electrons are heated, then $\Delta T_e \simeq 200 - 400$ eV, whereas the "initial" electron temperature at the instant when the generator is turned on is $T_e \simeq 250$ eV in the investigated regime. A comparison of τ_{decr} with τ_ε shows that what is heated is that fraction of the plasma column which has a "lifetime" not shorter than τ_ε. The increase of nT at a constant discharge current (the latter changes not more than 1.5% during the time of the generator pulse) should lead to an additional shift of the equilibrium position of the plasma column outward from the chamber axis. The experiments revealed satisfactory agreement between the additional shift and $\Delta(nT)$. The additional heating of the plasma electrons should, naturally, also lead to a decrease of the chamber circuit voltage. Such an effect actually takes place at sufficiently high electron concentration. In discharges with low concentration, however, the voltage increases during the course of the pulse. This fact can be attributed, in principle, to the increase of the number of trapped particles because of the increase of the transverse energy of the electrons.

We have thus registered with the TM-3 installation electron-cyclotron heating with $\Delta(nT)$ up to 4×10^{14} eV-cm^{-3}. The heating efficiency for such $\Delta(nT)$ amounts to 20 - 30%. In a hot plasma, heating can take place in the region $\omega_{ce}/\omega \simeq 1/2$.

We thank our co-workers for help with the experiment and for useful discussions.

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MEASUREMENT OF INFRALOW TEMPERATURES WITH THE AID OF THE MOSSBAUER EFFECT

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The possibility of using the Mossbauer effect to measure infralow temperatures has already been discussed a number of times [1]. Such a method is based on two assumptions: a) the populations of the nuclear levels are proportional to the Boltzmann factor, and b) the γ-quantum emission or absorption probability is proportional to the population of the initial state.

The cooled absorbers used in our experiments were samples of metallic iron. In this case we have for the ratio of the intensities of symmetrical absorption lines (e.g., corresponding to the transitions $\pm 1/2 \rightarrow \pm 3/2$), in a thin absorber,

$$p = (N_\infty - N_+) / (N_\infty - N_-) = e^{\Delta/T} \qquad (1)$$

where $N_\pm$ is the intensity of the transmitted radiation at resonance (+ corresponds to motion of the source towards the absorber), N_∞ is the intensity far from resonance, $\Delta = 2.33 \times 10^{-3}$°K is the hyperfine splitting of the ground state of Fe^{57}, and T is the absolute temperature.

We used samples with natural Fe^{57} contents (rolled foil of carbonyl iron of thickness 0.12 mg/cm^2 in terms of Fe^{57}) and samples enriched with Fe^{57} to 89% (thicknesses 0.17 and 0.31 mg/cm^2 in terms of Fe^{57}). The enriched foils

were obtained by electrolysis of a solution of the sulfate of divalent iron [2] on a copper foil, which was subsequently dissolved.

The absorbers were cooled with a dissolution cryostat essentially analogous to that of [3], with a small tubular heat exchanger; the attainable temperatures were 30×10^{-3}°K in the circulation regime and $(5 - 6) \times 10^{-3}$°K in the one-shot regime. The sample (Fe) with approximate area 1 cm^2 was glued to a beryllium plate 0.3 mm thick, which was glued in turn to a thin bakelite frame (Fig. 1). The frame was secured in the dissolution chamber, the lower part of which was a small beryllium container of 13 mm diameter and wall thickness 0.5 mm. The remaining walls in the lower part of the cryostat were also made of beryllium (the total thickness of the beryllium was 5 mm).

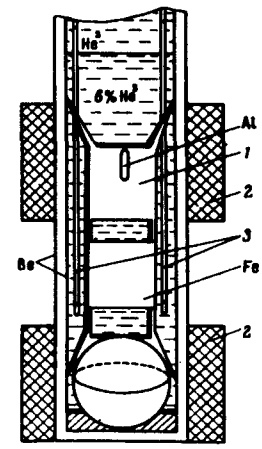

Fig. 1. Arrangement of dissolution chamber.

