged particles on the tube axis increases with amplification of the magnetic field from 0-50 Ørsted by about 12 times its amount. As already mentioned, the temperature values of the electron gas obtained by means of the two-probe method are determined by the distribution of the fast electron groups according to velocities. This distribution need not agree with that of more inert electrons, which are dealt with by Langmuir's probe method. There are 1 figure, 1 table, and 7 references, 5 of which are Soviet.

SUBMITTED: July 7, 1956

AVAILABLE: Library of Congress

Card 2/2 **1. High frequency discharges--Magnetic factors**

KAGAN, Yu. M.

AUTHORS: Kagan, Yu. M., Perel', V. I. 56-1-19/56

TITLE: On the Motion of Ions in a Mixture of Isotopes (O dvizhenii ionov v smesi izotopov).

PERIODICAL: Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, 1958, Vol. 34, Nr 1, pp. 126-128 (USSR).

ABSTRACT:

The present paper determines expressions for the drift velocity of the ions of isotopes in an isotope mixture. A pure charge exchange is considered to constitute the basic problem of the interaction of ions with atoms. In connection with the problem of isotope separation in a d.c.-discharge the question of the mobility of an ion in an isotope mixture is of growing interest. Blank's law for the mobility of ions in a mixture does not hold in this case because of the possibility of a change in charge between an ion of one isotope and an atom of another isotope. Here a mixture of two isotopes with concentrations N_1 and N_2 of the neutral atoms is assumed. The concentrations of the ions are said to be N_1 and N_2 and their distribution functions with respect to velocity are denoted by $f_1(v)$ and $f_2(v)$. The influence of the ions on the distribution function of the atoms with respect to the velocity

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On the Motion of Ions in a Mixture of Isotopes. 56-1-19/56

consideration the collisions of the ions of the isotopes with the particles of the third component. In the case of strong fields an accurate result is obtained for the drift velocities. There are 3 references, 2 of which are Slavic.

ASSOCIATION: **Leningrad Institute for Precision Mechanics and Optics** (Leningradskiy institut tochnoy mekhaniki i optiki).

SUBMITTED: July 12, 1957

AVAILABLE: Library of Congress

Card 3/3

On Some Characteristics of the Positive Discharge Column at Low Pressures and High Discharge Current Densities SOV/54-59-3-8/21

on the axis and the walls of the tube, the longitudinal field E, and the number of ionizations per electron per unit of time z were determined. Figures 1-4 show the curves of the dependence T_e and n_e on the amperage of the discharge current. The course of these curves on the axis and the walls of the tube is different. The minimum occurring in these curves is considerably weaker on the walls. Concentration n_e increases monotonously with increasing amperage. With rising pressure T_e decreases on the walls, and the concentration increases at all amperages. A complicated relation is observed on the axis. The temperature has a minimum at a certain pressure for all amperages, only at very small amperages it decreases monotonously with rising pressure. At certain pressures n_e has a maximum on the axis. The mentioned processes are explained by a dilution of the gas during the discharge occurring in the central part of the positive column. This is in agreement with the observations made by Shukhtin. Table 1 shows the values computed for z and

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the value measured for E. From the measurement of the Doppler shift toward and opposite to the direction of the field the directed velocity of the ions was computed. Table 2 shows the values of $\delta\lambda$ and $-v_z$. Curve v_z versus steam pressure has a maximum. In conclusion, the authors thank Professor F. E. Frish, Corresponding Member of the AS USSR, for the interest he showed in the work. There are 4 figures, 2 tables, and 9 Soviet references.

SUBMITTED: April 15, 1959

24(7)

AUTHORS: Kagan, Yu. M., Perel', V. I. SOV/54-59-3-9/21

TITLE: On the Influence of the Finite Life on the Contour of the Ion Lines of the Positive Discharge Column

PERIODICAL: Vestnik Leningradskogo universiteta. Seriya fiziki i khimii, 1959, Nr 3, pp 49-50 (USSR)

ABSTRACT: The finite life of the excited state of an ion may cause a line shift if the ion in an excited state in the electric field assumes a velocity comparable to thermal velocity. In the present paper the problem of the line contour is dealt with under conditions which make it necessary to take the finite life of the excited ion state into account. The authors proceed from the distribution function of the particle velocity $f(v_{xo},v_{yo},v_{zo})$. If a particle radiates after the time t after excitation, it attains the velocity $v_z = v_{zo} + \frac{eE}{m}t$ during this period. An expression for $F(v_x v_y v_z)$ is found (1) for the distribution function of the velocity of radiating particles which in its contour coincides with the observed line contour.

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The expression $\overline{v_z} = \overline{v_{zo}} + \tau\frac{eE}{m}$ (2) is obtained for the mean velocity in the field direction by partial integration and in similar way, the mean square velocity in the field direction:

$$\overline{v_z^2} = \iiint\limits_{-\infty}^{+\infty} v_z^2 F(v_x v_y v_z) dv_x dv_y dv_z = \overline{v_{z_0}^2} + 2\overline{v_{z_0}}\tau\frac{eE}{m} + 2\left(\tau\frac{eE}{m}\right)^2 \quad (3)$$

τ denotes the mean life of the excited state. The formulas 1-3 cannot be used if the duration of the excited state is longer than the period between the collisions of excited ions and atoms. In this case the collisions must be taken into account, however, formula (2) may be used for a rough calculation, and the time between the collisions may be substituted for τ. In a vertical field action v_{z_0} becomes equal to zero in the formulas. The line shift is then brought about by the finite life of the excited state.

ZAKHAROVA, V.M.; KAGAN, Yu.M.

Some positive column characteristics of a gas discharge at low pressures and high discharge current densities. Vest.LGU 14 no.16:44-48 '59. (MIRA 12:10)

(Electric discharges through gases)

SOV/48-23-8-14/25

24(3)

AUTHORS: Zakharova, V. M., Kagan, Yu. M., Perel', V. I.

TITLE: The Positive Column of Discharge in the Diffusion Procedure

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, 1959, Vol 23, Nr 8, pp 999-1003 (USSR)

ABSTRACT: In the introduction of the present paper some older articles of non-Russian scientists on the positive discharge column at low pressures are mentioned in addition to articles published by B. N. Klyarfel'd. An equation for the balance of electrons and ions (1) introduced by L. Frost is given. This article intends to obtain some relations by Frost's theory for a comparison with experiments, and to apply the comparison to the positive column of Hg, Ar, and K. In the first part, the drift velocity (2) is given by Frost's approximation, besides the approximation for potential distribution and concentration (4). By means of the latter the balance equation (7), a formula for the number of ions per unit of length of the column, and a formula for the ion current density (9) are developed. In the second part, experiments of Langmuir and Tonks (Ref 2) are referred to, and the equations (11) for the plasma boundaries

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SOV/48-23-8-14/25

The Positive Column of Discharge in the Diffusion Procedure

are given. Formulas (12) deliver the drift velocity and ionic concentration near the plasma boundary, equation (13) gives the average velocity of ions. An approximate formula (16) is given for calculating the thickness of the layer. Equation (17) supplies the potential difference between axis and wall of the tube. In the third part, the calculated results are compared to experimental results. The temperature of the electron gas was determined by means of a search electrode, the electron density was found by formula (18). The charges measured in Hg-, Ar-, and K-vapor are summarized in the diagrams of figures 1 to 3, and it was found that there is good agreement with theoretical values as long as diffusion procedure may be assumed. There are 3 figures and 13 references 5 of which are Soviet.

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24(4),24(7) SOV/53-69-1-10/11

AUTHORS: Bogdanova, I. P., Bochkova, O. P., Zaydel', A. N., Zakharova, V. M., Kagan, Yu. M., Kalitseyevskiy, N. I., Penkin, N. P., Chayka, M. P., Shukhtin, A. M., Lipis, L. V.

Kagan, Yu. M.

TITLE: Sergey Eduardovich Frish (Sergey Eduardovich Frish). On the Occasion of His Sixtieth Birthday (k shestidesyatiletiyu so dnya rozhdeniya)

PERIODICAL: Uspekhi fizicheskikh nauk, 1959, Vol 69, Nr 1, pp 165-167 (USSR)

ABSTRACT: On June 19th, 1959, the well-known Soviet physicist S. E. Frish, who made a name for himself especially in the field of spectroscopic optics, attained the age of sixty. He began his scientific work as a student at the fiziko-matematicheskoye otdeleniye Leningradskogo universiteta (Physico-mathematical Department of Leningrad University) under D. S. Rozhdestvenskiy. After completing his university studies he continued his work at the Gosudarstvennyy Opticheskiy institut (Optical State Institute). Since 1934 he held a chair for optics and supervised work at the Physics Department, first as dean and later as director of the Nauchno-issledovatel'skiy fizicheskiy institut LGU (Scientific Research Institute for Physics at Leningrad

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State University). In 1946 he was appointed Corresponding Member, AS USSR, and took active part in the work of the Academy. He is deputy chairman of the Spectroscopy Committee, chief editor of the periodical "Optika i spektroskopiya" and member of the International Committee for spectroscopy at the UNESCO. He first concentrated his scientific interest on atomic energy, the systematics of atomic spectra, the Zeeman effect in the sodium and potassium spectrum as well as upon experimental spectroanalytical investigations. In 1930 he started a cycle of works, which was devoted to optical methods of investigating the properties of the atomic nucleus. (An investigation of the interaction between nucleus and electron shell led to the discovery of the hyperfine structure of spectra). He investigated the hyperfine structure of Na and set up a rule concerning the interrelation between nucleus-spin and parity. He further investigated the fine structure of isotope mixtures, the excitation mechanism of the higher atomic levels, and questions of the interaction of elementary

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particles. Finally, mention is made of his pedagogical activities, especially his courses in physics (which are partly held together with A. V. Timoreva). There are 1 figure and 42 Soviet references.

