determine quantitatively the band structure of ferromagnetic nickel in the vicinity of the L-point. Some corroboration of the proposed identification may be the fact that the derivative of the interband density with respect to the frequency does not become infinite only for the A edge, and consequently only the 0.7 eV anomaly could not be observed by the thermoreflection method [3].

It should be noted that the proposed identification is more reliable for the subband of left-hand spins, and in the ↑ subband it is possible, in principle, to retain also the direct order of the levels, which readily explains at the same time the negative polarization of the s-p electrons.

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MEASUREMENT OF NEUTRAL HYDROGEN ATOM CONCENTRATION IN THE PLASMA PINCH IN THE TOKAMAK TM-3 MACHINE

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In toroidal machines of the Tokamak type, the interaction between the plasma particles and the walls of the vacuum chamber and the diaphragm leads to the influx of neutral gas sorbed by the walls into the plasma pinch. This can lead to plasma cooling by charge exchange of the hot hydrogen atoms. To estimate the energy carried away by the charge-exchanging hydrogen ions, it is necessary to know the concentration of the neutral hydrogen atoms in the plasma pinch. The concentration of the neutral atoms in the plasma pinch can be determined by measuring the absolute intensities of the individual spectral lines, on the basis of a number of theoretical considerations, provided the temperature and density of the electrons are known together with the level population for the given spectral line. Calculations of this type, with allowance for multistep processes, were performed for hydrogen and hydrogenlike atoms in [1, 2], but for low values of the electron temperatures. Similar calculations for the electron temperature and density intervals prevailing in Tokamak machines were performed by V. A. Abramov, V. I. Kogan, and E. I. Kuznetsov. Using these data, we can calculate the concentration of the neutral atoms by measuring the intensities of the H_α and H_β lines.

To determine the concentration of the neutral hydrogen atoms in the plasma pinch in the TM-3 unit[3], measurements were made of the absolute intensities of the hydrogen Balmer lines H_α and H_β, with simultaneous measurement of the electron density with the aid of a radio-interferometer. The electron-temperature data were obtained from earlier measurements of the diamagnetic signal [4].

The measurements were made in macroscopically stable discharge modes [5] at magnetic field intensities from 9 to 24 kOe and discharge currents from 16 to 46 kA. The initial pressure of the hydrogen ranged from 4×10^{-4} to 1.3×10^{-3} Torr. The pressure of the residual gas in the chamber was of the order of 10^{-7} Torr. The discharge duration was 6 msec.

The radiation emerging through a quartz window in the direction of the larger radius of the toroidal chamber, from the side opposite the diaphragm location, was registered with a calibrated system consisting of a monochromator and a photomultiplier. The radiation was registered at a certain instant of time following the maximum glow, i.e., during that period of the discharge when the ionization of the working gas was already complete and the radiation was due to the flow of neutral gas into the plasma column from the outside. Radiation of only one of the lines was registered during one discharge.

In calculating the concentration of the neutral atoms, account was taken of the effect of light reflection from the chamber surface and of the unevenness of the emission intensity at different points along the toroidal chamber axis.

It is seen from measurements of the intensity profile of the H_α line in the transverse section of the column at different instant of the discharge (Fig. 1), obtained by the method described in [6], that in the second millisecond the radiation intensity at the center is several times weaker than on the periphery. At later instants of the discharge, the radiation intensity becomes equalized. Considerable electron density

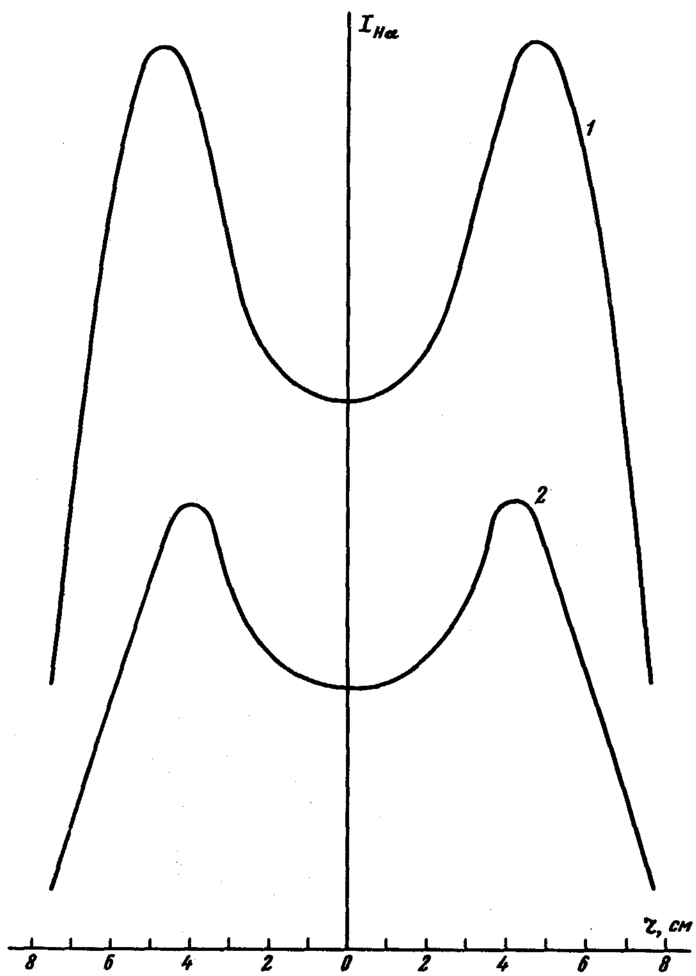

Fig. 1. Distribution of radiation sources in cross section of the plasma column for the H_α Balmer line. Discharge current I = 40 kA, longitudinal magnetic field intensity H_z = 24 kOe, initial pressure p_0 = 4.6×10^{-4} Torr. 1 - Curve for second millisecond of the discharge; 2 - curve for fourth millisecond.

