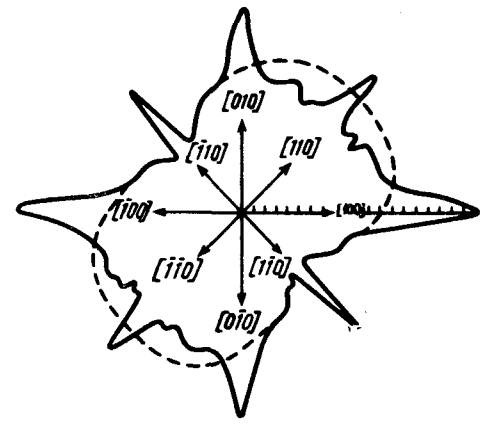
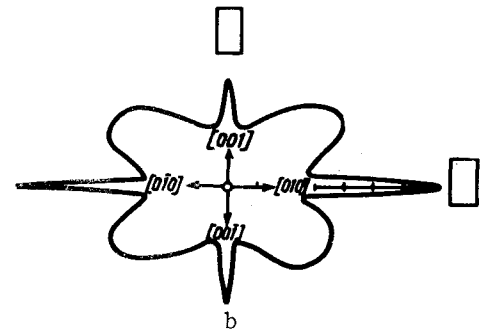
Angular dependence of neutron transmission (in polar coordinates) for a cylindrical Fe + 3.5% Si crystal of 13 mm diameter and 22 mm height. One scale division on the polar axis corresponds to 200 counts/min (beam cross sections 5 x 15 and 5 x 11 mm for Figs. a and b, respectively. a) Rotation axis [001], b) rotation axis [100]. The dashed line in Fig. a corresponds to the theoretical change of intensity for one wall system. Figure b shows schematically the position of the sample relative to the neutron beam.



a



b

(001) perpendicular to it, and there are no walls of type {101} inclined 45° to the cylinder axis. This conclusion is further corroborated by the absence of any transmission maxima (other than those listed) on the picture obtained by rotation about [110].

As is well known, {100} and {110} in iron are 180° and 90° walls, respectively. We have thus observed all the possible 180° walls and some of the possible 90° walls. The absence of {101} walls separating domains magnetized along the cylinder axis and those perpendicular to it indicates that all the domains are magnetized perpendicular to this axis. The domain structure has a quasi-two-dimensional layered character, the layers being separated by (001) walls, but it does not follow from experiment that they pass through the entire crystal. A picture similar to the parallelogram grid observed by Shur and co-workers in disk-shaped Fe-Si crystals [3] is apparently realized in the (001) section. It can be assumed that the quasi-two-dimensional character of the domain structure is connected with singularities of the shape of the crystals investigated by us (with the presence of a preferred direction).

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[1] S. Sh. Shil'shtein, V. A. Somenkov, and M. Kalanov, Zh. Eksp. Teor. Fiz. 63, 2214 (1972) [Sov. Phys.-JETP 36, No. 6 (1973)].
[2] S. Sh. Shil'shtein, V. I. Marukhin, M. Kalanov, and V. A. Somenkov, Prib. Tekh. Eksp. No. 3 No. 3, 70 (1971).
[3] I. E. Startseva, V. V. Shulika, and Ya. S. Shur, Izv. AN SSSR ser. fiz. 36, 1597 (1972).

THERMODYNAMICS OF THE MELTING OF CESIUM AT HIGH PRESSURES

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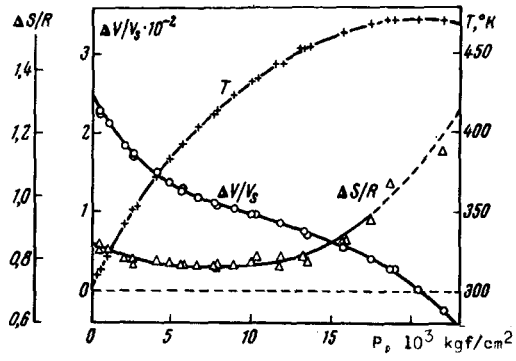
We obtain, for the first time, data characterizing the thermodynamics of melting cesium at pressures up to 22×10^3 kgf/cm^2. The nature of the maximum on the melting curve of cesium is discussed briefly.