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S/057/60/030/04/07/009
B004/B002

AUTHORS: Zakharova, V. M., Kagan, Yu. M., Mustafin, K. S., Perel', V. I.

TITLE: Probe Measuring Under Middle Pressures

PERIODICAL: Zhurnal tekhnicheskoy fiziki, 1960, Vol. 30, No. 4, pp. 442-449

TEXT: It was the purpose of the present paper to investigate the applicability of the Langmuir probe for measuring the characteristic plasma values at pressures higher than 1 torr. The authors derived equations (4), (5) for the ion currents directed upon spherical and cylindrical probes with strong negative charges, and their current densities (equations 8-10). Furthermore, equation (11) is given for the plasma potential V_o. The following method of measuring the characteristic plasma values is suggested: a) the electron temperature T_e is determined by means of the two-probe method given in Ref. 11; b) the electron concentrations are determined by means of equations (4), (5) and by applying the electron section of the characteristics. The effective cross

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Probe Measuring Under Middle Pressures

S/057/60/030/04/07/009
B004/B002

sections of the ion overcharge, gas temperature, and concentration of the normal atoms must be known for the determination of the ion concentration n_{∞}. The theoretical calculations are experimentally proven in Hg vapor at 10^{-1} to 1 torr. Table 1 shows that the values n_{∞} of spherical and cylindrical probes are in good agreement with calculations. Furthermore, plasma measurements were carried out in neon and argon at 1 to 20 torr, 50, 200, and 400 ma, and in Hg at 10 torr, 0.5, 1.0, 1.5, and 2.0 a. Table 2 gives the field voltages of Ne and Ar, Table 3 the values of T_e, Table 4 the density of the ion current, and Table 5 the values of n_{∞}. The T_e values were taken according to Ref. 14 and measurements by O. P. Bochkova. The dependence of the electron concentration distribution on pressure in the case of Ne and Ar, is given in Figs. 1 and 2. These Figs. show that a pressure increase is accompanied by a compression along the axis, and differs for Ne and Ar. The column contraction observed, and the difference between calculated and measured wall current related thereto, indicate that the Schottky theory no longer holds true for the pressures applied. The authors finally investigate the

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VB

Probe Measuring Under Middle Pressures

S/057/60/030/04/07/009
B004/B002

possible effect of electron- and photon emission on the result of their method, and prove this effect to be very low. They mention a paper by N. P. Penkin, and thank Professor S. E. Frish for the interest he took in this paper. There are 2 figures, 5 tables, and 16 references: 10 Soviet, 3 American, 1 British, and 1 Japanese.

ASSOCIATION: Leningradskiy gosudarstvennyy universitet im. A. A. Zhdanova (Leningrad State University imeni A. A. Zhdanov)

SUBMITTED: July 16, 1959

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Card 3/3

S/057/60/030/008/010/019
B019/B060

AUTHORS: Kagan, Yu. M., Mustafin, K. S.

TITLE: The Velocity Distribution Function of Electrons in a Positive Discharge Column of Mean Pressure

PERIODICAL: Zhurnal tekhnicheskoy fiziki, 1960, Vol. 30, No. 8, pp. 938 - 947

TEXT: With reference to papers by Smit, Druyvesteyn, and V. Ye. Golant, the authors devote the first three sections of the present article to deriving the velocity distribution functions of electrons in the positive columns in neon, argon, and mercury under consideration of elastic and inelastic impacts. They obtain formulas (8), (20), and (26), and discuss them. The fourth section deals with the shapes of distribution functions, and in Tables 1, 2, and 3 the measured temperatures of electron gas are compared with those obtained by calculation. Moreover, the measured axial electron concentrations are compared with those calculated in Tables 4, 5, and 6. In the discussion of results in the final part, reference is made to the satisfactory agreement achieved in the first three tables, and

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B

The Velocity Distribution Function of Electrons S/057/60/030/008/010/019
in a Positive Discharge Column of Mean Pressure B019/B060

it is stated that the nonelastic collisions must be considered at pressures below 1 torr. It is further shown that while there is an interaction between the electrons, it exerts little influence on the calculation of the electron gas temperature and of the oriented velocity. This influence is discussed. The authors finally thank V. Ye. Golant and V. I. Perel' for their discussion of results. There are 1 figure, 6 tables, and 8 references: 6 Soviet and 2 American.

ASSOCIATION: Leningradskiy gosudarstvennyy universitet im. A. A. Zhdanova
(Leningrad State University im. A. A. Zhdanov)

SUBMITTED: February 15, 1960

L-B

Card 2/2

KAGAN, Yu.

Cyclotron resonance in germanium and silicon and the roll of negative effective masses. Zhur.eksp.i teor.fiz. 38 no.6: 1854-1865 Je '60. (MIRA 13:7)

(Germanium)
(Silicon)
(Cyclotron resonance)

ZAKHAROVA, V.M.; KAGAN, Yu.M.

Spectroscopic determination of ion mobility in a mixture of inert gases. Opt. i spektr. 10 no.4:547-549 Ap '61.

(MIRA 14:3)

(Ions--Migration and velocity)

26641

S/051/61/011/003/002/003
E032/E314

24.6110

AUTHORS: Kagan, Yu.M. and Koretskiy, Ya.P.

TITLE: A Direct Method for Measuring the Mean Half-life of Excited States of Ions

PERIODICAL: Optika i spektroskopiya, 1961, Vol. 11, No. 3, pp. 308 - 311

TEXT: In this method, an electron beam is used to ionise and excite gas molecules so that ions in excited states are produced. If the gas pressure is such that the half-life of the excited ion is smaller than the average time between collisions of the ion with the gas atoms, and if there is a constant electric field in the region where the ions are produced, then the excited ions will have a preferred direction of motion. By measuring this velocity one can determine the average half-life of the excited ions. The relation between the ion drift velocity $\bar{v}_2$ and the half-life in the excited state is (Ref. 4: Yu.Kagan, V.Perel'. Vestn. LGU, No.16, 49, 1959)

$$\bar{v}_2 = \tau \frac{eE}{M} \qquad (1)$$

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S/051/61/011/003/002/003
E032/E314

A Direct Method for ....

where e and M are the charge and mass of the ion and E is the electric field. The average drift velocity $\bar{v}_2$ can be measured from the Doppler shift of the ion line, i.e.

$$\delta\lambda = \lambda \frac{\bar{v}_2}{c} = \lambda\tau \frac{eE}{Me} \qquad (2)$$

In the present work, the authors have used the apparatus shown schematically in Fig. 1. The source of electrons was in the form of the tungsten cathode K , which was a spiral 1.4 cm long and 0.5 cm in diameter. The wire diameter was 0.25 mm and the heating current 5 A. The positive extracting electrode A_1 was at a distance of 2 mm from the cathode. The second positive electrode A_2 was at a distance of 2 mm from A_1 . The apertures in A_1 and A_2 were rectangular (0.4 x 1 cm^2). The collector A_3 and the anode A_2 ·

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A Direct Method for ....

were at some potential. Ions produced as a result of collisions between the electrons and the atoms experienced the field between the grids C_1 and C_2 (0.5 mm mesh). The potential between A_2 and K was about 250 V and the electron current through the gun was about 5 mA. The field strength between C_1 and C_2 was 120 V/cm. The tube was filled with spectroscopically pure helium at a pressure of 3×10^{-2} mm Hg). The line He II $\lambda = 4686$ Å was investigated with the aid of a glass two-prism spectrograph. A Fabry-Perrot etalon was placed between the collimator and the prisms (spacing 5 and 10 mm). The small Doppler shifts were measured by the method described by Frish and Kagan (Ref. 5 - ZhETF, 17, 577, 1947). Half-lives between 0.7×10^{-9} and 1.1×10^{-9} sec were obtained. These are in agreement with quantum-mechanical estimates.

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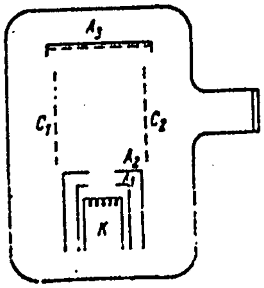
E032/E314

A Direct Method for ....

There are 5 figures and 6 references: 5 Soviet and 1 non-Soviet. The English-language reference quoted is: Ref. 1 - L. Maxwell - Phys. Rev., 38, 1664, 1931.

