constant D it follows that V_{ijk}/R_{ijk} has the same order of magnitude as the ratio A/D.

A detailed experimental and theoretical investigation of this effect can yield added information on the main mechanisms causing the hyperfine interaction in paramagnetic complexes.

Detailed results will be published later.

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SPECIFIC HEAT OF ANHYDROUS $CrCl_3$ BELOW 4°K

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In connection with our investigations of the specific heat of layered halides of the iron group [1 - 3], we measured in the present investigation the specific heat of $CrCl_3$ in the temperature range from 2 to 4°K.

The specific heat of $CrCl_3$ was measured earlier above 12°K [4, 5]. The temperature of the antiferromagnetic transformation in $CrCl_3$, according to calorimetric data, is $T_c = 16.8$°K. $CrCl_3$ has a layered crystal lattice of type D_3. The layers of the metallic ions are separated by two layers of Cl ions, and the principal symmetry axis C_3 is directed perpendicular to the plane of the layer.

Neutron diffraction investigations [6] confirmed the magnetic-ordering picture first predicted by Landau [7]. The spins within each layer are ferromagnetically ordered, and a weak antiferromagnetic interaction takes place between layers. The spins in neighboring layers are antiparallel. The spins in antiferromagnetic $CrCl_3$ are oriented in the basal plane.

Magnetic susceptibility data [8] have shown that the anisotropy in $CrCl_3$ is small, since the difference in the fields at which saturation takes place when H is parallel and perpendicular to C_3 does not exceed 2 kOe. Measurements of the susceptibility [9] yielded an estimate of the antiferromagnetic interaction between layers: the exchange integral is $I_{af}/K = -0.018$°K.

Recently, Narath and Davis investigated the temperature dependence of the magnetization of the sublattices by a nuclear magnetic resonance method [9, 10]. A near-linear temperature dependence of the magnetization is observed at helium temperatures and is attributed to the singularity of the energy spectrum of a two-dimensional ferromagnetic system with small anisotropy.

Besides the investigations of Narath and Davis [9, 10], theoretical studies of the energy spectrum of layered antiferromagnets were made by Yoshimori [11] and Shore [12]. The latter have shown that if the ferromagnetic interaction inside the layer greatly exceeds the antiferromagnetic interaction between layers, then the spin-wave dispersion law is strongly anisotropic and spin waves with wave vector parallel to the C_3 axis reach the band

