

the values \dot{x}_a figuring in this theory the components of the tensor σ'_{ik} and the vector q^* . It is then evident from Eq. (6) that the role of the corresponding quantities X_a will be played by

$$-\frac{1}{2T} \left(\frac{\partial v_i}{\partial x_k} + \frac{\partial v_k}{\partial x_i} \right) \Delta V + \frac{1}{T^2} \frac{\partial T}{\partial x_i} \Delta V,$$

while Eqs. (4) and (5) play the role of the relations $\dot{x}_a = -\gamma_{ab} X_b + \gamma_a$ (see Ref. 3, Sec. 120), where the s_{ik} and g_i correspond to the quantities γ_a . The coefficients γ_{ab} in these relations determine directly the mean values

$$\overline{y_a(t_1) y_b(t_2)} = k(\gamma_{ab} + \gamma_{ba}) \delta(t_1 - t_2).$$

The final formulas have the form:

$$\begin{aligned} \overline{s_{ik}(r_1, t_1) s_{lm}(r_2, t_2)} &= 2kT [\eta (\delta_{ii} \delta_{km} + \delta_{im} \delta_{kl}) \\ &+ (\zeta - 2\eta/3) \delta_{ik} \delta_{lm}] \delta(r_2 - r_1) \delta(t_2 - t_1), \quad (7) \\ \overline{g_i(r_1, t_1) g_k(r_2, t_2)} &= 2kT^2 \kappa \delta_{ik} \delta(r_2 - r_1) \delta(t_2 - t_1), \\ \overline{g_i(r_1, t_1) s_{lm}(r_2, t_2)} &= 0. \end{aligned}$$

If use is made of the spectral components of the fluctuating quantities, which are defined by

$$x_\omega = \frac{1}{2\pi} \int_{-\infty}^{\infty} x(t) e^{i\omega t} dt, \quad \bar{x}^2 = \iint_{-\infty}^{\infty} \overline{x_\omega x_{\omega'}} d\omega d\omega',$$

then the factor $\delta(t_2 - t_1)$ in eqs. (7) is replaced by $\delta(\omega + \omega')/2\pi$.

These results are generalized without difficulty to the case of the presence of dispersion in the coefficients of viscosity or thermal conductivity and the quantum nature of the fluctuations with the aid of the general theory of Callen and others, in the form set forth in Ref. 4. There appears only the factor $(\hbar\omega/2kT) \coth \hbar\omega/2kT$ in the expressions for the average values of the products of the spectral components s_{ik} and g_i , while the quantities η , ζ , κ are to be replaced by their real parts.

¹S. M. Rytov, *Theory of electrical fluctuations and heat radiation*, Academy of Sciences Press, 1953.

*An inessential difference, connected with the fact that we are dealing here with a continuous (values at each point of the liquid) as against a discrete set of fluctuating quantities (for which the formulas in Ref. 3 were developed), can easily be removed formally by dividing the volume of the liquid into small but finite regions ΔV and carrying out the transition $\Delta V \rightarrow 0$ in the final equations.

²L. D. Landau and E. M. Lifshitz, *Mechanics of continuous media*, 2nd edition, Gostekhizdat, 1954.

³L. D. Landau and E. M. Lifshitz, *Statistical physics*, 3rd edition, Gostekhizdat, 1951.

⁴L. D. Landau and E. M. Lifshitz, *Electrodynamics of continuous media*, Gostekhizdat, in press.

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Dipole Moment of the HDSe Molecule

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THE dipole moment of the D_2Se molecule has been determined¹ from the Stark splitting of its rotational spectrum. For the dipole moment, the relatively small value of 0.24 Debye units was obtained. It would be interesting to confirm this result with another isotopic form of hydrogen selenide, HDSe. In the investigation² of the microwave spectrum of this molecule, the transitions $2_{20} - 2_{21}$, $4_{31} - 4_{32}$ and $9_{54} - 9_{55}$ were identified. For the purpose of determining the dipole moment of HDSe, the Stark splitting of four lines was investigated: $2_{20} - 2_{21}$, $4_{31} - 4_{32}$, $9_{54} - 9_{55}$ and $7_{43} - 7_{44}$. The $7_{43} - 7_{44}$ transition was observed by us at 22,229.8 Mc. Although a natural selenium mixture contains five isotopes we used only the most abundant isotope Se^{80} .