SUBMITTED: October 19, 1960

Fig. 1:



X

Card 4/4

28758
S/056/61/041/003/011/020
B125/B102

24.2200 (1160, 1395, 1144)

X

AUTHORS: Kagan, Yu., Maksimov, L.

TITLE: Transfer phenomena in a paramagnetic gas

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 41, no. 3(9), 1961, 842-852

TEXT: Based on a study of the kinetic equation for molecules with rotational degrees of freedom, a theory for the transfer phenomena in a paramagnetic neutral gas, which is located in a magnetic field, has been developed. With the help of this theory it is possible to derive all fundamental rules. The present study is limited to linear, diatomic molecules at temperatures, where the rotational motion can be treated with classical mechanics and where no vibrational degrees of freedom have been excited. For such a case, the kinetic equation reads as follows:

$$\frac{\partial f}{\partial t} + \vec{v}\nabla f + \frac{\partial}{\partial \vec{M}}(f\vec{M}) = \left[\frac{\partial f}{\partial t}\right]_{st} \quad (2.1).$$

$\vec{M} = \left[\vec{\mu}\vec{H}\right]$ (2.2), where $\vec{\mu}$ denotes the magnetic moment of the molecule. The

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28758 S/056/61/041/003/011/020
B125/B102

Transfer phenomena in a paramagnetic gas

magnetic moment is obtained as a mean value of the undisturbed state of the molecule: $\vec{\mu} = \hat{\vec{\mu}} = \gamma \vec{M}$ (2.3), where $\gamma = \mu_0 g/\hbar$ (2.4). μ_0 denotes the Bohr magneton, g the gyromagnetic ratio, and $\vec{M}$ the total momentum of the molecule. For the molecules considered the energy of the interaction between spin and axis (for sufficiently high temperatures) is small with respect to the rotational energy. Then, for $M \gg \hbar$ the following relation holds: $\gamma \cong 2\mu_0 \sigma/M$ (2.5) with $\sigma = -S, -S+1, \ldots, S$. S denotes the spin of the molecule. The kinetic equation (2.1) furnishes, in first approximation, $f = f^{(0)}[1+\chi]$ (2.8), and maintaining the first non-vanishing terms,

$$f^{(0)}\left\{\left(\frac{\varepsilon}{kT}-\frac{7}{2}\right)\mathbf{u}\nabla\ln T+\frac{m}{2kT}\left(u_i u_k-\frac{1}{3}\delta_{ik}u^2\right)\times\right.$$
$$\times\left(\frac{\partial v_{0k}}{\partial x_i}+\frac{\partial v_{0i}}{\partial x_k}-\frac{2}{3}\delta_{ik}\frac{\partial v_{0l}}{\partial x_l}\right)+\left.\left(\frac{mu^2}{3kT}-\frac{2}{5}\frac{\varepsilon}{kT}\right)\frac{\partial v_{0l}}{\partial x_l}\right\}+$$
$$+\gamma[\mathbf{MH}]\frac{\partial\chi}{\partial\mathbf{M}}f^{(0)}=J_{\sigma\tau}(\chi),$$
$$J_{\sigma\tau}(\chi)=\int f^{(0)}f_1^{(0)}(\chi'+\chi_1'-\chi-\chi_1)\,W\,d\Gamma_1^{*}d\Gamma^{*\prime}d\Gamma_1^{*\prime}. \qquad (2.13)$$

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is obtained. In general, the collision probability W is unknown. For a small non-sphericity the following relation holds approximately:

$$W d\Gamma'' d\Gamma_1'' = w g d\sigma, \qquad (2.14)$$

$$w = 1 + \lambda\,[P_2(\cos\widehat{gM}) + P_2(\cos\widehat{gM_1}) + P_2(\cos\widehat{g'M}) + P_2(\cos\widehat{g'M_1})],$$

where $\vec{g}$ and $\vec{g}'$ denote the relative velocities before and after a collision, $d\sigma$ the differential elastic scattering cross section, neglecting the non-sphericity. P_2 represents a Legendre polynomial. The thermal conductivity tensor for the general case is given by:

$$\varkappa_{ik} = k(2kT/m)\left(\frac{5}{4}\,\overline{T}_{ki}^{1010} + \frac{1}{2}\,\overline{T}_{ki}^{1001}\right),\ \overline{T} = \frac{1}{2S+1}\sum_{\sigma} T(\sigma) \qquad (3.4).$$

When limiting oneself to the terms with $p = 1$ and $q \leq 2$, the kinetic equation $-u_i(u^2 + M^2 - 7/2)f^{(o)} + \gamma f^{(o)}[\vec{M}\vec{H}]\partial\chi_i/\partial\vec{M} = J_{st}(\chi_i)$ will have the approximate solution

$$\chi_i = T^1_{ik}\psi^1_k + T^2_{ik}\psi^2_k + T^3_{iklm}\psi^3_{klm}, \qquad (3.5)$$

$$\psi^1_k = u_k(u^2 - {}^5/_2), \quad \psi^2_k = u_k(M^2 - 1), \quad \psi^3_{klm} = u_k(M_l M_m - {}^1/_3\delta_{lm} M^2), \qquad (3.6$$

$$T^1 = T^{1010}, \quad T^2 = T^{1001}, \quad T^3 = T^{1100}. \qquad (3.7)$$

The coefficients of (3.5) are given in a mathematical appendix. The thermal conductivity of a paramagnetic gas located in a magnetic field becomes anisotropic, i.e., the thermal conductivity will depend on the orientation of the magnetic field with respect to the temperature gradient. If the angles between H and ∇T are different from 0° or 90°, then the heat flux will have a component normal to the temperature gradient. The Senftleben effect is completely determined by the following expressions:

$$Y^{+}_{1ik} = (c'_1\delta_{ik} + c'_2 H_i H_k/H^2)\, X_3, \qquad (3.24)$$

$$c'_1 = -\frac{3\eta^2(3+4\eta^2)}{(1+\eta^2)(1+4\eta^2)}, \quad c'_2 = \frac{\eta^2(7+4\eta^2)}{(1+\eta^2)(1+4\eta^2)}. \qquad (3.25)$$

$$\Delta\varkappa_{ik} = \varkappa_{ik} - (\varkappa_{ik})_{H=0} = \varkappa_0 \frac{\psi}{2S+1} \sum_{\sigma} \left(c_{1}'\delta_{ik} + c_{\parallel}' \frac{H_i H_k}{H^2} \right), \qquad (3.26)$$

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and

$$\psi = \frac{(A^{12})^2}{A^{11}A^{22}} \left\{ 1 + 5 \frac{A^{22}}{A^{11} + B^{11}} \left[1 - \frac{10}{3} \frac{(A^{12})^2}{A^{11}A^{22}} \right] \right\}^{-1} \qquad (3.27)$$

At a fixed temperature, the Senftleben effect is only a function of the ratio H/p; this agrees with basic experimental results. The temperature dependence is closely related to the shape of the scattering cross section of molecules. For the change of the thermal conductivity coefficient, and any values of η, the following holds:

$\Delta\varkappa_{\perp}/\varkappa_0 < 0$, $\Delta\varkappa_{\parallel}/\varkappa_0 < 0$ (4.3)

for an $\vec{H}$ which is parallel or normal to ∇T; if the values of η are sufficiently high, one obtains $(\Delta\varkappa_{\parallel}/\Delta\varkappa_{\perp})_{\infty} = 2/3$ (4.5); this agrees very well with the experimental results of Senftleben. There are 8 references: 2 Soviet and 6 non-Soviet. The reference to the English-language publication reads as follows: J. O. Hirschfelder, C. F. Curtiss,

28758

Transfer phenomena in a paramagnetic gas S/056/61/041/003/011/020
B125/B102

R. B. Bird. Molecular Theory of Gases and Liquids.

X

SUBMITTED: April 3, 1961

Card 6/6

32328
S/051/61/011/006/011/012
E039/E385

24.2120

AUTHORS: Zakharova, V.M., Kagan, Yu.M. and Perel, V.I.

TITLE: Spectroscopic observation of the rotation of a positive column discharge in a magnetic field

PERIODICAL: Optika i spektroskopiya, v.11, no.6, 1961, 777-779

TEXT: It has been shown that, in powerful arc discharges at low pressures in a magnetic field, the ions rotate about the axis of the arc. This azimuthal motion is explained as the effect of the action of the magnetic field on a radial current of ions. In this work an argon discharge was studied in a tube 1.5 cm in diameter and 180 cm long. The pressure range covered was 0.5 to 2.5 mm Hg. The discharge current was 1.6 A and the magnetic fields used were 250, 600 and 1 000 Oe. Two solenoids 60 cm long were placed on the centre of the tube with a space of 1.5 cm for the spectroscopic observations. The speed of rotation of the atoms was measured by observing the displacement of the 4 300 and 4 044 Å lines using a specially designed spectrograph and a Fabry-Perot etalon. It was shown that the direction of the rotation of the atoms was the same as for the positive ions and

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32528
S/051/61/011/006/011/012
E039/E385

Spectroscopic observation ....

that the speed of rotation depended on the strength of the magnetic field and the gas pressure. The maximum value observed was 1.5 x 10^4 cm/sec at a pressure of 1 mm Hg and a field of 600 Oe. At fields of 250 and 1 000 Oe the speeds of rotation were 0.3 and 0.4 x 10^4 cm/sec respectively.

