

FIG. 2

FIG. 3

FIG. 2. Shift (in meV) of $K_{\beta 1}$ line of samarium in SmS as a function of pressure. The analogous relation for the magnetic susceptibility χ is indicated by the dashed curve.

FIG. 3. Shift (in meV) vs. line type relations for cerium (a) and SmS (b) (samples are compared before and after the phase transition). The analogous experimental relationships for the chemical compounds are indicated by the dashed lines.

perimental relations for the chemical compounds $Ce^{III} - Ce^{IV}$ and $Sm^{II} - Sm^{III}$ (the electron structure within each pair is known in this case and is distinguished by a single 4f electron) also makes it possible to determine the numbers of 4f electrons participating in the transition in cerium and SmS as 0.5 and 0.6 electron/atom, respectively.

The basic results were published in ^{2,3}.

¹E. V. Petrovich, Yu. P. Smirnov, V. Z. Zykov, A. I. Grushko, O. I. Sumbaev, I. M. Band, and M. B. Trzhaskovskaya, Zh. Eksp. Teor. Fiz. 61, 1756 (1971) [Sov. Phys.-JETP 34, 935 (1972)].

²E. A. Shaburov, I. M. Band, A. I. Grushko, T. B. Mezentsova, E. V. Petrovich, A. E. Sovestnov, Yu. P. Smirnov, O. I. Sumbaev, M. B. Trzhaskovskaya, and I. A. Markova, Zh. Eksp. Teor. Fiz. 65, 1157 (1973) [Sov. Phys.-JETP 38, 573 (1974)].

³V. A. Shaburov, A. E. Sovestnov, and O. I. Sumbaev, ZhETF Pis. Red. 18, 425 (1973) [JETP Lett. 18, 249 (1973)].

G. M. Drabkin, V. A. Noskin, É. G. Tarovik, A. Z. Yagud, M. M. Agamalyan, and N. P. Zhuchenko. Investigation of Diffusive Mass Transport of the Isotope He^3 in Liquid He I with the Aid of Thermal Neutrons. The temperature dependence of the mass diffusion coefficient D_m was investigated in a liquid isotope mixture of He I and He^3 with the aid of thermal neutrons. The basic idea of the method was to use the large difference between the neutron absorption cross sections of the He^4 and He^3 atoms. The studies were made in the temperature range from $T_{\lambda} = 2.17^{\circ}K$ to $T \approx 3^{\circ}K$ for various concentrations of He^3 ($c \approx 1\%$ and 2%). To check for possible hydrodynamic effects on the measurement of D_m in specific diffusion-cell geometries, the experiments were performed with the latter filled in various ways, namely:

1) diffusion cell in the form of a 2-mm capillary 2 cm in length;

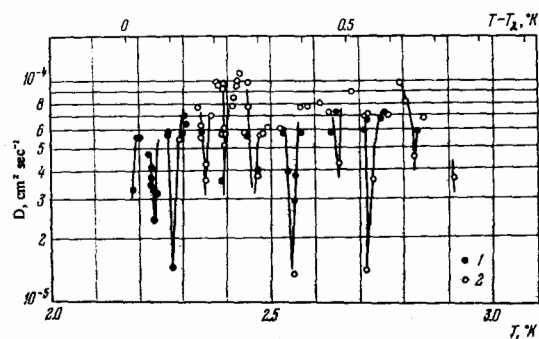


FIG. 1. Temperature dependence of mass diffusion coefficient. 1) Diffusion into a capillary filled with a porous packing having a characteristic pore dimension of $100 \mu m$; 2) diffusion into a 2-mm capillary.

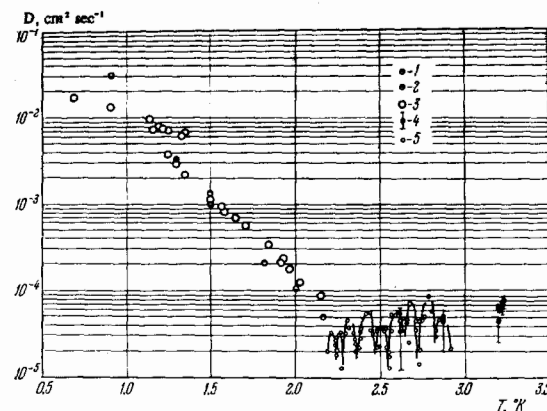


FIG. 2. Comparison of our results with those of other authors. 1) According to [1]; 2) [2]; 3) [3]; 4) [4]; 5) our results.