The splitting $\Delta\nu$ in Mc for a Stark component corresponding to a given quantum number M_j is given by

$$\Delta\nu = 2.05535 [M_j^2 / J(J+1)(2J+1)] (S/\nu) \mu_a^2 E^2.$$

Here μ_a is the component of the dipole moment along the a axis (in Debye units), E is the applied electric field strength in volts/cm, S is the dipole matrix element for the given transition and ν is the transition frequency in Mc. Terms proportional to μ_b^2 in the expression for $\Delta\nu$ are very small and have therefore been neglected.

In order to avoid the error associated with inaccurate determination of the field strength in the wave guide, we measured the Stark effect for semi-heavy water HDO. For this purpose we used the 8577.7 and 22307.67 Mc lines³. The field strength

Transition	$\alpha = \mu_a(\text{HDSe}) / \mu_a(\text{HDO})$
$2_{20} - 2_{21}$	$0,68 \pm 0,02$
$4_{31} - 4_{32}$	$0,67 \pm 0,02$
$7_{43} - 7_{44}$	$0,70 \pm 0,02$
$9_{54} - 9_{55}$	$0,67 \pm 0,02$
	$\alpha_{av} = 0,68 \pm 0,02$

for these measurements was 2kv/cm. The resulting value of α is the ratio of the dipole components along the a axis for the molecules HDSe and HDO; values are given in the table. The total dipole moment of HDSe is associated with α by the simple expression

$$\mu(\text{HDSe}) = \alpha \mu(\text{HDO}) \sin \delta_2 / \sin \delta_1,$$

where $\mu(\text{HDO})$ is the dipole moment of HDO and δ_1 and δ_2 are the angles between the a axis and the direction of the dipole moment for HDSe and HDO respectively. δ_1 is approximately 45° , and if we take $\delta_2 = 20^\circ 30'$ and $\mu(\text{HDO}) = 1.84$ Debye units⁴ we obtain 0.62 Debye units for the dipole moment of HDSe, which differs extremely from the value of 0.24 Debye units obtained in Ref 1.

¹Jache, Moser and Gordy, J. Chem Phys. **25**, 209 (1956).

²V. G. Veselago and A. M. Prokhorov, J. Exptl. Theoret. Phys. (U.S.S.R.) **31**, 731 (1956); Soviet Phys. JETP **4**, 750 (1957).

³Weisbaum, Beers and Herrmann, J. Chem. Phys. **23**, 1601 (1955).

⁴M. W. P. Strandberg, J. Chem. Phys. **17**, 901 (1949).

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Second Relaxation in a Spin System at Room Temperature

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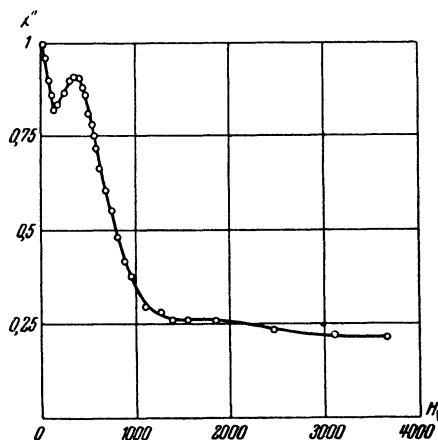
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THE investigation of paramagnetic absorption in $\text{Cr}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$ in parallel fields at 300°K ,

employing Zavoiskii's grid current method¹, revealed an effect which is unusual at room temperature. The absorption $\chi''(H_{\parallel})$ plotted in the figure for a 160 Mc oscillating field has quite a narrow peak. The right-hand half width was of the order of 300 oersteds. As ν increases the absorption peak is shifted in the direction of higher constant magnetic field strengths; this is shown in the following set of data:

ν in Mc =	48	93	131	160
Magnetic field in oersteds at peak =	250	290	330	360



The intensity of the absorption peak compared with absorption at $H=0$ diminishes with increasing frequency from 10 to 160 Mc. At frequencies of the order of 660 Mc, the shape of the paramagnetic absorption curve differs very little from the usual $\chi''(H_{\parallel})$ curve which is described by Shaposhnikov's formula² $\chi'' = (1-F)^2 \rho_s \nu$.

Below 10 Mc, spin-lattice relaxation influences the absorption curve so strongly that a peak is hardly discernible.

This phenomenon is apparently associated with the new form of spin-spin relaxation discovered by DeVrijer and Gorter^{3,4} in potassium chrome alum at the temperature of liquid hydrogen. Gorter and his associates⁵ later detected this type of relaxation in a number of other materials but again only at very low temperatures. So far as we know the effect has not previously been observed at room temperature.

At the present time the author is using the grid current method in similar investigations of other chromium salts and salts of Mn^{++} , Cu^{++} and Fe^{+++} .

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