There are 1 figure and 9 references: 3 Soviet-bloc and 6 non-Soviet-bloc. The four latest English-language references mentioned are: Ref. 5: J.M. Wilcox - Rev. Mod. Phys., 31, 1045, 1959, Ref. 7: A. Simon - Proc. of the II United Nation Conference of the Peaceful Uses of Atomic Energy, 32, 343, 1958, Ref. 8: B. Kadomtsev, A. Nedospasov - J. nucl. energy C 1, 230, 1960, Ref. 9: F. Hoh, B. Lehnert - Phys. of Fluids 3, no. 4, 1960.

SUBMITTED: June 21, 1961

X

Card 2/

64344

9.3150 (1049, 1143, 1532, 2205)
24.2120 (also 3617, 3817)

S/057/61/031/004/008/018
B125/B205

AUTHORS: Kagan, Yu. M. and Lyagushchenko, R. I.

TITLE: Electron energy distribution function in the positive column of a neon discharge

PERIODICAL: Zhurnal tekhnicheskoy fiziki, v. 31, no. 4, 1961, 445-449

TEXT: The authors propose a new method of approximation for the calculation of the electron energy distribution function in the positive column of a neon discharge, taking account of elastic and inelastic collisions. For the solution of problems related to the excitation of ionization in plasma, a knowledge of the distribution functions with regard to elastic and inelastic collisions between electrons and atoms, and also electron-electron interactions is required for solving problems related to the excitation of ionization in plasma. It is noted that none of the relevant previous papers has fulfilled this requirement. The present authors proceed from the experimental values for n_e and T_e. The kinetic equation for electrons in a constant, homogeneous electric field $\vec{E}$ oriented along

X

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21542
S/057/61/031/004/008/018
B125/B205

Electron energy distribution...

the x-axis reads $\frac{eE}{m}\frac{\partial f}{\partial v_x} = \left(\frac{\delta f}{\delta t}\right)_{el} + \left(\frac{\delta f}{\delta t}\right)_{inel} + \left(\frac{\delta f}{\delta t}\right)_e$ (1), where $f(v_x, v_y, v_z)$ is the velocity distribution of the electrons, and $\left(\frac{\delta f}{\delta t}\right)_{el}$, $\left(\frac{\delta f}{\delta t}\right)_{inel}$, and $\left(\frac{\delta f}{\delta t}\right)_e$ are the parts of the impact term corresponding to the elastic and inelastic interactions between electrons and atoms, and to electron-electron interactions. When looking for an equation for the symmetric part of the distribution function $f_o(v)$, then

$$\left(\frac{\partial f_0}{\partial t}\right)_{\text{упр.}} = \frac{1}{v^2}\frac{m}{M}\frac{d}{dv}\left(\frac{v^4}{\lambda^*}f_0\right), \qquad (2)$$

$$\left(\frac{\partial f_0}{\partial t}\right)_{\text{неупр.}} = -\frac{v}{\lambda_{н}^{*}}f_0, \qquad (3)$$

will hold. Here, λ^* and λ^*_{inel} symbolize the mean free paths related to elastic and inelastic electron-atom collisions. The general expression for the interelectronic term $\left(\frac{\delta f}{\delta t}\right)_e$ reads

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B125/B205

Electron energy distribution...

$$\left(\frac{\partial f}{\partial t}\right)_e = \frac{1}{v^2}\frac{d}{dv}\left\{v^2\nu_{ee}\left[A_1(f_0)\frac{df_0}{dv} + A_2(f_0)\, v f_0\right]\right\}, \qquad (4)$$

$$\nu_{ee} = \frac{4\pi e^4 n_e}{m^2 v^3}\ln\left[\frac{k^{3/2} T_e T^{1/2}}{e^3 n_e^{1/2}}\right] \equiv \frac{\nu_0}{v^3}, \qquad (5)$$

$$A_1 = \frac{4\pi}{3n_e}\left\{\int_0^v v_1^4 f_0(v_1)\, dv_1 + v^3\int_v^\infty v_1 f_0(v_1)\, dv_1\right\}, \qquad (6)$$

$$A_2 = \frac{4\pi}{n_e}\int_0^v v_1^2 f_0(v_1)\, dv_1. \qquad (7)$$

In the case where the interelectronic term predominates in the elastic range, which is important in practice, it is possible to simplify the interelectronic term suggested by A. G. Gurevich (ZhETF, 37, 304, 1959) and, thus, one obtains:

X

$$A_1^{(0)} = \frac{kT_e}{m} A_2^{(0)} = \frac{kT_e}{m} A\left(\sqrt{\frac{m}{2kT_e}}\, v\right),$$

$$A(x) = \Phi(x) - \frac{2}{\sqrt{\pi}} x e^{-x^2}, \quad \Phi(x) = \frac{2}{\sqrt{\pi}}\int_0^x e^{-y^2} dy.$$

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On account of the integral character of the terms A_1 and A_2 and due to the rapid decrease of the functions $f_0(v)$, the resulting coefficients are also valid in the inelastic range. In this manner, the following relation is obtained for the symmetric part of the distribution function $f_0(v)$:

$$\frac{1}{v^2}\frac{d}{dv}\left\{\frac{mv^4}{\lambda^* M}f_0+\frac{e^2E^2}{3m^2}\lambda^* v\frac{df_0}{dv}\right\}+\frac{1}{v^2}\frac{d}{dv}\left\{v^2\nu_{ee}(v)\left[\frac{kT_e}{m}A\left(\sqrt{\frac{m}{2kT_e}}v\right)\frac{df_0}{dv}+\right.\right.$$
$$\left.\left.+vA\left(\sqrt{\frac{m}{2kT_e}}v\right)f_0\right]\right\}-\frac{v}{\lambda^*_{11}}f_0=0. \qquad (8)$$

Solving the kinetic equation (8) requires a knowledge of the velocity dependence of the elastic and inelastic scattering cross sections which are taken from experimental data. The authors have studied only the case of neon, for which the inelastic scattering cross section can be assumed to be approximately independent of the velocity. The method proposed here does not depend on any concrete form of the velocity dependence of the cross sections. Solution of the kinetic equation: In the range where the electron energy is lower than the energy of the nearest excited states, Eq. (8) has the solution

S/057/61/031/004/008/018
B125/B205

Electron energy distribution...

$$f_0(u)=\exp\left[-\int_0^u \frac{\nu_0 A(\sqrt{u})+\frac{4k^2T_e^2}{m\lambda^* M}u^2}{\nu_0 A(\sqrt{u})+\frac{2}{3}\frac{e^2E^2}{m^2}\lambda^* u}\,du\right]\times$$

$$\times\left\{B_1+B_2\int_0^u \exp\left[\int_0^x \frac{\nu_0 A(\sqrt{u})+\frac{4k^2T_e^2}{m\lambda^* M}u^2}{\nu_0 A(\sqrt{u})+\frac{2}{3}\frac{e^2E^2}{m^2}\lambda^* u}\,du\right]dx\right\}, \qquad (9)$$

$$u=\frac{mv^2}{2kT_e}.$$

Using the notations $a_E=\frac{e^2E^2\lambda^*\lambda_o}{12k^2T_e^2}$; $2a_e=\frac{\lambda_o\nu_o m^2}{4k^2T_e^2}$; $a_y=\frac{m\lambda_o}{\lambda^* M}$, the equation

$$f_0(u)=B_3(a_0+a_1u)^{-\frac{1}{2}\left(\frac{b_0}{a_1}+\frac{b_2a_0^2}{a_1^3}\right)}\sqrt{\frac{w}{q}}\,K_{1/4}(w)\,e^{-\frac{b_2}{4a_1}u^2+\frac{b_2a_0}{2a_1^2}u}. \qquad (18)$$

is obtained in the inelastic case. Formulas (9) and (18) yield a solution

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for $f_0(u)$ at all values of u. The constants B_1, B_2, and B_3 are determined from the conditions for the continuity of the function $f_0(u)$, from its derivative at the point $u = u_1$, and from the normalization condition for $f_0(u)$. Discussion of results: The approximation used by the authors in the range $u < u_1$ is the better the greater is the role of interelectronic interactions with respect to elastic interactions between electrons and atoms and with respect to the interaction between electrons and field. According to (9), the criterion for the applicability of this approximation consists in that $f_0(u)$ differs only slightly from the Maxwell function and only in that range where it yields a significant contribution in $A_1(f_0)$ and $A_2(f_0)$. This integral is reduced to the inequalities

$$\left.\begin{aligned} \frac{4k^2T_e^2}{m\lambda^{*}M\nu_0} &= \frac{a_T}{2a_e} \ll \frac{A\sqrt{u})}{u^3}, \\ \frac{2}{3}\frac{e^2E^2}{m^2\nu_0}\lambda^{*} &= \frac{a_E}{a_e} \ll \frac{A\sqrt{u}}{u}. \end{aligned}\right\} \qquad (19)$$

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21542

S/057/61/031/004/008/018
B125/B205

Electron energy distribution...

