the same for samples with $N = 4\pi$, by extrapolating the lines $E(H_e)$ to $H_e = 0$). Further, the values of R_F and R_j/R_F obtained from Eqs. (3) and (4) by the above-described method are listed for a number of temperatures near the Curie point. The table shows that the coefficients R_F determined by two methods at identical T/θ_f for the aforementioned samples coincide, within the limits of measurement accuracy, and furthermore the ratios R_j/R_F are close to zero. Similar results were obtained for an Ni-Cu alloy (23.4 at.% Cu) [6].

Thus, the method described above makes it possible to determine with a sufficient degree of accuracy the Hall coefficients of ferromagnets in the paraprocess region, and the presented data show convincingly that there is no need to introduce a third term in (2) for the investigated samples.

It is interesting that the ferromagnetic Hall coefficient R_F does not experience a jump on going through the Curie temperature. This is seen from the table, which shows for comparison the values of R_F obtained in [3 - 5] on the basis of measurements in the paramagnetic temperature region $T/\theta_f \gg 1$.

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ION HEATING IN THE TOKAMAK-3 SETUP

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In toroidal magnetic traps of the Tokamak type, the plasma loop with longitudinal annular current is heated by Joule heat and is stabilized by a strong magnetic field, the intensity of which exceeds the intensity of the current field by many times.

Experiments [1, 2] have shown that the main magnetohydrodynamic instabilities of a plasma are efficiently suppressed in Tokamak setups. A possible index of the stability is the average particle lifetime in the plasma. In the largest Tokamak in operation (T-3, in which the plasma pinch cross section radius is 12 - 15 cm, and the major axis of the toroidal chamber is 100 cm), the charged-particle lifetime exceeds 10^{-2} sec.

We describe in this paper the results of ion temperature measurements made recently with this setup.

The measurements were made at a longitudinal magnetic field intensity 25 - 38 kOe, a longitudinal current 60 - 120 kA, and a process duration 30 - 70 msec. The plasma density

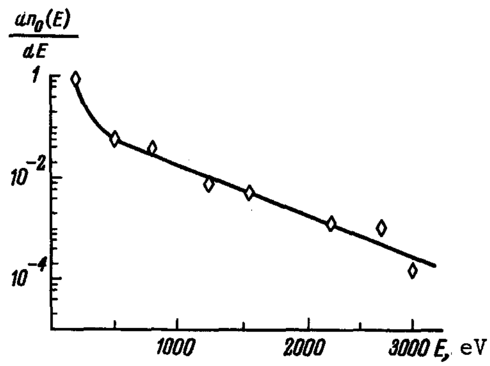

Fig. 1

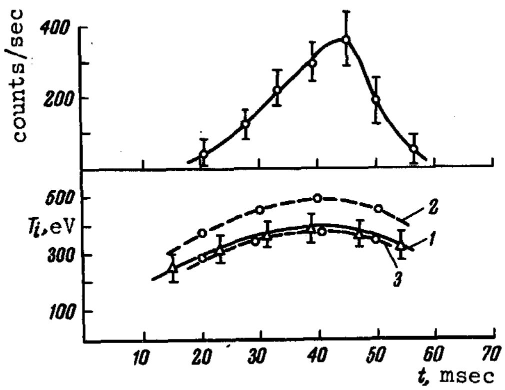

Fig. 2

Fig. 1. Energy spectrum of neutral atoms. Slope of curve yields T_i = 390 eV, I = 120 kA, H = 36 kOe

Fig. 2. Top - neutron-radiation intensity as a function of the time. Bottom - plots of time variation of ion temperature. Curve 1 - from charge exchange atom spectrum, curves 2 and 3 - from neutron radiation intensity.

was (3 - 6) x 10^{13} cm^{-3} and the temperature of the electronic component was ∿ 1 keV.

The value of T_i is usually measured in Tokamak devices by analyzing the energy distribution of the neutral atoms produced by charge exchange of the plasma ions with the residual gas and escaping from the pinch [3].

