where $\tau_b^{2\%}$ is the additional cleavage stress causing a 2% elongation of the edge rays. This quantity (in absolute magnitude) is at the same time a measure of the accuracy of the estimate of the linear charge density given by relation (1).

In conclusion, we thank E.D. Shukin, N.A. Tapunina, and L.A. Kochanova for a discussion of the work and for valuable advice.

[1] R.L. Sproull, Phil. Mag. 5, 56, 815 (1960).
[2] R. Strumane, R. de Batist, and S. Amelinckx, Phys. Stat. Solidi 3, 8, 1379 (1963).
[3] A.A. Urusovskaya, Review in: Dinamika dislokatsii (Dislocation Dynamics), Khar'kov, 1968, p. 611.
[4] I.V. Zagoruiko, Kristallografiya 10, 81 (1965) [Sov. Phys.-Crystallogr. 10, 63 (1965)].

SONOLUMINESCENCE FOLLOWING FOCUSING OF LASER RADIATION INTO A LIQUID

A.A. Buzukov and V.S. Teslenko
Hydrodynamics Institute, Siberian Division, USSR Academy of Sciences
Submitted 2 August 1971
ZhETF Pis. Red. 14, No. 5, 286 - 289 (5 September 1971)

We report here data on the sonoluminescence phenomenon [1], which is observed upon collapse of cavitation voids produced in a liquid by a laser beam.

We used in the experiments a ruby laser operating in the monopulse regime, with radiation energy 0.5 J and duration 30 - 50 nsec, and also in the free-running regime. The experimental setup is shown in Fig. 1. The laser beam after passing through a Ks-15 filter (1) was focused by a lens (F = 2 cm) into a liquid (water, carbon tetrachloride, acetone) filling a cell (2) with blackened interior surface. The cell had symmetrically placed windows of optical glass, through which the luminescence of the liquid was recorded with the aid of an FEU-18A or FEU-22 photomultiplier (3) on an OK-17 oscilloscope. The spectral regions were separated with interference filters and with standard filters of colored glass (4). The laser radiation was monitored by diverting part of the radiation to an FEU-22 photomultiplier (5) with the signals recorded with an S-1-11 and an OK-17 oscilloscope (to establish the time correlation).

A piezoelectric pickup (6) with resolution 0.25 μsec was placed in the cell. The pickup registered pressure pulses at distances from 5 to 10 mm from the focal region, and the signal was fed from the pickup through a cathode follower (7) to the second channel of the OK-17 oscilloscope.

It is known that when monopulse laser radiation acts on a liquid, breakdown occurs at the focus of the beam and a pulsating cavity is produced [2]. The maximum radius R of the cavity is determined mainly by the radiation energy.

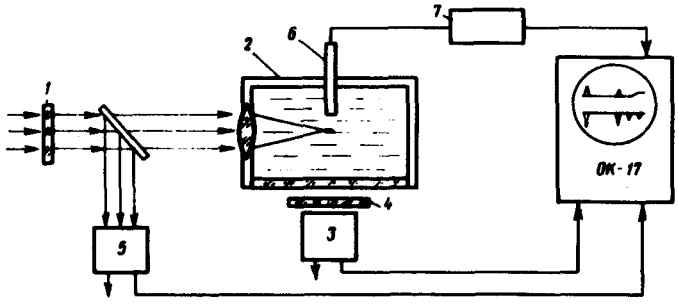

Fig. 1. Experimental setup: 1 - Ks-15 filter, 2 - cell with investigated liquid, 3 - FEU-18A or FEU-22 photomultiplier; 4 - filters, 5 - FEU-22 photomultiplier, 6 - piezoelectric pickup, 7 - cathode follower.

$$R = 0.62\,(kE/P)^{1/3}, \quad (1)$$

and its pulsation period T satisfies the relation

$$T = 1.83R\,(\rho/P)^{1/2}. \quad (2)$$

Here E is the laser radiation energy, k the optical-hydrodynamic coefficient [2, 3], P the hydrostatic pressure in the liquid, and ρ the density of the liquid.

At the instant of the next collapse of the cavitation cavity, a shock-acoustic wave is radiated [4]. The registration of such waves, and of the primary shock wave produced during the breakdown, by means of the piezoelectric pickup, was used to establish the connection between the time of appearance of the luminescence and the process of pulsation of the cavity.

Figure 2 shows a typical oscillogram of the luminescence of water (a), recorded with an FEU-18A photomultiplier, and an oscillogram of the pressure pulses (b) from the pulsating cavity (c). The quantitative measurements show that the maximum intensity of the sonoflash from the first collapse of the cavity lies in the 3750 - 4400 Å region and amounts to 5 - 10 mW at a distance of 5 cm from the photoreceiver.