For $\sqrt{u} = 1.7$ the function $A(\sqrt{u})$ assumes the value 0.88. These inequalities (19) must be satisfied in the range from $\sqrt{u} = 0.3$ to $\sqrt{u} = 1.7$. The contribution made by the ranges neglected here to the integrals does not exceed 10%. With such a choice of the range it follows that $a_y/a_e \ll 0.6$ and $a_E/a_e \ll 0.5$ (20). If the interelectronic term is one order of magnitude higher than the remaining terms, the approximation applied here is still permissible. If the terms in (20) are very unequal, (9) can be replaced in the range $u < u_1$ by the distribution function $f_o(u) = e^{-u}\left[B_1 + B_2(e^u - 1)\right]$ (21). The second term in (9) and (21) is due to the effect of inelastic collisions. G. F. Drukarev and V. Ye. Golant are thanked for advice and discussions. There are 9 references: 5 Soviet-bloc and 4 non-Soviet-bloc. The two references to English language publications read as follows: T. Lewis. Proc.Roy.Soc.A,244,166, 1958; I. Cahn. Phys.Rev.,17,293,346,838,1949.

ASSOCIATION: Leningradskiy gosudarstvennyy universitet im. A. A. Zhdanova
(Leningrad State University imeni A. A. Zhdanov)

SUBMITTED: July 5, 1960

Card 7/7

36501
S/051/62/012/003/012/016
E202/E435

24.3200
6,3600

AUTHORS: Kagan, Yu.M., Perel', V.I., Chayka, M.P.

TITLE: Theory of optical signal amplification using a medium with negative absorption

PERIODICAL: Optika i spektroskopiya, v.12, no.3, 1962, 427-433

TEXT: Problems of amplifying an optical signal by means of negative absorption medium are discussed but without references to the generation. Formulae for the integral amplification of the incident signal A, are derived for the Lorentz and Doppler profiles, the integrals being evaluated by means of Bessel's function and power series respectively. In the case of high amplification, i.e. $k_0 L \gg 1$, these are

$$A_{Lor} = \frac{e^{k_0 L}}{\sqrt{\pi k_0 L}} ; \qquad A_{Dopp} = \frac{e^{k_0 L}}{\sqrt{k_0 L}}$$

where k_0 is the amplification coefficient at the centre of the line and L is the thickness of the medium. These considerations are applied to a parallel mirror containing the active medium

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Theory of optical signal ... S/051/62/012/003/012/016
E202/E435

within and a uniform medium outside the mirrors. Relations are developed for the ratio of incident $\mathcal{J}_o$, and emergent $\mathcal{J}$, intensities of the beam, which in the case of ideal mirror and narrow beam are

$$\frac{\mathcal{J}}{\mathcal{J}_o} = \frac{(1 - r)^2 e^{kl}}{1 - r^2 e^{2kl}}$$

The ideal case is developed further to account for real finite mirrors with surface defects. The effects of the edges on the width of the diffraction rings and the departures from optical flatness are considered and a working example based on experimentation of A.Javan and associates (Ref.6: Phys. Rev., Letters, 6, 1961, 106) are given. The work is completed by considering frequency distribution in the amplified beam in the absence of interference for the Doppler and Lorentz profiles. There are 3 figures.

SUBMITTED: July 24, 1961

Card 2/2

34208

S/057/62/032/002/009/022
B104/B102

24.6712

AUTHORS: Kagan, Yu. M., and Lyagushchenko, R. I.

TITLE: Velocity distribution of electrons, distribution of excitation and ionization in the positive column of a neon discharge

PERIODICAL: Zhurnal tekhnicheskoy fiziki, v. 32, no. 2, 1962, 192-196

TEXT: In a previous paper (ZhTF, 31, no. 4, 1961) the authors calculated the electron energy distribution in neon with allowance for elastic and inelastic collisions between electrons and atoms and electron interaction. The distribution functions are calculated for 5-20 mm Hg and amperages of 200 and 400 ma. The distribution function for $u < u_1$ is

$$f_0(u) = \exp[-\psi(u)]\left\{B_1 + B_2\int_0^u \exp[\psi(z)]\,dz\right\} \quad (1),$$

for $u > u_1$,

$$f_0(u) = \sqrt{\frac{w}{q}}\,B_3K_{1/3}(w)\exp\left[-\frac{1}{2}\int\frac{b_0 + b_1u^2}{a_0 + a_1u}\,du\right] \quad (2)$$

Card 1/6

34208
S/057/62/032/002/009/022
B104/B102

Velocity distribution of ...

$u = mv^2/2kT_e$, T_e is the temperature of the electron gas, $u_1 = eV_1/kT_e$, V_1 is the first excitation potential, T is the gas temperature, n_e is the electron concentration, λ^* is the mean free path, $K_{1/3}$ is the MacDonald function. The number Z of direct ionization and the number Z^* of step-by-step ionizations was calculated with the aid of

$$Z=\frac{2k^2T_e^2}{m^2}N\int\limits_{u_i}^{\infty}Q_i(u)\,uf_0(u)\,du, \qquad (4)$$

and

$$Z^*=\frac{2k^2T_e^2}{m^2}\sum_n N_n\int\limits_{u_n}^{\infty}Q_n(u)\,uf_0(u)\,du, \qquad (5).$$

Q(u) is approximated with $N_0Q(V) = 0.055(V-20.6)$, where $N_0 = 3.52\cdot10^{16}$ cm^{-3} and V is the potential in volts. It can be seen that under the conditions chosen direct ionization can be neglected. This agrees with the known data. Under the conditions chosen, dissipative recombination need not be considered when calculating the electron concentrations (Table 2). The annihilation probability of a metastable atom by diffusion to the wall, by

Card 3/8

S/056/62/042/003/034/049
B102/B138

10 1200 24 5300

AUTHORS: Zhdanov, V., Kagan, Yu., Sazykin, A.

TITLE: Effect of viscous momentum transfer on diffusion in a gas mixture

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 42, no. 3, 1962, 857 - 867

TEXT: A theoretical investigation of the diffusion of a multi-component gas mixture is given when assuming viscous momentum transfer. The well-known method of moments by H. Grad (Comm. Pure and Appl. Math. 2, 331, 1949) is applied and the general system of diffusion equations is derived in the "13-moment" approximation. The relations obtained make it possible to analyze the effects of viscous momentum transfer on the diffusion. The calculations are carried out on the assumption that $\lambda/L \ll 1$ and $\tau/T \ll 1$; λ and τ are the mean free path and time, resp. and L and T are the characteristic length and time parameters of the changes in the mixture. The distribution function of the component α in a gas mixture is expanded into a series of Hermite polynomials $H^{(s)}_{\alpha i_1 \dots i_s}(\vec{c}_\alpha)$:

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system of diffusion equations is obtained as

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B102/B138

Effect of viscous momentum transfer...

$$\sum_{\beta}\frac{n_\alpha n_\beta kT}{n[D_{\alpha\beta}]_1}(u_{\alpha i}-u_{\beta i})=-\left[\frac{\partial p_\alpha}{\partial x_i}-\frac{\rho_\alpha}{\rho}\frac{\partial p}{\partial x_i}\right]+\left[n_\alpha X_{\alpha i}-\frac{\rho_\alpha}{\rho}\sum_{\beta}n_\beta X_{\beta i}\right]+$$
$$+\sum_{\beta}\xi_{\alpha\beta}\left(\frac{\lambda_\alpha}{m_\alpha n_\alpha}-\frac{\lambda_\beta}{m_\beta n_\beta}\right)\frac{\partial T}{\partial x_i}+2\left[\eta_\alpha-\frac{\rho_\alpha}{\rho}\eta\right]\frac{\partial e_{ik}}{\partial x_k}+$$
$$+\frac{4}{5}k\left(\frac{T}{p}\right)^2\sum_{\beta=1}^{N}\sum_{\delta=1}^{N}\xi_{\alpha\beta}\eta_\delta\left[\frac{|b|_{\delta\beta}}{m_\beta|b|}-\frac{|b|_{\delta\alpha}}{m_\alpha|b|}\right]\frac{\partial e_{ik}}{\partial x_k}-$$
$$-k\left(\frac{T}{p}\right)^2\sum_{\beta=1}^{N}\sum_{\delta=1}^{N}\sum_{\nu=1}^{N}\frac{kT}{m_\delta}\xi_{\alpha\beta}\xi_{\delta\nu}\left(\frac{|b|_{\delta\beta}}{m_\beta|b|}-\frac{|b|_{\delta\alpha}}{m_\alpha|b|}\right)(u_{\delta i}-u_{\nu i}).\qquad(3.8)$$