Since the discovery of temperature maxima on the melting curves of various substances (see [1]), the question of the nature of this phenomenon was discussed in the literature many times [1 - 4]. There are, however, still no reliable experimental data describing the melting

Thermodynamics of the melting of cesium [3)]

T, °K	P, kg/cm²	ΔV cm³/mole	ΔV/V_s	ΔS/R	ΔH cal/mole	ΔU cal/mole
301,52	1	1,691	0,0243	0,8477	507,7	507,7
323,23	1000	1,408	0,0210	0,8272	531,1	498,1
341,85	2000	1,188	0,0184	0,8104	550,3	494,7
372,08	4000	0,888	0,0148	0,7904	584,2	501,0
305,75	6000	0,707	0,0124	0,7852	617,3	517,9
415,08	8000	0,587	0,0108	0,7854	647,6	537,6
431,25	10000	0,493	0,0096	0,7853	672,8	557,3
444,76	12000	0,410	0,0083	0,7895	697,5	582,4
455,70	14000	0,331	0,0069	0,8103	733,5	625,0
463,95	16000	0,250	0,0054	0,8618	794,2	700,5
469,34	18000	0,158	0,0036	0,9525	888,0	821,4
471,76	20000	0,042	0,0012	1,0746	1007,0	987,3
471,20	22000	-0,101	-0,0023	1,1864	1110,4	1162,7

T, P. — melting temperature and melting pressure, ΔV — discontinuity of the volume upon melting, V_s — volume of solid phase at the melting point, ΔS — melting entropy, R — gas constant, ΔH — melting heat, ΔU — change of internal energy upon melting.



Pressure dependence of melting temperature T, relative jump of volume upon melting $\Delta V/V_s$ and melting entropy ΔS/R of cesium.

thermodynamics of any of the investigated substances. We report here results of an investigation of the thermodynamics of the melting of cesium, the phase diagram of which has a number of remarkable features, including a double maximum on the melting curve at pressures $(20 - 25)\times10^3$ kgf/cm³. The research method, as in our earlier studies [5, 6], consisted of measuring the volume of solid and liquid cesium and of the coordinates of the melting curve, followed by calculations of the changes in the thermodynamic functions after melting, using the known thermodynamic relations.

The cesium volume was measured with a specially developed piston piezometer with an intermediate liquid[1)]. The investigated sample of doubly-distilled cesium was placed in a hermetically sealed ampule of stainless steel with walls ∿ 0.05 mm thick. The much more complicated procedure than that used in [6, 7] was the direct consequence of the extremely high reactivity of the cesium.[2)]

The table and the figure show the results of the corresponding measurements and calculations. The accuracy with which the volume discontinuity ΔV was measured was ± 0.0015 cm³/mole. The temperature and pressure were measured accurate to ± 10 kgf/cm² and 0.01°C at pressures up to 1.5×10^3 kgf/cm² and with accuracy ± 25 kgf/cm² and ± 0.1°C at pressures exceeding the indicated value.

An analysis of the results (see the table and the figure) shows that at low pressures the behavior of the thermodynamic quantities characterizing the melting of the cesium agrees, from the qualitative point of view, with the known results for sodium and argon [5, 6]. At high pressures, however, this agreement ceases. The sharp increase of the melting entropy and the reversal of the sign of the second derivative of ΔV(P) at pressures above 10^4 kgf/cm² point definitely to new features in the behavior of compressed cesium. Thus, the experimental data indicate clearly that the onset of maxima on the melting curves does not reflect the general tendencies of the melting curve at high pressures [3, 4], but, to the contrary, is an "anomalous" phenomenon. The most probable cause of the "anomaly" in the investigated case is the s-d electronic transition [9], the essential result of which should be a change in the parameters of the electron-ion interaction.

This question will be considered in greater detail in a forthcoming paper.

In conclusion, the authors thank A. F. Uvarov for constructing the piezometer, and V. I. Fedosimov and A. M. Nikolaenko for hlep with the data reduction.

[1)] To be published.

[2)] In this connection the significance of the data of [8] seems uncertain, in view of the lack of data on the measures taken to prevent interaction between the cesium and the pressure-transmitting medium.