2) 2-mm capillary filled with a 41 $200\text{-}\mu m$ capillary;

3) 2-mm capillary filled with a porous packing consisting of $100\text{-}\mu m$ stainless-steel balls sintered on a ceramic;

4) 2-mm capillary filled with porous teflon with a characteristic pore dimension $\approx 20 \mu m$.

Diffusive mass transport was studied at each given temperature through the time variation of the intensity of a neutron beam passing through a diffusion cell filled with He^3 atoms. A further inference can be drawn as to the diffusive nature of mass transport on the basis of the observed time dependence, as illustrated in Fig. 1.

That convective diffusion does not influence the process studied can be concluded from the nondependence of the corresponding diffusion coefficient D_m on the characteristic dimensions of the filler used in the diffusion cell.

The basic result of this study was to confirm the nonmonotonic temperature dependence of D_m in the temperature range investigated. Figure 2 presents the data of the present study in a comparison with the results of other authors.

The results have also been published in the following papers: G. M. Drabkin, V. A. Noskin, V. A. Trunov, A. F. Shchebetov, and A. Z. Yagud, Zh. Tekh. Fiz. 42, 180 (1972) [Sov. Phys.-Tekh. Phys. 17, 142 (1972)]; G. M. Drabkin, V. A. Noskin, and A. Z. Yagud, ZhETF Pis. Red. 15, 504 (1972) [JETP Lett. 15, 357 (1972)]; G. M. Drabkin, G. G. Tarovik, V. A. Noskin, and A. Z. Yagud, Phys. Lett. A43, 83 (1973).

¹A. C. Cramers, J. I. Waffchir, C. J. Gorter, *Physica* **18**, 329 (1952).

²J. J. M. Beenakker, K. W. Taconis, E. A. Lynton, Z. Deokoupil, J. van Soest, *ibid.*, p. 433.

³T. P. Ptukha, *Zh. Eksp. Teor. Fiz.* **40**, 1583 (1961) [*Sov. Phys.-JETP* **13**, 1112 (1961)].

⁴B. Carreri, I. Reuss, I. M. Beenakker, *Nuovo Cimento* **13**, 148 (1959).

S. V. Maleev. Magnetic Dipole Forces and Dynamics of Critical Fluctuations Above the Curie Point in Ferromagnetics. Usually, only exchange forces are considered in studies of critical fluctuations in ferromagnets. This approximation is not adequate for description of the relaxation of homogeneous magnetization or the absorption of long-wave electromagnetic oscillations, since the exchange Hamiltonian conserves the total spin of the system. This conservation law is violated by magnetic interaction of atomic spins. The latter is anisotropic and long-range. Above the Curie point, this causes the spin Green's function to decompose into two parts, longitudinal and transverse with respect to the wave vector k . Because of the long-range action of the dipole forces at small k , these two parts are connected by the Krivoglaz relation

$$G = G_{\perp} \frac{1}{1 + \omega_0 G_{\perp}}, \quad \omega_0 = \frac{4\pi |\mu_B|^2}{v_0},$$

with $\omega_0 G_{\perp} = 4\pi\chi$, where χ is the ordinary susceptibility. Near T_C , the susceptibility increases without limit, so that only the fluctuations perpendicular to the momentum k increase without limit in the temperature range where $4\pi\chi \gg 1$, and the parallel fluctuations are limited; but if $4\pi\chi \ll 1$, the fluctuations are isotropic. Thus, because of the long range of the dipole forces, there exists a temperature range (it might be called the dipole range) in which these forces, despite their smallness, cannot be considered in perturbation theory. As a result, the critical dynamics of the ferromagnet in the dipole range undergoes a radical change. A new characteristic momentum $q_0 = a^{-1} \sqrt{\omega_0/T_C}$ at which G_{\parallel} and G_{\perp} become equal makes its appearance. For fluctuations with momentum larger than q_0 , there is the usual dynamic similarity with the same critical exponent $Z \approx 5/2$ as in the range $4\pi\chi \ll 1$. At the same time, a dynamic similarity regime with the new critical exponent $Z_d \approx 1$ appears for fluctuations with momentum k smaller than q_0 , and the characteristic energy of the critical fluctuations takes the form