The equations obtained are used to investigate the diffusion in a two-component mixture. Several formulas for the barodiffusion constant α_p are derived. In the Kihara approximation

$$\alpha_p=\frac{9A^*}{5+3A^*}\left[1+\frac{(6C^*-5)(25+25A^*-18A^{*2})}{24A^{*2}(5+2A^*)}\right]\frac{m_2-m_1}{m_2+m_1}-$$
$$-\frac{6A^*}{5+3A^*}\left[1-\frac{5(6C^*-5)(1+3A^*)}{12A^*(5+2A^*)}\right]\frac{\sigma_2-\sigma_1}{\sigma_{12}}.\qquad(4.10)$$

is obtained for a viscous flow of an arbitrary binary mixture; for an incompressible liquid

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S/056/62/042/003/034/049
B102/B138

Effect of viscous momentum transfer...

$$\alpha_p = p\left(\frac{\partial\mu}{\partial p}\right)_{y_1,\,T} \Big/ \left(\frac{\partial\mu}{\partial y_1}\right)_{p,\,T} y_1(1-y_1) + kTc \Big/ 2\eta D_{12} y_1 (1-y_1).$$

is obtained. y is the molar concentration, μ the chemical potential,

$$p_{\alpha ik} = -2\eta_\alpha e_{ik}, \quad \eta_\alpha = y_\alpha \sum_{\beta=1}^{N} \frac{y_\beta |a|_{\beta\alpha}}{|a|} \quad (3.6).$$

$|\alpha_p|$ depends significantly on the nature of the interaction between the molecules and can have any sign. The cause of the difference between the value of α_p obtained and

$$\alpha_p = (m_2 - m_1)/[m_1 y_1 + m_2(1-y_1)]. \quad (4.6)$$

obtained by irreversible thermodynamical methods is discussed. There are 1 figure and 10 references: 2 Soviet and 8 non-Soviet. The four most recent references to English-language publications read as follows: C. Muckenfuss, C. Curtiss. J. Chem. Phys., 29, 1273, 1958; T. Kihara. Rev. Mod. Phys. 25, 873, 1953; C. Curtiss, J. Hirschfelder. J. Chem. Phys. 17, 550, 1949; S. Chapman, T. Cowling. Proc. Phys. Soc. A179, 159, 1941.

SUBMITTED: October 9, 1961

Card 4/4

3 6936

[illegible]

S/057/62/032/007/011/013
B104/B102

AUTHORS: Kagan, Yu. M., and Lyagushchenko, R. I.

TITLE: Theory of photoelectric currents in gases

PERIODICAL: Zhurnal tekhnicheskoy fiziki, v. 32, no. 7, 1962, 891-896

TEXT: An attempt is made to improve the Thomson-Loeb formula for photoelectric currents in gases. If electrons are ejected from a metal cathode by light, the equation for particle equilibrium allowing for back diffusion of electrons to the cathode reads:

$$D\frac{dn}{dx}-bEn=j_0\left(1-e^{-\int_0^x \frac{dx}{\lambda(x)}}\right)+C,$$

where C is an integration constant. This gives

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S/057/62/032/007/011/013
B104/B102

Theory of photoelectric currents ...

$$j = j_0 + j_e = j_0 \frac{\int\limits_0^\infty \frac{1}{D} e^{-\int\limits_0^x \left(\frac{1}{\lambda}+\frac{b}{D}E\right) dy} dx}{\int\limits_0^\infty \frac{1}{D} e^{-\int\limits_0^x \frac{b}{D} E dy} dx} = j_0 \frac{I_1}{I_2} \qquad (8)$$

for the current density towards the anode, which shows that the observable photoelectric currents are far from saturation. (8) is integrated for hydrogen and argon:

$$\frac{j}{j_0} = \frac{\frac{1}{b_0 E + \frac{1}{3} v_0}}{\frac{1}{bE}\left(\frac{\varepsilon_0}{\varepsilon}\right)^{\frac{eE\lambda}{\varepsilon-\varepsilon_0}\sqrt{\frac{1}{\delta}}} + \frac{\frac{3}{2} m v_0}{eE\lambda - \frac{1}{2}\frac{\varepsilon-\varepsilon_0}{\sqrt{\frac{1}{\delta}}}}\left(1-\left(\frac{\varepsilon_0}{\varepsilon}\right)^{\frac{eE\lambda}{\varepsilon-\varepsilon_0}\sqrt{\frac{1}{\delta}}-\frac{1}{2}}\right)}$$

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44214

S/057/62/032/012/010/017
B104/B186

24,2120

AUTHORS: Kagan, Yu. M., and Perel', V. I.

TITLE: On the theory of ionic current towards the probe

PERIODICAL: Zhurnal tekhnicheskoy fiziki, v. 32, no. 12, 1962, 1479-1482

TEXT: The formulas

$$i_p = cn_0e\sqrt{\frac{2kT_e}{M}}S_n, \tag{1}$$

$$i_p = \frac{4\sqrt{2}}{9}\sqrt{\frac{e}{M}}\frac{V^{3/2}}{\beta^2\left(\frac{r_s}{a}\right)}, \tag{2}$$

for this were derived on the assumption that the electron concentration in the space layer round the probe can be neglected in comparison with the ion concentration (The characteristics of electrical discharges in magnetic fields, edited by A. Guthrie and R. Wakerling, Yu. M. Kagan, V. I. Perel', DAN SSSR, 91, 1321, 1953). V is the negative potential of the probe, n_0 and T_e are the concentration and the temperature of the electrons in the

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undisturbed plasma, $S_c = 4\pi r_c^2$ is the surface of the space charge layer, a the probe radius, $\beta^2(r_c/a)$ is the tabulation function by Langmuir and Blodgett (Phys. Rev. 22, 317, 1923, 24, 49, 1924). The distribution of the potential η, of the electron concentration n_e and of the ion concentration n_p (Fig. 1) given by F. Wenzl, lead to the more precise formulas

$$i_p = \alpha n_0 e\sqrt{\frac{2kT_e}{M}}S_p; \quad S_p = 4\pi r_p^2, \tag{7}$$

and

$$i_p = \frac{4\sqrt{2}}{9}\sqrt{\frac{e}{M}}\frac{V^{3/2}}{\beta^2\left(\frac{r_p}{a}\right)}. \tag{8}$$

With $\gamma \simeq T_p/T_e = 0$ the value of α lies between $\alpha_{min} = 0.43$ and $\alpha_{max} = 0.82$. Elimination of r_p in (7) and (8) gives

$$\eta' = \frac{9}{4} i'_p \beta^2\left(\sqrt{i'_p}\right). \quad \eta' = \frac{eV}{kT_e}\left(\frac{h^2}{a^2\alpha_{max}}\right)^{2/3}; \quad i'_p = i_p\frac{h^2}{a^2\alpha_{max}}\frac{e}{kT_e\sqrt{\frac{2kT_e}{M}}}; \quad h^2 = \frac{kT_e}{4\pi n_0 e^2}. \tag{9}$$

On the theory of ionic current...

S/057/62/032/012/010/017
B104/B186

A comparison with numerical results, if $3 \leqslant a/h \leqslant 10$ shows that the ionic part of the probe characteristics if described well by (9). There are only deviations with small η'. There are 2 figures.

ASSOCIATION: Leningradskiy gosudarstvennyy universitet im. A. A. Zhdanova (Leningrad State University imeni A. A. Zhdanov)

SUBMITTED: July 2, 1962

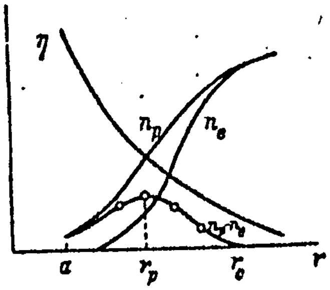

Fig. 1

Card 3/3

KAGAN, Yu. M.; LYAGUSHCHENKO, R. I.; KHAKHAYEV, A. D. 2

"The Positive Column Discharge in the Inert Gases under Medium Pressures."

report submitted to 11th Intl Spectroscopy Colloq, Belgrade, 30 Sep-4 Oct 63.

VOROB'YEVA, N. A.; KAGAN, Yu. M.; LYAGUSHCHENKO, R. I.; MILENIN, V. M.

"The Energy Distribution of Electrons in the Discharge of the Positive Column."

report submitted to 11th Intl Spectroscopy Colloq, Belgrade, 30 Sep-4 Oct 63.

L 9846-63 EWT(1)/BDS/EEC(b)-2--AFFTC/ASD/ESD-3--IJP(C)

ACCESSION NR: AP3000576 S/0051/63/014/005/0598/0606

57

58

AUTHOR: Kagan, Yu. M.; Lyagushchenko, R. I.; Khatsev, A. D.