[3)] Since it is impossible to include in this brief communication a complete summary of the experimental data, the table lists only the smoothed values of the thermodynamic quantities.

[1] S. M. Stishov, Usp. Fiz. Nauk 96, 467 (1968) [Sov. Phys.-USP. 11, 831 (1969)].
[2] E. J. Rapoport, Chem. Phys. 46, 2891 (1967).
[3] N. Kawai and G. Inokuchi, Japan J. Appl. Phys. 7, 989 (1968).
[4] M. Wadati and S. Fujita, Phys. Lett. 33A, 85 (1970).
[5] V. A. Ivanov, I. N. Makarenko, and S. M. Stishov, ZhETF Pis. Red. 12, 12 (1970) [JETP Lett. 12, 7 (1970)].
[6] S. M. Stishov and V. I. Fedosimov, ibid. 14, 326 (1971) [14, 217 (1971)].
[7] I. N. Makarenko, V. A. Ivanov, and S. M. Stishov, Dokl. Akad. Nauk SSSR 188, 564 (1969) [Sov. Phys.-Dokl. 14, 924 (1970)].
[8] V. S. Bogdanov, ZhETF Pis. Red. 3, 44 (1966) [JETP Lett. 3, 26 (1966)].
[9] R. Sternheimer, Phys. Rev. 78, 235 (1950).

ELECTRON RESONANCE WITH LOCALIZED MAGNETIC MOMENTS OF Er in SUPERCONDUCTING La

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Electron resonance absorption by localized moments of Er in superconducting La was observed. The temperature and concentration dependences of the g-factor and of the line width were investigated. A possible qualitative interpretation of the results is presented.

The feasibility in principle of investigating electron paramagnetic resonance (EPR) in type-II superconductors was demonstrated experimentally in [1], where we were the first to observe a spin resonance signal from Gd^{3+} ions in the in-ermetallic compound $La_{3-x}Gd_xIn$ in a superconducting (SC) state below H_{c2}. More detailes investigations of EPR with Gd impurities in the SC compound $La_{1-x}Gd_xRu_2$ were subsequently carried out in [2].

We present here preliminary results of the study of EPR with localized magnetic moments of Er in La. The choice of Er as the paramagnetic impurity has made it possible to conduct the research in a much larger range of concentrations and in weaker resonant fields. The measurements were made at ∿ 9400 MHz in the temperature interval 2 - 4.5°K, on bulky samples of polycrystalline La with Er concentrations from 0.5 to 3 at.%.

Figure 1 shows a typical plot of the EPR signal superimposed on the surface-impedance curve of the SC sample. The resonance line has a near-Lorentz shape, with an asymmetry parameter A/B = 2.5. The measured g-factor was $g_{exp} = 6.83 \pm 0.05$. It is known that metallic La crystallizes in the form of a mixture of two modifications with a hexagonal lattice (α-La) and a cubic lattice (β-La). Measurement of the temperature dependence of H_{c2} in our samples has revealed the presence of an appreciable fraction of β-La. It is impossible to observe the EPR signal from Er^{3+} in polycrystalline α-La, owing to the large anisotropy of the

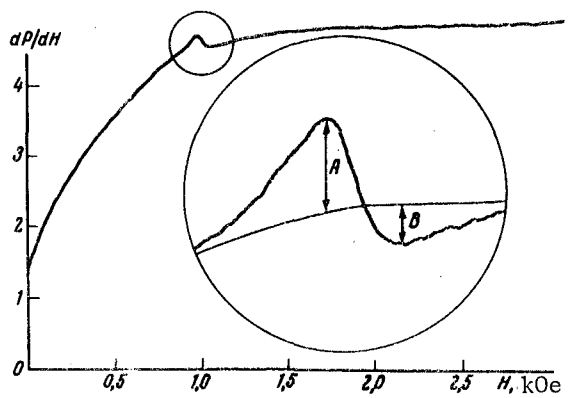

Fig. 1. Plot of EPR signal (dP/dH in relative units) for a sample of La + 1.5 at.% Er at T = 2.5°K and ν = 9369.4 MHz.