boundary at low energies. Consequently a large number of spin waves can be excited even at low temperatures, and a transition is observed from a three-dimensional ferromagnet to a two-dimensional ferromagnetic system. The magnetic specific heat of such a two-dimensional system should vary linearly with the temperature if the anisotropy is small, or quadratically if the anisotropy is large.
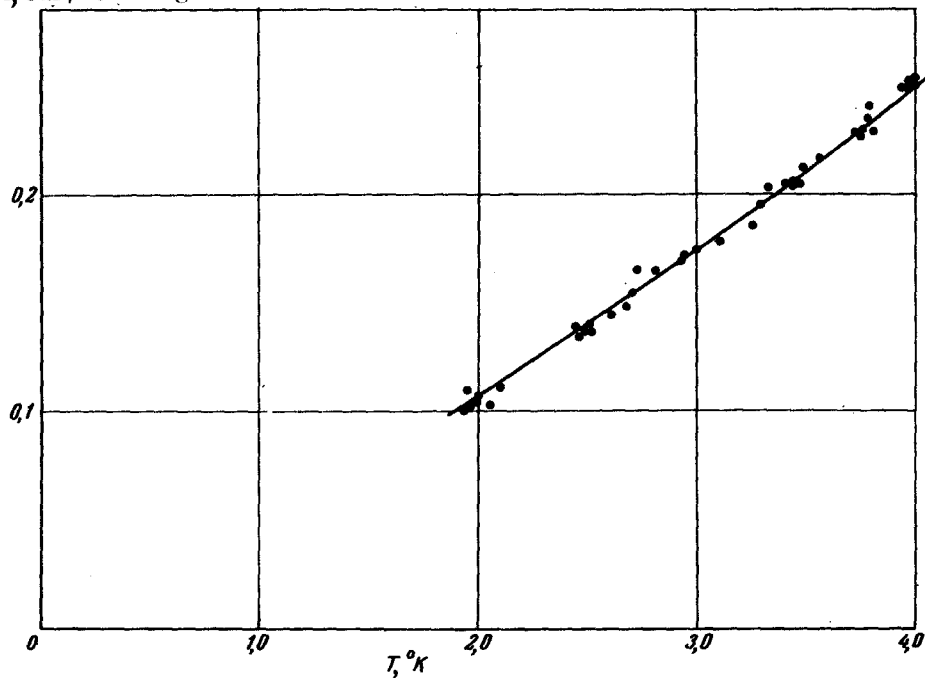
C, cal/mole-deg
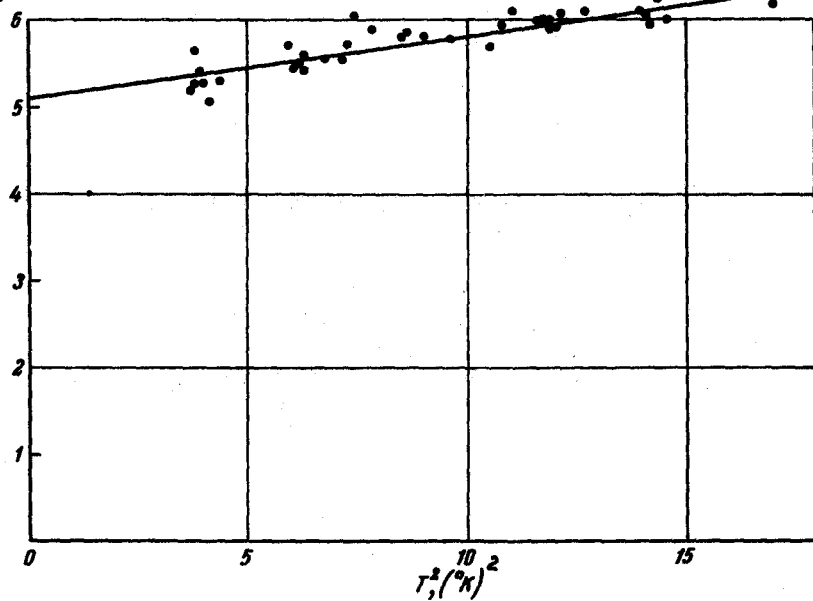

Fig. 1

C/T, cal/mole-deg^2

Fig. 2

The results of the measurement of the specific heat of $CrCl_3$ between 2 and 4°K are shown in Fig. 1, in coordinates C and T. We see that the temperature dependence of the specific heat is close to linear.

To estimate the contribution of the lattice to the specific heat of $CrCl_2$, Fig. 2 shows the measurement results in coordinates C/T and T^2. It is assumed here that the lattice specific heat is proportional to T^3, as is the case with other layered halides at helium temperatures [3], and the magnetic specific heat is characterized by a linear temperature dependence.

The specific heat of $CrCl_3$ is well described by the relation

$$C[cal/mole-deg] = 0.051T + 7.1 \times 10^{-4}T^3.$$

At 4°K the cubic term amounts to 18% of the total specific heat, and at 2°K it is of the order of 5%, i.e., the magnetic specific heat greatly exceeds the lattice contribution.

Using for the magnetic specific heat the expression obtained for a ferromagnetic model with low anisotropy, $C_M/R = \pi kT/24I_f s$, where s is the spin and I_f the exchange integral characterizing the interaction within the layer, we obtained from our data $I_f s/k = 5.1°K$.

According to the estimates of Narath and Davis, obtained from magnetization data [9, 10] for different spin-wave theory approximations, $I_f s/k$ amounts to 6 - 7.8°K.

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UNUSUAL HYDROGEN ISOTOPIC EFFECT IN CRYSTALS OF SODIUM HYDROSELENITE. PHASE DIAGRAM OF THE SYSTEM $Na(D_x H_{1-x})_3(SeO_3)_2$

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We have recently shown [1] that sodium deuteroselenite crystals, $NaD_3(SeO_3)_2$, become ferroelectric below the Curie point T_c, in analogy with the sodium hydroselenite crystals, $NaH_3(SeO_3)_2$, and not antiferroelectric as claimed in [2 - 4]. However, the effect of deuteration in sodium hydroselenite consists not only of shifting T_c [2, 5], but also, as established by us, in a sharp change of the symmetry (and accordingly of the physical properties) below T_c. Whereas the hydroselenite is tricilinic of class I below $T_c = -78.6°K$,