The temperature in the dissolution chamber was determined by measuring the magnetic susceptibility of a spherical sample (pressed powder with density 1.90 g/cm^3) of cerium-magnesium nitrate (CMN). The susceptibility was measured by a ballistic method (with the aid of ballistic coils 2). The sensitivity of the system was calibrated in a special experiment, by determining the change of the magnetic moment of a tin sphere during its superconducting transition. In addition, in two separate experiments, we demagnetized the salt from an approximate temperature 10×10^{-3}°K and a magnetic field 300 Oe. The deflection of the ballistic galvanometer after the demagnetization was the same in both cases, within 1%, remained constant for 5 and 30 min, and corresponded to a magnetic temperature 2.3×10^{-3}°K. The reference point was the temperature (1.1°K) of the superconducting transition of an aluminum sample.

Figure 1 shows only part of the vacuum jacket and of the dissolution chamber, which were placed in the lower part (made of beryllium) of a Dewar with helium at 1.2°K. One of the tubes 3 served to return the He^3 in the circulation regime, and the other was used to deliver the dissolved He^3 to the evaporation chamber.

A Co^{57} source in platinum (approximate activity 5 mCi) and a γ-radiation detector were placed on the outside on a massive frame. The constant-velocity spectrometer [4] could be easily set to any velocity in the range 0.5 - 10 mm/sec, with accuracy and long-time stability not worse than 0.001 mm/sec. The velocity resolution of the spectrometer was not worse than 0.01 mm/sec and was determined by the velocity fluctuations during the counting time of each half-cycle. The half-width of the absorption lines was determined mainly by the level of the absorber vibrations and amounted, under typical conditions, to 0.5 - 0.6 mm/sec. The counting rate remained constant within 0.5% during the entire experiment, and was monitored periodically.

At an approximate temperature 1.2°K, the spectrometer was tuned to a pair of symmetrical absorption peaks and the vibrator was carefully adjusted to eliminate the possible geometrical difference between the counting rates N_+ and N_-. The intensities of the symmetrical peaks in the non-enriched absorbers were the same, with accuracy better than 1%, for all three pairs of lines. This pertained also to the enriched absorbers, with the exception of the pair of outermost lines of the spectrum, for which p = 1.025 at 1.2°K. This asymmetry is possibly connected with the presence of iron oxides in the samples of thickness 0.2 - 0.4 mm. A suitable correction was introduced in the temperature measurement in this case.

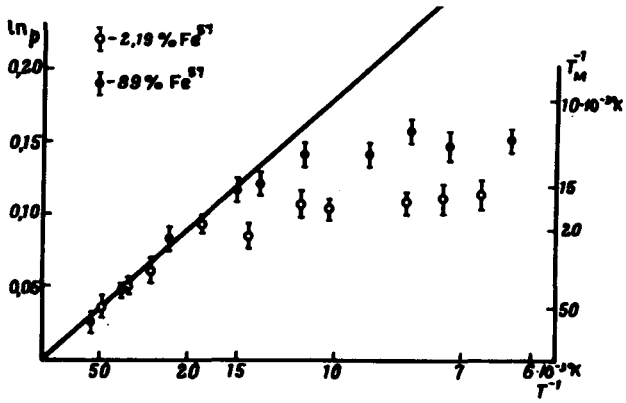

Fig. 2. Temperature dependence of the asymmetry of the absorption-line intensity. The continuous line corresponds to $T_M = T$. The indicated errors are statistical.

The value of p could be measured (time of one run 20 min, number of pulses in each counting channel about 10^6) during the entire process of cooling and subsequent reheating (the time to cool from 30×10^{-3} to 6×10^{-3}°K was approximately 3 hours). The instrument has made it possible to maintain a constant temperature with accuracy not worse than 5% during not less than 1.5 hours in the interval $(7 - 20) \times 10^{-3}$°K and not less than four hours in the interval $(20 - 100) \times 10^{-3}$°K. No dependence of the measured quantity on the rate of change of the temperature was observed. We could therefore conclude that the time of establishment of the thermal equilibrium between the nuclear spins and the surrounding helium was much shorter than the measurement time (the corresponding time for CMN was less than 5 min at $T > 6 \times 10^{-3}$°K).

Figure 2 shows the measured dependence of p on the reciprocal temperature. The right-hand ordinate axis shows the "Mossbauer" temperature T_M calculated from formula (1) with allowance for corrections for the absorber thickness [5], which amounted on the average to 29% and was practically independent of p.

