ameter 11-12 mm and height 4 mm. A thin plate of bismuth is embedded in the silver chloride, with five contacts which make it possible to measure the resistance, the dependence of resistance on magnetic field, and the Hall effect, as functions of pressure. The magnetic field is introduced into the matrix through the plungers exerting the pressure. In one of the plungers are found four miniature electrical conductors. The measurements were made on bismuth of 99.99% purity.

The occurrence of the I-II and II-III transitions in bismuth was clearly seen by jumps in the resistance. With increasing pressure the Hall effect in bismuth progressivley decreases, and in modification III, it becomes at least three orders of magnitude smaller than for bismuth under normal pressure. The dependence of resistance on magnetic field in modification III also falls below the limits of sensitivity of the measuring system. Noting that in modification III, according to the measurements of Bridgman[2] and also of Butuzov and Gonikberg[3], the melting point increases with pressure; and that, according to the measurements of Chester and Jones[4], superconductivity occurs in bismuth III, it is obviously possible to assume that bismuth III is a true metal, in contrast to bismuth I, which is characterized as a "semi-metal". Since details of the change of Hall effect with pressure in modification I obviously depend on the orientation of the plate, the necessity arose of carrying out the experiments with monocrystalline plates, after which we shall publish a detailed article.

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Translated by C. W. Helstrom
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Hydrodynamic Fluctuations

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(Submitted to JETP editor November 29, 1956)
J. Exptl. Theoret. Phys. (U.S.S.R.) 32, 618-619 (March, 1957)

A GENERAL theory of hydrodynamic fluctuations can be constructed by introducing "outside" terms into the equation of motion of the liquid, as was done by Rytov[1] for the fluctuations of an electromagnetic field in continuous media; he introduced corresponding "outside" fields in Maxwell's equations.

The introduction of such additional terms can be accomplished in different equivalent ways. The most advantageous is the form in which the fluctuations of the "outside quantities" at the various points of the liquid are not correlated with one another. This is accomplished by the introduction of "outside stress tensor" s_{ik} in the Navier-Stokes equation and the "outside heat flow" vector g in the heat conduction equation (the equation of continuity remains unchanged). The system of hydrodynamic equations then takes the form

$$\frac{\partial \rho}{\partial t} + \operatorname{div}(\rho \mathbf{v}) = 0, \tag{1}$$

$$\rho \frac{\partial v_i}{\partial t} + \rho (\mathbf{v}\nabla) v_i = -\frac{\partial \rho}{\partial x_i} + \frac{\partial \sigma'_{ik}}{\partial x_k}, \tag{2}$$

$$\rho T \left(\frac{\partial s}{\partial t} + \mathbf{v}\nabla s\right) = \frac{1}{2}\sigma'_{ik}\left(\frac{\partial v_i}{\partial x_k} + \frac{\partial v_k}{\partial x_i}\right) - \operatorname{div}\mathbf{q}, \tag{3}$$

$$\sigma'_{ik} = \eta\left(\frac{\partial v_i}{\partial x_k} + \frac{\partial v_k}{\partial x_i} - \frac{2}{3}\delta_{ik}\frac{\partial v_l}{\partial x_l}\right) + \zeta \frac{\partial v_l}{\partial x_l}\delta_{ik} + s_{ik}, \tag{4}$$

$$\mathbf{q} = -\varkappa \Delta T + \mathbf{g} \tag{5}$$

(all the notation agrees with that used in our book[2]). To these equations should be added the relations which define the mean values of the products of components s_{ik} and g_i. We do this by first assuming the fluctuations to be classical (*i.e.*, their frequencies $\omega \ll kT/\hbar$), while the viscosity and the thermal conductivity of the liquid are non-dispersive.

The rate of change of the total entropy of the liquid S is given by the expression [see Ref. 2, Sec. 49]

$$\dot{S} = \int \left\{\frac{\sigma'_{ik}}{2T}\left(\frac{\partial v_i}{\partial x_k} + \frac{\partial v_k}{\partial x_i}\right) - \frac{\mathbf{q}\nabla T}{T^2}\right\} dV. \tag{6}$$

Following the general rules of fluctuation theory laid down in Ref. 3, Secs, 117, 120, we select as 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

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

while Eqs. (4) and (5) play the role of the relations $\dot{x}_a = -\gamma_{ab}X_b + y_a$ (see Ref. 3, Sec. 120), where the s_{ik} and g_i correspond to the quantities y_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:

$$\begin{aligned}\overline{s_{ik}(\mathbf{r}_1,t_1)s_{lm}(\mathbf{r}_2,t_2)} &= 2kT\,[\eta(\delta_{il}\delta_{km}+\delta_{im}\delta_{kl}) \\ &+ (\zeta-2\eta/3)\,\delta_{ik}\delta_{lm}]\,\delta(\mathbf{r}_2-\mathbf{r}_1)\,\delta(t_2-t_1), \qquad (7)\\ \overline{g_i(\mathbf{r}_1,t_1)\,g_k(\mathbf{r}_2,t_2)} &= 2kT^2\varkappa\delta_{ik}\delta(\mathbf{r}_2-\mathbf{r}_1)\,\delta(t_2-t_1),\\ \overline{g_i(\mathbf{r}_1,t_1)\,s_{lm}(\mathbf{r}_2,t_2)} &= 0.\end{aligned}$$

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

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

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 $(h\,\omega/2kT)\coth\hbar\,\omega/2kT$ in the expressions for the average values of the products of the spectral components s_{ik} and g_i, while the quantities η, ζ, $\varkappa$ are to be replaced by their real parts.

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*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 $\Delta V \to 0$ in the final equations.

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Translated by R. T. Beyer
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Dipole Moment of the HDSe Molecule

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(Submitted to JETP editor December 6, 1956)
J. Exptl. Theoret. Phys. (U.S.S.R.) 32, 620 (March, 1957)

THE dipole moment of the D_2Se, molecule has been determined[1] from the Stark splitting of its rotational spectrum. For the dipole moment, the relatively small value of 0.24 Debye units was obtainned. It would be interesting to confirm this result with another isotopic form of hydrogen selenide, HDSe. In the investigation[2] 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

$$\Delta\nu = 2\cdot 0{,}5535\,[M_J^2\,/\,J\,(J+1)\,(2J+1)]\,(S\,/\,\nu)\,\mu_a^2 E^2.$$

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 semiheavy water HDO. For this purpose we used the 8577.7 and 22307.67 Mc lines[3]. The field strength