quency of 58 mc and acceleration time of 10,000 μ-sec. Preliminary investigation shows the azimuthal spread of the electron bunch at the end of the cycle is $100 \pm 10°$.

A detailed description of the method and results of this experiment will be published at a later date.

The author expresses his sincere gratitude to Prof. P. A. Cerenkov for valuable discussions.

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On the Derivation of a Formula for the Energy Spectrum of Liquid He^4

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As is well known, Feynman [1], using a wave function of a special form, has obtained an expression for the spectrum of the elementary excitations in liquid He^4. A hydrodynamical derivation of this formula is presented below.

We shall begin with the Hamiltonian for a quantum liquid in the form[2]

$$\hat{H} = \frac{1}{2}\int m\hat{\mathbf{v}}n\hat{\mathbf{v}}d\tau + \hat{H}^1[n], \tag{1}$$

where n is the number of atoms per unit volume and $\hat{H}^1[n]$ is the velocity-independent part of the Hamiltonian. We shall assume it to be a function of n. We set $n = \overline{n} + \delta n$ and expand H in terms of the second order in δn. The first-order term drops out and we obtain

$$\hat{H} = \hat{H}^1[\overline{n}] + \frac{m\overline{n}}{2}\int \hat{\mathbf{v}}^2 d\tau + \int \varphi(\mathbf{r}, \mathbf{r}')\, \delta n \delta n' d\tau d\tau', \tag{2}$$

where φ is the second functional derivative of $\hat{H}^1$ with respect to n. Transforming now to Fourier components

$$\delta n = \sum_{\mathbf{k}} n_{\mathbf{k}} e^{i\mathbf{kr}}$$

and taking into account the equation of continuity in the form

$$\delta\dot{n} + \overline{n}\,\mathrm{div}\,\hat{\mathbf{v}} = 0, \tag{3}$$

as well as the fact that φ depends only upon $|r - r'|$, we obtain

$$\hat{H} = \hat{H}^1[\overline{n}] + \sum_{\mathbf{k}} \left(\frac{m\,|\dot{n}_{\mathbf{k}}|^2}{2\overline{n}k^2} + \frac{1}{2}\varphi_{\mathbf{k}}|n_{\mathbf{k}}|^2 V \right). \tag{4}$$

This expression has the form of a sum of the Hamiltonians of oscillators having frequencies:

$$\omega^2(\mathbf{k}) = (k^2\varphi_{\mathbf{k}}\overline{n}/m)\, V. \tag{5}$$

For the determination of φ_k we note that the average value of the potential energy of an oscillator in the ground state is equal to $\hbar\omega/4$, whence

$$\tfrac{1}{2}\varphi_{\mathbf{k}}\overline{|n_{\mathbf{k}}|^2}V = \tfrac{1}{4}\hbar\omega(\mathbf{k}). \tag{6}$$

As is well known, however, $S(k) = |\overline{n}_k|^2/\overline{n}$ is the Fourier component of the correlation function for the atoms of a liquid, which can be determined from diffraction experiments. Substituting φ_k from (6) into (5), we find for the energy of excitation

$$E(\mathbf{k}) = \hbar\omega(\mathbf{k}) = \hbar^2k^2/2mS(\mathbf{k}),$$

which agrees with Feynman's result.

In conclusion, I would like to express my thanks to L. D. Landau for his advice.

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The Effect of a Transverse Magnetic Field on the Thermal Conductivity of Metals

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LET us consider a metal, in which there is a heat flow $Q = Q_x$ and a magnetic field $H = H_x$. For the calculation of the coefficient of thermal conductivity we use the model of Sommerfeld,[1] according to which the flow depending on the motion of electrons under the action of the temperature gradient is set equal to zero. Accordingly,[2]

$$I_x = -\frac{3ne}{mv^3}\int \xi f v d\varepsilon, \qquad Q_y = \frac{3n}{2v^3}\int \eta f v^3 d\varepsilon \quad (1)$$

and analogously for I_y and Q_x. Here $(-e)$ is the charge on the electron, m is the mass of the electron, v is the velocity, ξ and η are the components of the velocity along the x and y axes, ϵ is the kinetic energy of the electron. The distribution function is taken to have the form

$$f = f_0 + \xi\chi_x + \eta\chi_y, \quad (2)$$

where f_0 is the Fermi distribution function, and the functions χ_x and χ_y (found with the aid of the kinetic equation, in which the term taking into account collisions, was derived by Lorentz[3]) equal:

$$\chi_x = -l(f_1 - qf_2)/v(1+q^2), \quad (3)$$
$$\chi_y = -l(f_1 q + f_2)/v(1+q^2).$$

Here l is the length of the mean free path of the electron, and the rest of the variables are defined as follows:

$$q = \omega l/v = (eH/mc)\,l/v; \quad (4)$$
$$f_1 = \partial f_0/\partial x - eE_x \partial f_0/\partial\varepsilon;$$
$$f_2 = \partial f_0/\partial y - eE_y \partial f_0/\partial\varepsilon;$$

E_x and E_y are the components of the electric field resulting from the motion of the electrons under the action of the temperature gradient.

Calculation shows that the dependence of l on v for the present problem is immaterial, because the terms containing the derivative of l with respect to v, are small and do not enter into the expression for the coefficient for thermal conductivity $\varkappa$.

Making the usual calculation for the coefficient of thermal conductivity $\varkappa = -Q_x/\partial T/\partial x$ (in the present problem $I_x = I_y = 0$, $Q_y = 0$) with accuracy to the terms $\sim (kT/\overline{\varepsilon})^3$ ($\overline{\varepsilon}$ is the Fermi level), we obtain

$$\varkappa = \varkappa_0\left[1 - \frac{4\pi^2}{15}\left(\frac{kT}{mv^2}\right)^2 \frac{q^2(4+2q^2+3q^4)}{(1+q^2)^3}\right], \quad (5)$$

where $\varkappa_0 = \pi^2 nlk^2 T/3mv$ is the coefficient of thermal conductivity in the absence of a magnetic field.

Approximate calculation shows that formula (5) gives a decrease in the thermal conductivity of less than 0.01% of $\varkappa_0$ in a field of 10,000 Oersteds.

It can be shown that consideration of the effect is necessary for metals of the type of Bi which have a small number of conduction electrons.

In conclusion I must thank K. B. Tolpygo for a number of suggestions and E. I. Rashba for certain advice in the course of carrying out the work.

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Application of the Theory of Random Processes to Radiation Transfer Phenomena

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IN this note the motion of the photon is treated as a random process under the following very general assumptions: the medium is isotropic; its properties may be functions of time and space; the photon may be scattered, absorbed by an atom and reemitted, or absorbed in a collision of the second kind; the polarization of the radiation and the motion of the atom excited by a photon are not taken into account.

We begin with the function

$$f_{\nu_1}^{\nu_2}(\mathbf{r}_1, \eta_1, \nu_1, t_1;\ \mathbf{r}_2, \eta_2, \nu_2, t_2)\, dV_2\, d\eta_2\, d\nu_2,$$