TITLE: Excitation of inert gases in the positive column of a discharge at medium pressures. 1. Neon

SOURCE: Optika i spektroskopiya, v. 14, no. 5, 1963, 598-606

TOPIC TAGS: electric discharges in gases, Ne

ABSTRACT: The investigation was undertaken in view of the paucity of data on excitation of inert gases in the positive column of a discharge. The discharges were realized in a special discharge tube at pressures from 1 to 30 mm Hg and currents from 10 to 400 mA. The spectra were recorded by means of an ISP-51 spectrograph with a photoelectric attachment. Intensities were determined with reference to a tungsten ribbon lamp. The changes in electron concentration and temperature and the field strength were gaged by the method of two probes. The absolute intensity of some transitions and the numbers of photons emitted in de-excitation from upper to all 2p sup 5 3s levels are tabulated as a function of

Card 1/2

L 9846-63
ACCESSION NR: AP3000576

the gas pressure. Excitation cross sections for some pressures and current values are given. The report includes a diagram of the low-lying levels and transitions in neon. "The author thanks S. E. Frish for discussion of the results and valuable suggestions." Orig. art. has: 5 equations, 4 figures and 6 tables.

ASSOCIATION: none

SUBMITTED: 28Sep63 DATE ACQ: 12Jun63 ENCL: 00

SUB CODE: PH NR REF SOV: 010 OTHER: 002

ja/nh

Card 2/2

L 13090-63 BDS/EWT(1)/ES(w)-2 AFFTC/ASD/ESD-3/SSD Pab-4 IJP(C)
ACCESSION NR: AP3003404 S/0051/63/015/001/0013/0020

66

63

AUTHOR: Kagan, Yu. M; Lyagushchenko, R. I.; Khakhayev, A. D.

TITLE: On excitation of inert gases in the positive column of a discharge at medium pressures. 2. Argon

21

SOURCE: Optika i spektroskopiya, v.15, no.1, 1963, 13-20

TOPIC TAGS: positive column, level population, A

ABSTRACT: In the first part of the study (Optika i spektroskopiya, 14, 598, 1963) the authors investigated the excitation conditions obtaining in the positive column of a discharge in neon at pressures from 1 to 30 torr and with currents from 10 to 400 mA; in the present work the investigation was concerned with discharges in argon at pressures from 0.18 to 10 torr and I = 25 to 400 mA, using a similar 24 mm diameter tube, probe, etc. The data were obtained on an ISP-51 spectrograph (f = 1 meter) with a photoelectric attachment. A level and transition diagram for argon is given. The measurement results, including the populations of some levels, are tabulated. Energy balances for some 3p levels are analyzed, and equations for the energy balances adduced together with the corresponding constants. It is inferred that electron impact is the predominant excitation mechanism. "The authors thanks S. E. Frish for discussion of the results and students S. Irkina and Yu. Golubovskiy for assistance in the measurements."

Card 1/2

KAGAN, Yu.M.; LUIZOVA, L.A.; LYAGUSHCHENKO, R.I.; KHAKHAYEV, A.D.

Excitation of inert gases in a positive d-c discharge column at medium pressures. Part 3: Upper levels of neon and argon. Opt. i spektr. 15 no.4:446-452 O '63. (MIRA 16:11)

L 9921-63 EWT(1)/BDS/EEC(b)-2--AFFTC/ASD/ESD-3--Pi-4/Po-4--
IJP(C)
ACCESSION NR: AP3000013

S/0057/63/033/005/0571/0575

67

65

AUTHOR: Vorob'yeva, N. A.; Kagan, Yu. M.; Milenin, V. M.

TITLE: Concerning the electron velocity distribution function in the positive column of a mercury discharge. Part one

SOURCE: Zhurnal tekhnicheskoy fiziki, v. 33, no. 5, 1963, 571-575

TOPIC TAGS: electron velocity distribution, plasma, discharges

ABSTRACT: The velocity distribution of electrons in discharges, an important characteristic of discharges, has been determined experimentally by many investigators, but in most cases the measurement accuracy has been such as to allow of only quantitative determination of the shape of the distribution function. Accordingly, the purpose of the present work was to improve the procedure proposed by Maly*shev, G. M., and Fedorov, V. L. (ZhTF, 23, no. 6, 1953) and to investigate systematically the distribution function in the positive column of a mercury discharge. The measurement technique involves the use of a probe, modulation and a narrow band amplifier. Different flat,

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L 9921-63
ACCESSION NR: AP3000013

cylindrical and spherical probes were used. The measurements were carried out at pressures from 10 sup -4 to 10 sup -1 mm Hg, and for discharge current values from 0.01 to 1.0 amperes. The quantities measured were the probe current and its second derivative for different values of the potential between the probe and the plasma. The approximations involved in the method are discussed. For pressures above 10 sup -2 there was obtained a near Maxwellian distribution in the 0 to 4 eV energy interval. Orig. art. has: 3 equations and 10 figures.

ASSOCIATION: Leningradskiy gosudarstvenny*y universitet im. A. A. Zhdanova (Leningrad State University)

SUBMITTED: 06 Apr 62 DATE ACQ: 12Jun63 ENCL: 00

SUB CODE: PH NR REF SOV: 004 OTHER: 004

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Card 2/2

ACCESSION NR: AP4043001 S/0051/64/017/002/0168/0175

AUTHORS: Kagan, Yu. M.; Lyagushchenko, R. I.

TITLE: Excitation of inert gases in the positive column of a discharge at medium pressures. IV.

SOURCE: Optika i spektroskopiya, v. 17, no. 2, 1964, 168-175

TOPIC TAGS: excitation, inert gas, discharge column, positive column, neon, argon, atomic energy level, ionization

ABSTRACT: The present paper is devoted to an analysis of the experimental data obtained in earlier work (ZhTF v. 30, 442, 1960 and in Opt. i spektr. v. 14, 598, 1963, v. 15, 13, 1963, and v. 15, 446, 1963). The concentration of the atoms at the metastable and resonant levels is determined within the framework of a definite model describing the excitation and ionization processes. The difference between the number of excitations and the number of second-

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ACCESSION NR: AP4043001

order collisions between the atoms and the electrons is determined also on the basis of the transport equation. The calculated concentrations for neon and argon are compared with experiment and agree with the assumption that the quenching does not go to the ground state but to the $2p^5 3s$ level in neon or $3p^5 4p$ level in argon. Orig. art. has: 1 figure, 19 formulas, and 4 tables.

ASSOCIATION: None

SUBMITTED: 04Jul63

ENCL: 00

SUB CODE: OP, IC

NR REF SOV: 011

OTHER: 000

Card 2/2

L 2234-65 EWT(1)/EWG(k)/EWT(m)/EPA(sp)-2/EPF(c)/EPF(n)-2/EWR/EPA(w)-2/
[illegible] Pz-6/Po-4/Pab-24/Pi-4/Ps-4/Pl-4/Pu-4

[illegible] 33/0336

[illegible] M., Kagan, [illegible]

[illegible] atom line contours in the positive column of a discharge in argon

[illegible] Optika i spektroskopiya, v. 17, no. 3, 1964, 333-336

[illegible] spectrum line, discharge column, ion temperature, plasma ion motion, plasma atom

ABSTRACT: [illegible] the earlier investigations (Kagan and Zakharova, ZhETF v. 22, 400, 1952), which were made at pressures [illegible] 1.5 mm Hg [illegible] densities (as high as 55 A/cm^2), the present [illegible] at low pressures (10^{-2}--5 x 10^{-1} mm Hg) and at [illegible] The discharge tube and the setup for [illegible] yielded the atom and [illegible] directional component of the ion velocity in [illegible]

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L 2134-65
ACCESSION NR: AP4044842

[illegible] The experimental data are compared with the theoreti- [illegible] same quantities and confirm the pre- [illegible] of ions in a plasma. [illegible]

EN [illegible]

NR REF SOV: 007

OTHER: 001

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L 2134-65
ACCESSION NR: AP4044842

ENCLOSURE: 01

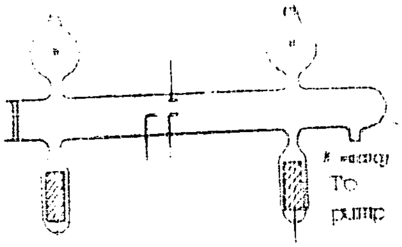

Fig. 1. Discharge tube

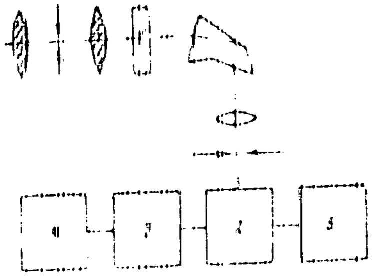

Fig. 2. Contour recorder

1 - Fabry-Perot etalon, 2 - photo-multiplier, 3 - dc amplifier, 4 - [illegible] recorder [illegible]

Card 3/4

L 2134-65
ACCESSION NR: AP 4044842

ENCLOSURE: 02

Table 1

p mm. Hg	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] parameters

Table 2

p mm. Hg	T	T_p exp.	T_p theor.
[illegible]	350	570	400
[illegible]	[illegible]	750	500
	[illegible]	700	400

Atom and ion temperatures

Table 3

	p mm. Hg			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Ion directional velocities

Card 4/4

ACCESSION NR: AP4009934 S/0057/64/0034/001/0146/0148

AUTHOR: Vorob'yeva,N.A.' Kagan,Yu.M.; Lyagushchenko,R.I.; Milenin,V.M.