$$\Gamma_k = T_c q_0^{3/2} \kappa f(k/\kappa) \sim \begin{cases} T_c q_0^{3/2} \kappa, & k \ll \kappa, \\ T_c q_0^{3/2} k, & k \gg \kappa, \end{cases}$$

where κ is the reciprocal radius of the critical fluctuations. Since $\kappa \sim \tau^{2/3}$ ($\tau = (T - T_C)/T_C$), as we should expect, the homogeneous relaxation time $t = \Gamma_0^{-1}$ increases without limit. In the range $4\pi\chi \ll 1$, the value of Γ_0 calculated from perturbation theory is then proportional to $\omega_0^2/T_C \tau$, so that the homogeneous relaxation time behaves nonmonotonically as τ decreases, reaching a minimum in the temperature range where $4\pi\chi \sim 1$.

O. M. Sumbaev, E. V. Petrovich, Yu. P. Smirnov, I. M. Band, and A. I. Smirnov. Use of a Method of Small X-Ray Line Shifts to Investigate the Electronic Structure of Crystal Chemical Bonds. An effect in which the energies of K-series x-ray emission lines vary with the chemical state of the emitting atom (a chemical shift) has been observed experimentally in the range of

heavy elements ($30 < Z < 75$). It has been shown that the effect is directly related to the specific nature of the changes in the valence shells of the atom on formation of the chemical bond, and is explained by a mutual screening mechanism.

The general classification of experimental data on the chemical shifts (ΔE) of the $K_{\alpha 1}$ x-ray lines of the heavy elements (metals) in oxides or compounds with oxygen-group elements has been considered. It has been established that all of these experimental data, which cover more than 30 elements and 50 compounds, are described approximately by a relation of the type

$$\Delta E = i \sum_l m_l C_l,$$

where i is the Pauling ionicity, $m = \sum_l m_l$ is the valence,

m_l is the number of valence electrons with a given orbital quantum number l , and C_l is the energy change of the $K_{\alpha 1}$ line on complete removal of one valence electron of type l (s, p, d, f) from the atom, with $C_s = C_p \equiv C_{s,p} = 80 \pm 10$ meV, $C_d = -115 \pm 10$ meV, and $C_f = -570 \pm 30$ meV over the entire range of Z considered. The dependence of the effect on the distribution of the valence electrons over the l sublevels, i.e., on the valence configurations, and the differences in the signs and absolute values of the coefficients $C_{s,p}$, C_d , and C_f are alone sufficient to permit use of the effect as an experimental method of studying valence configurations. However, the scope of the method can be expanded by measuring the $K_{\alpha 1}$ shifts of both (electropositive and electronegative) partners in the compound and, most importantly, by using the other intense lines of the K series: $K_{\beta 1, 3}$ and $K_{\beta 2, 4}$. The experimentally measured shifts of the $K_{\alpha 1}$, $K_{\beta 1}$, and $K_{\beta 2, 4}$ lines on stripping of s (p), d, or f electrons from the atoms are compared with theoretical calculations made within the framework of the Hartree-Fock-Slater method. Quite good agreement between the experimental and calculated shift vs. line-type relations is noted, especially in the case of 4f electrons. It is important that these relationships are found to be quite characteristic, differing for s(p), d, and f electrons and remaining unchanged in general outline in a broad range of Z (see figure). They serve as electron "facsimiles" of a sort, from which it is possible in a number of cases to judge with certainty which electron is involved in the phenomenon under study. If we compare the shapes of the experimental and calculated (experimental standard) "facsimiles," the ionicity is no longer needed, thus illustrating the advantages of the multiparameter (more precisely, three-parameter) character attained in the method. Study of the valence state of the formally bivalent thulium monochalcogenides TmTe, TmSe, and

Typical shift vs. line type ($K_{\alpha 1, 2}$, $K_{\beta 1, 3}$, and $K_{\beta 2, 4}$) relations observed on removal (incorporation into an ionic chemical bond) of one s (p), d, or f electron and serving as "facsimiles" of valence electrons.