In view of the considerable difference between T_M and T at $T < 15 \times 10^{-3}$°K, we undertook a more detailed study of the absorption spectrum at $T \lesssim 10 \times 10^{-3}$°K. These measurements have shown that (a) the position of the lines remain unchanged, accurate to 0.02 mm/sec, (b) the possible line broadening does not exceed 0.1 mm/sec and is the same for all lines, and (c) the total area of the absorption spectrum remains constant accurate to 5%.

A trivial cause of the observed $T_M(T)$ dependence might be heat transfer to the sample (on the order of 5×10^{-3} erg/sec of Zinov'eva's data [6] on the Kapitza jump are extrapolated). In our experiments, the heating due to γ-quantum absorption was $(1 - 2) \times 10^{-4}$ erg/sec for the samples of natural iron and on the order of 10^{-6} erg/sec for the enriched samples. Control experiments, in which the absorption intensity was varied by an approximate factor of 10 by varying the distances between the source and absorber, have shown that T_M remains constant within 10% (at the same temperature).

We have also performed control experiments aimed at revealing other possible causes of sample heating (external variable fields, mechanical vibration, heat transfer from the chamber walls through the bakelite). In all cases, T_M remained constant within the limits of statistical errors when the temperature was kept constant.

The results cast doubts on the validity of relation (1). Experiments aimed at determining the causes of this anomaly are now under way.

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INFLUENCE OF GIANT ZEEMAN EFFECT ON THE DIELECTRIC CONSTANT OF AN ANTIFERROMAGNETIC CONDUCTOR

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It will be shown in this paper that an external magnetic field can exert an anomalously strong influence on the dielectric constant $\varepsilon(\vec{k}, \omega)$ of the conduction electrons in an antiferromagnetic semimetal or in a strongly doped semiconductor. It is assumed that the magnetic properties of the crystal are governed mainly by the localized moments of the magnetic atoms, and not by the conduction electrons (s-d model). Owing to the exchange interaction with the localized moments, the state of the conduction electrons depends strongly on the character and degree of magnetic ordering of the crystal, which can be varied with an external magnetic field.

In many magnetic conductors the width W of the conduction band greatly exceeds the product of the s-d exchange integral A by the spin S of the magnetic atom. According to [1], in the first-order approximation in AS/W, the appearance of an average moment $\bar{S}$ in the crystal causes a shift of the conduction electron with spin projection σ by an amount $AS\sigma$. The average moment $\bar{S}$ of the antiferromagnet in the field is determined from the condition that the total energy of the system be a minimum. At sufficiently low electron densities n, this energy consists of the exchange energy $\sim kT_N \cos 2\theta$ of the localized moments and the energy $\sim \mu H \cos\theta$ of these moments in the field. Here T_N is the Neel temperature, μ the Bohr magneton, and 2θ the angle between the moments of the antiferromagnet sublattices (the field is perpendicular to the antiferromagnetism vector, so that $\bar{S} = S \cos\theta$).

It follows from the foregoing that $\bar{S} \sim \mu HS/kT_N$, so that the spin splitting of the electronic levels turns out to be here $\sim(AS/kT_N)\mu H$, which is larger by several orders of magnitude than the usual Zeeman splitting μH. Indeed, according to [2], the energy AS of all magnetic materials without exception is of the order of the atomic energy, i.e., it amounts at least to several tenths of an electron volt, and in many cases also to several electron volts. At the same time kT_N is a quantity of second order of smallness relative to the overlap of the d-functions of the neighboring magnetic ions, and its typical value is therefore $\sim 10^{-4} - 10^{-2}$ eV [2].

At small n, if the Fermi energy of the conduction electrons is $E_F \lesssim AS$, the giant Zeeman effect (GZE) described above can lead to complete polarization of the electrons with respect to spin even in moderate fields

$$H \gtrsim H_N = \frac{kT_N}{\mu} \ll \frac{E_F}{\mu}$$

In the case of ordinary antiferromagnets, the sublattice-collapse field is $H_N \lesssim 10^5$ Oe, but in the case of metamagnets it can be only $\sim 10^3$ Oe [1]. Since