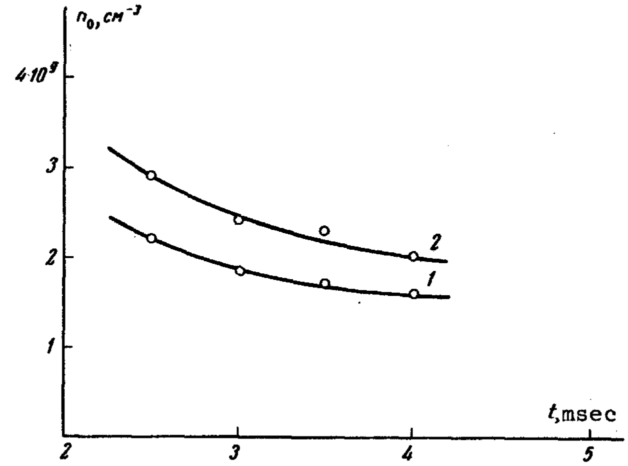

Fig. 2. Variation of the mean concentration of the neutral atoms in the plasma column during the course of the discharge; 1 - measurements with H_α line; 2 - measurements with H_β line. $I = 40$ kA, $H_z = 24$ kOe, $p_0 = 4.6 \times 10^{-4}$ Torr.

and temperature gradients can exist on the periphery of the plasma column, and the accuracy of the calculations for this region is small. However, for all reasonable distributions of these quantities, say parabolic (as was observed experimentally for the electron density [4]), the electron temperature and density in the central region of the column can be regarded as rigorously specified. Then the concentration of the neutral atoms in the central region of the column, with a radius 5 - 6 cm (the diaphragm radius is 8 cm), can be determined with sufficient accuracy.

Theoretical calculations of the level populations of hydrogen atoms make it possible to determine the concentration of the neutral atoms only accurate to a factor of 2. Therefore, in calculating the neutral-atom concentration averaged over the cross section of the column, it is possible to use the mean values of the temperature and density of the electrons and of the absolute intensities. The values obtained in this manner differ little, within the limits of calculation accuracy, from the mean concentrations of the neutral atoms as determined with allowance for the observed line intensity profile in the cross section of the column.

Figure 2 shows the change occurring in the mean concentration of the neutral hydrogen atoms in the plasma column during the course of the discharge, calculated from the measured intnesities of the H_α and H_β lines for two successive discharges under identical experimental conditions.

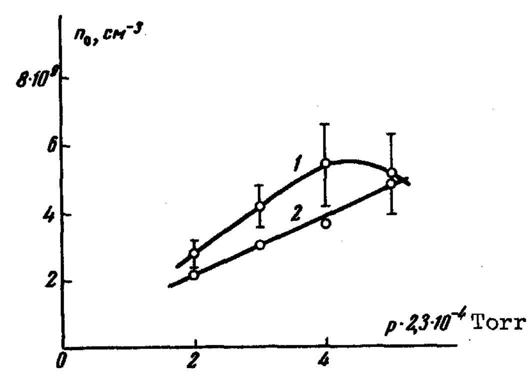

Fig. 3. Concentration of neutral hydrogen atoms in plasma column vs. initial pressure; 1 - curve for second millisecond of discharge, 2 - for fourth millisecond. $I = 40$ kA, $H_z = 24$ kOe.

The concentration of the neutral atoms in the plasma column, under the conditions investigated by us, was $(1 - 7) \times 10^9$ cm^{-3}. During the time interval from 2.5 to 4 msec following the start of the discharge, the concentration of the neutral atoms in the column decreased. Figure 3 shows a plot of the neutral-atom concentration against the initial pressure for the 2.5-th and 4-th milliseconds of the discharge, averaged over several discharges for each set of experimental conditions. The concentration of the neutral atoms increases with increasing initial pressure. The relative content of the neutral atoms at an electron density 2.5×10^{13} cm^{-3} amounts to 2×10^{-4}, and increases to $(0.8 - 1) \times 10^{-3}$ when the electron density decreases to 3×10^{12} cm^{-3}.

Using the obtained values of the densities of the neutral hydrogen atoms and of the electrons, and also the electron temperatures, it is possible to estimate the temperature to which the ions can be heated by Coulomb collisions, with allowance for the loss to charge exchange.

At large densities, the electron temperature was of the order of 400 eV, and the density ratio was $(1 - 2) \times 10^{-4}$. The calculated ion temperature is 140 - 210 eV, and that measured from the spectrum of the neutral charge-exchange atoms[7] is 150 eV. At low densities, the ion temperature calculated in the same manner is 40 - 50 eV, and the measured value is 50 eV. This makes it possible to assume that the energy loss due to charge exchange, under the conditions investigated by us, can play an important role in the ion energy balance.

The concentration of the neutral atoms remains practically the same for different values of the discharge current and for different intensities of the longitudinal magnetic field.

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LOW-FREQUENCY INTENSITY OSCILLATIONS OF HELIUM-PLASMA RADIATION AT LOW TEMPERATURES

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While investigating a pulsed hf discharge in a helium plasma, we observed low-frequency oscillations of the radiation intensity. The oscillations were observed only when the discharge vessel was cooled to low temperatures. They were seen both during the time of the pulse (in the glow) and after its termination (in the afterglow). There were no radiation oscillations at room temperature. Figure 1 shows the time dependence of the afterglow intensity of the 4650 Å molecular band of helium under different conditions of cooling the discharge vessel. With decreasing temperature, the amplitude of the oscillations increases and their frequency decreases. Similar intensity oscillations of the glow and afterglow were