The energy distribution of the charge-exchange atoms is a reflection of the energy distribution of the plasma ions. Figure 1 shows, in a logarithmic scale, a typical ion energy distribution curve obtained by this method. A slow neutral atom falling into the plasma from the surrounding space experiences charge exchange in the outer regions of the plasma pinch. During the first act of charge exchange, neutral atoms are produced with an energy corresponding to the temperature of the ions in the peripheral layers of the plasma. The flux of these atoms causes the initial part of the energy-distribution curve, in which a rapid drop of $dn_0(E)/dE$ takes place. The gently sloping part of the curve, covering the region of high-energy ions, is due to the atoms emitted from the plasma after the second-exchange act, which takes place in the deep layers of the plasma pinch. The ion temperature determined from the slope of the logarithmic plot at high energies should approach the maximum value of the ion temperature over the plasma cross section, i.e., to the values of T_i near the axial line of the plasma pinch. All the statements that follow will pertain to that value of the temperature. Measurements show that T_i increases with increasing plasma density and with increasing current.

Figure 2 shows the variation of T_i as the current passes through the plasma (curve 1). Within 20 msec following the start of the discharge, the ion temperature reaches 300 - 400 eV and stays at this level during the process. At these values, the ion temperature of a deuterium plasma can be determined by measuring the intensity of the thermonuclear neutron radiation, since the measured spectrum of the charge-exchange atoms (Fig. 1) indicates that the energy distribution of the deuterons is Maxwellian up to 3 keV.

The neutron-radiation intensity (Fig. 2) is measured in the T-3 setup with proportional counters filled with BF_3. Control experiments in which the counter placed inside a paraffin block was covered with a thick layer of boron have made it possible to exclude the influence of the hard x-rays of the plasma on the measured effect. To determine the absolute value of the neutron yield, the counters were calibrated with a (Po + Be) source under geometrical conditions analogous to those obtaining in the T-3 setup.

In determining T_i from the value of the neutron flux it is necessary, in general, to know the distributions of the temperature and of the density over the cross section of the plasma pinch. However, owing to the exponential dependence of the neutron radiation on T_i, the error in the determination of the maximum value of the ion temperature, due to the arbitrary choice of the temperature distribution function over the plasma cross section, is relatively small. The inaccuracy in the determination of the profile of the plasma density, which can be determined by means of a multichannel radio-interferometer, affects the estimate of T_i even less.

Curves 2 and 3 of Fig. 2 show the maximum ion temperature determined from the neutron yield under various assumptions concerning the distribution $T_i(r)$: when the temperature varies parabolically, i.e., in proportion to $1 - (r^2/a^2)$, where r is the distances from the axial line of the plasma turn (curve 2), and when the ion temperature is the same over the entire cross section of the plasma turn (curve 3). In both cases we assumed a = 12 cm.

Comparison of the $T_i(r)$ dependence determined from the neutron yield (curves 2 and 3) with the $T_i(r)$ dependence obtained from the energy spectrum of the charge-exchange atoms (curve 1) shows that for one of the chosen temperature-distribution profiles the difference between the values of T_i determined by two different experimental methods lies within the limits of the measurement errors, and for the other profile it does not exceed 25%.

This principal result of the experiments, on the one hand, is a confirmation that the gently sloping part of the curve of Fig. 1 represents the true value of T_i for the internal layers of the plasma, and on the other hand provides a convincing argument in favor of the thermonuclear origin of the observed neutron radiation. The regularity and large duration ($\sim$ 40 msec) of this radiation also favor the thermal mechanism of occurrence of nuclear reactions. It is easy to verify that the neutron radiation is due to a volume effect. At the energy spectrum shown in Fig. 1, the neutron yield due to the bombardment of the walls by fast deuterons emitted from the plasma should be at least five orders of magnitude smaller than the value measured in the experiment. Special experiments have shown that the neutron radiation is isotropic near the turn of the torus. Thus, it can be assumed that we have recorded in these experiments, for the first time, a prolonged thermonuclear neutron radiation from a stable plasma loop.

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