$$E_{dip} = (40.7 \pm 1.8) A^{-20 \pm 0.01} \text{ MeV} \qquad (8)$$

For $F^{(0)}$ and $F^{(i)}$ we used the values obtained by Migdal and Larkin [7] on the basis of an analysis of data on the compressibility of nuclear matter and its concentration

$$F^{(0)} = 0.5, \quad F^{(i)} = 1.5, \qquad (9)$$

and for v_F we used $v_F = 0.2c$. The dashed curve is the function $\omega(A) \sim A^{-1/3}$, which is obtained by neglecting the Coulomb interaction.

We see thus that the model of the Fermi-liquid drop with free boundary, which takes into account in addition to the pure nuclear interaction also the electric interaction of the nucleons, describes well the position of the giant dipole resonance for a large number of nuclei. In particular, it is possible to explain why the energy of the giant dipole resonance decreases more slowly than the usual $A^{-1/3}$ law for liquids. We emphasize that the parameters $F^{(0)}$ and $F^{(i)}$ which enter in the theory are obtained in this case for an analysis of data that do not pertain to giant resonance [7].

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EXCITATION OF SOUND IN A FERMI-BOSE LIQUID

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As is well known, weak solutions of He^3 and He^4 constitute at $T \ll T_F$ (T_F is the Fermi temperature for He^3 in solution) a peculiar mixture of Fermi and Bose liquids. The phenomenological theory of Fermi-Bose liquids was constructed by Khalatnikov [1]. In such a liquid, there exist two types of acoustic modes. Following [1], we call them first and second sound. When the He^3 concentration in the solution tends to zero, the first sound goes over into first sound in He II. The second sound propagates through the Fermi component of the liquid and has much in common with first sound in a Fermi liquid.

One of the possible methods of observing second sound in a solution is to excite it by oscillations of a plane boundary. We consider below the problem of excitation of sound in a solution by the indicated method, and find the ratio of the values of the radiated energy fluxes of first and second sounds. The ratio obtained is of the order of 10^{-3} at ~1% He^3 concentration, making it possible to hope to observe experimentally second sound in a solution when excited by the indicated method.

We are interested, naturally, in the hydrodynamic region, where both first and second sound propagate, and neglect dissipation. The calculation scheme is the same as in Lifshitz's paper on excitation of sound in He II [2].

According to [1], the spectrum of the Fermi excitations is given by

$$\epsilon(\mathbf{p}) = \epsilon_0(n_3, n_4) + \frac{p^2}{2m^*} + \frac{\Delta m}{m^*}\left(1 + \frac{F_1}{3}\right)\mathbf{p}\mathbf{v}_s + \int f(\mathbf{p}, \mathbf{p}')\delta n' d\tau', \quad (1)$$

where $\vec{p}$ is the momentum, m^* the effective mass of the excitation, $\Delta m = m^*(1 + F_1/3)^{-1} - m_3$, v_s the velocity of superfluid motion, n_3 and n_4 the numbers of He^3 and He^4 particles per unit volume, $f(\vec{p}, \vec{p}')$ the Landau function, F_0 and F_1 the Landau parameters, and $n(\vec{p}, \vec{r}, t)$ is the distribution function of the Fermi excitations. It is convenient to write the kinetic equation for the Fourier component of the distribution function of the Fermi excitations

$$\delta n_{q,\omega} = \frac{\partial n_0}{\partial \epsilon} \sum_{n=0}^{\infty} \nu_n P_n(\cos\theta) . \quad (2)$$

Here θ is the angle between the wave vector $\vec{q}$ and the momentum $\vec{p}$. In (2) we can retain only the first two terms of the sum, since the next terms have a relative order $\omega\tau$ and higher (ω is the frequency and τ is the relaxation time), as follows from the conservation laws. In the absence of dissipation, it can be assumed that ν_0 and ν_1 do not depend on ε (see [3]) and are constants. Averaging the kinetic equation over the angles in the same manner as in [4], and adding to it the equations of continuity and superfluid motion, we can obtain a complete system of equations describing the solution. We shall not write this system out here, since it coincides with the system (2.9 - 2.12) of [4], where it is only necessary to set the extraneous force equal to zero.

Let the sound be excited by a plane oscillating in a direction perpendicular to itself with velocity $v(t) = v_0 \exp(-i\omega t)$. We write the boundary conditions for the normal and superfluid components of the velocity

$$v_{s_1}^b + v_{s_2}^b = v_0 , \quad (3)$$

$$\int p^b (\delta n_1^b + \delta n_2^b) d\tau = m_3 n_3 v_0 , \quad (4)$$

where the indices 1 and 2 correspond to first and second sound. The energy density in the wave is

$$E = m_4 n_4 \overline{v_s^2(t)} + \overline{\int \epsilon(\mathbf{p}) \delta n_{\mathbf{p}} d\tau_{\mathbf{p}}} . \quad (5)$$

We carry out in (5) the time-averaging designated by the superior bar. Taking into account the condition for the extremum of the entropy at equilibrium, and also relation (1), we have

$$2E = m_4 n_4 v_s^2 + \frac{p_F m^*}{\pi^2 \hbar^3}\left[\left(1 + F_0\right)\nu_0^2 + \left(1 + \frac{F_1}{3}\right)\frac{\nu_1^2}{3}\right]. \tag{6}$$

We now find the ratio of the energy fluxes $I_{1,2} = E_{1,2}U_{1,2}$ (U is the speed of sound) in the lowest order in the He^3 concentration $x = n_3/(n_3 + n_4)$. Solving the system (2.9 - 2.12) of [4] together with the boundary conditions (4) and (5), and using (6), we obtain ultimately

$$\frac{I_2}{I_1} = \frac{4x}{\sqrt{3}} \frac{m_4}{m^*}\left(a - \frac{m_3}{m_4}\right)^2 \frac{v_F}{c} . \tag{7}$$

For

$$x = 5 \cdot 10^{-2}, \quad m^* = 2.5\, m_3, \quad a = \frac{n_4}{m_4 c^2} \frac{\partial \epsilon_0}{\partial n_4} = 1{,}3 ,$$

$v_F = 5.38 \times 10^3$ cm/sec, and $c = 2.4 \times 10^4$ cm/sec we have $I_2/I_1 \simeq 2 \times 10^{-3}$, which apparently makes it possible to observe second sound in a solution upon excitation by the method under consideration.

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