TITLE: On the electron velocity distribution in the positive column of a mercury discharge. Part.2.

SOURCE: Zhurnal tekhnicheskoy fiziki, v.34, no.1, 1964, 146-148

TOPIC TAGS: velocity distribution, electron velocity distribution, mercury discharge, positive column

ABSTRACT: Electron velocity distributions were measured in the positive columns of hot cathode mercury discharges at pressures from 1.2×10^{-3} to 5×10^{-2} mm Hg and currents from 20 to 500 mA. The measurements were performed by a probe method described earlier(N.A.Vorob'yeva ,Yu.M.Kagan,V.M.Milenin,ZhTF,33,571,1963). Except for an improved narrow-band amplifier, the apparatus was identical with that previously employed. The new amplifier has a gain of 6×10^5 and a pass band of 8 cps. The resulting improvement in the signal to noise ratio made it possible to follow the velocity distributions to higher electron energies than previously reported. The results of the measurements at 200 mA are presented in the form of graphs. At pres-

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ACC.NR: AP4009934

sures of 1.2 x 10^{-3} and 6 x 10^{-3} mm Hg, the distributions were found to be Maxwellian out to the highest electron energies recorded (12 eV and 9 eV, respectively). At 2.5 x 10^{-2} and 5 x 10^{-2} mm Hg, deviations from the Maxwell distribution were observed; fewer high energy electrons were present than required by the Maxwell function fitting the low energy portion of the distribution. At 2.5 x 10^{-2} mm Hg the electron temperature was about 12 000°K and deviations from the Maxwell distribution first became appreciable at electron energies slightly greater than 4 eV; the corresponding figures at 5 x 10^{-2} mm Hg were 9000°K and 2 eV. Possible experimental errors due to the presence of ion currents would tend to mask the observed effect, which is therefore regarded as real. Orig.art.has: 7 figures.

ASSOCIATION: Leningradskiy gosudarstvenny*y universitet im.A.A.Zhdanova (Leningrad State University)

SUBMITTED: 01Nov62 DATE ACQ: 10Feb64 ENCL: 00

SUB CODE: PH NR REF SOV: 002 OTHER: 000

Card 2/2

ACCESSION NR: AP4035690 S/0057/64/034/005/0821/0827

AUTHOR: Kagan, Yu.M.; Lyagushchenko, R.I.

TITLE: On the energy distribution of electrons in the positive column of a discharge

SOURCE: Zhurnal tekhnicheskoy fiziki, v.34, no.5, 1964, 821-827

TOPIC TAGS: plasma, discharge plasma, positive column, electron distribution, argon, neon

ABSTRACT: The energy distribution of electrons in an infinite plasma in a uniform electric field is discussed theoretically. The energy regions below and above the excitation energy of the first atomic level are treated separately. Inelastic collisions are neglected in the low energy region, and the electron distribution function is quoted from earlier work (Yu.M.Kagan and R.I.Lyagushchenko, ZhTF 31,445,1961). In the high energy region the effect of inelastic collisions on the asymmetric portion of the distribution function is neglected. This approximation, which is said to be valid for inert gases but not for mercury vapor, permits separate kinetic equations to be written for the symmetric and the asymmetric portions of the distri-

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ACCESSION NR: AP4035690

ASSOCIATION: Leningradskiy gosudarstvenny*y universitet im.A.A.Zhdanova (Leningrad State University)

SUBMITTED: 10Jun63

DATE ACQ: 20May64

ENCL: 00

SUB CODE: ME, EM

NR REF SOV: 009

OTHER: 000

Card 3/3

ACCESSION NR: AP4035691

S/0057/64/034/005/0828/0832

AUTHOR: Vorob'yeva, N.A.; Kagan, Yu.M.; Milenin, V.M.

TITLE: On the electron velocity distribution function in the positive column of a mixture of gases

SOURCE: Zhurnal tekhnicheskoy fiziki, v.34, no.5, 1964, 828-832

TOPIC TAGS: plasma, positive column, electron velocity distribution, electric discharge, multicomponent plasma, mercury, inert gas

ABSTRACT: The electron velocity distribution function was determined in the positive columns of gas discharges taking place in a mixture of mercury vapor and one of the inert gases Ne, He, A, Xe. The discharge tube was 50 cm long and 2.5 cm in diameter. The electron velocity distribution was calculated from the characteristics of a set of five probes located at 5 cm intervals along the axis of the tube. The experimental technique is described in more detail elsewhere (N.A.Borob'yeva, Yu.M. Kagan, R.I.Lyagushchenko and V.M.Milenin,ZhTF 34,1964). In all the measurements the discharge current was 200 mA and the partial pressure of mercury vapor was 2.5×10^{-3} mm Hg. The electron velocity distribution in the positive column of a pure

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mercury vapor discharge at this pressure was previously found to be Maxwellian (loc. cit.supra), and this finding was confirmed in the present series of measurements. Electron distribution functions were determined with various amounts of inert gas present, ranging from 0.006 mm Hg of Xe to 4.0 mm Hg of Ne, several different quantities of each gas being employed. In each case it was found that when enough of the inert gas was present the electron distribution deviated from the Maxwellian in the sense that too few high energy electrons were present. The heavier gases were more efficient in depressing the number of high energy electrons than were the lighter one,s 0.02 mm Hg of Xe producing about the same effect as 0.5 mm Hg of Ne. The data are presented graphically, and on each experimental curve the Maxwell distribution is drawn corresponding to the electron temperature obtained from the negative probe characteristic. In some cases, in addition to the large deviations at high energies, small deviations between the experimental curve and the Maxwell distribution can be discerned in the region of the maximum. These small deviations are ascribed to error in determining the space potential from the position of the maximum of the second derivative of the negative probe current with respect to the probe potential. This maximum was sharp in the case of pure mercury vapor, but in mixtures showing considerable deviation from the Maxwell distribution the maximum was broad and could not

ACCESSION NR: AP4035691

be located precisely. This source of error, however, could not appreciably affect the observations of the large deviations at high electron energies.

ASSOCIATION: Leningradskiy gosudarstvenny*y universitet im.A.A.Zhdanova (Leningrad State University)

SUBMITTED: 24May63

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SUB CODE: ME, EM

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OTHER: 001

Card 3/3

[illegible]

ACCESSION NR: AP4044[illegible]

2/3

VOROB'YEVA, N.A.; KAGAN, Yu.M.; MILENIN, V.M.

Electron distribution function in a positive discharge column in neon and helium. Zhur.tekh.fiz. 34 no.11:2079-2081 N '64.
(MIRA 18:1)

1. Leningradskiy ordena Lenina gosudarstvennyy universitet imeni A.A.Zhdanova.

L 61691-65

ACCESSION NR: AP5011384

BORODIN, V.S.; KAGAN, Yu.M.

Discharge in a hollow cathode. Opt. i spektr. 18 no.6:966-967 Je '65. (MIRA 18:12)

L 4385-66 EWT(1)/ETC/EPF(n)-2/EWG(m)/EPA(w)-2 IJP(c) AT

ACC NR: AP5017907 UR/0051/65/019/001/0140/0141
537.523.527

AUTHOR: Zakharova, V. M.; Kagan, Yu. M. 44,55

TITLE: Concerning the rotation of the positive column of a discharge in a magnetic field

SOURCE: Optika i spektroskopiya, v. 19, no. 1, 1965, 140-141

TOPIC TAGS: neon, argon, helium, krypton, gas discharge plasma, turbulent plasma, pressure effect, plasma magnetic field

ABSTRACT: This is a continuation of earlier work (Opt. i spektr. v. 11, 77, 1961) in which the rotation of the positive column of argon discharge in a longitudinal magnetic field was observed by a spectroscopic method. In the present work, the speed of rotation of the plasma in helium, neon, argon, and krypton was investigated in the pressure range between 0.5 and 2.5 mm Hg, for a discharge current 600 ma in magnetic fields from 50 to 1000 Oe. The method of observation was improved by substituting photoelectric recording for photography. A discharge tube 2.2 cm in diameter was used. The pressure in the chamber could be varied linearly. The image of the edge of the positive column was projected on the slit of a 2PS spectrograph crossed with a Fabry-Perot etalon 30 mm thick. The image of the slit and of the interference pattern was projected on the spectrograph camera lens, and part of the central-ring image was cut out by mutually perpendicular slits and projected on the photomultiplier (FEU 51).

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The study showed that the speed or rotation of the plasma increased with increasing current in all gases and decreased with increasing pressure. Measurements made with various lines in different gases gave similar results. All plots of the speed of rotation against the magnetic field exhibited maxima at approximately 150, 300, 600, and 800 Oe for helium, neon, argon, and krypton, respectively. It is shown that the rotation cannot be attributed to transfer of momentum to the atoms from the electrons and ions. "The authors thank V. I. Perel' for a discussion of the results of this work." Orig. art. has: 2 figures. 44,55

ASSOCIATION: None

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Card 2/2