For carbon tetrachloride the amplitude values of the sonoluminescence burst turned out to be lower than for water by a factor 2 - 3. It can be assumed that this is due not only to the physical and chemical differences between the liquids, but also to the difference in their optico-hydrodynamic coefficients.

Figure 3 shows an oscillogram of the scattering of the radiation and luminescence in acetone (a) for a free-running laser. The same figure shows the corresponding control oscillogram of the laser emission (b). Instead of a relatively large cavity, a certain number of small cavitation bubbles are produced in this case, and their pulsations produce short-duration luminescence pulses of low amplitude.

Experiments have shown that when laser radiation is focused in a liquid, hydrodynamic sonoluminescence is produced, and the time of appearance of the luminescence is shifted relative to the emission time by one period of the cavitation pulsation. The sonoluminescence effect must be taken into account in spectral investigations of stimulated Raman scattering, where powerful radiation sources are used.

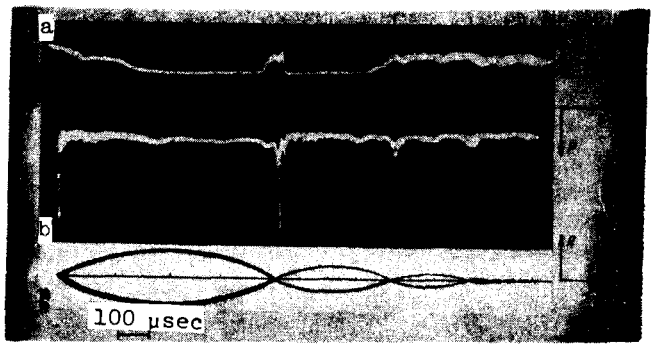

Fig. 2. a - Oscillogram of luminescence of water, b - oscillogram of pressure pulses, c - cavity pulsation.

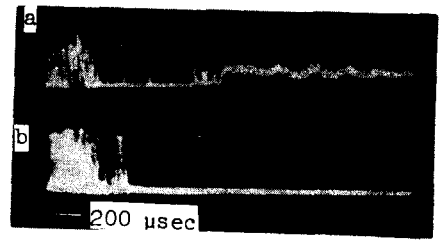

Fig. 3. Oscillograms of the scattering of the radiation and luminescence in acetone for a free-running laser (a) and control oscillogram of the laser emission (b).

[1] M.A. Margulis, Akust. zh. 15, 153 (1969) [Sov. Phys.-Acoust. 15, 135 (1969)].
[2] A.A. Buzukov, Yu.A. Popov, and V.S. Teslenko, Prikl. mat. teor. fiz. No. 5, 17 (1969).
[3] A.I. Ioffe, N.A. Mel'nikov, K.A. Naugol'nykh, and V.A. Upadyshev, ibid. No. 3, 225 (1970).
[4] A.D. Pernik, Problemy kavitatsii (Problems of Cavitation), Sudpromgiz, 1963.

SPECTRUM OF COLLECTIVE EXCITATIONS IN LIQUID ^{4}He

V.M. Sysoev
Kiev State University
Submitted 12 July 1971
ZhETF Pis. Red. 14, No. 5, 289 - 291 (5 September 1971)

Experiments on inelastic coherent scattering of cold neutrons by simple classical liquids reveal the presence of definite elementary excitations of the density-fluctuation type in the frequency region $\omega \sim 10^{12}$ sec^{-1} and in the wave-number region $Q \sim 1 - 3$ Å^{-1} in simple liquids [1, 2]. Theoretical calculations of the spectrum of elementary excitations for liquid argon were carried out in [3, 4]. On the other hand, it was established in [5] that the spectrum of elementary excitations in superfluid liquid helium retains a form similar to the spectrum of elementary excitations in simple classical liquids on going through the λ point, and only the damping of the elementary excitations increases somewhat.

It seems possible therefore to calculate the spectrum of collective excitations in liquid ^{4}He in the region of high frequencies and large wave numbers, where the hydrodynamic description is not applicable [6], and an important role is played by the quasicrystalline properties of the liquid; this was the purpose of the present investigation.

Using the method of equations of motion for two-time Green's function of the "displacement-displacement" type, we obtained the spectrum of the collective excitations in liquid He within the framework of the quasicrystalline model of the liquid [7]. The collective motions in the liquid are regarded as oscillations of the atoms in equilibrium positions, the distribution of which in space is described by the function g(R). To take into account the strong anharmonicity due to the large zero-point oscillations, we used methods of self-consistent theory of anharmonic crystals, which make it possible to take into account all the even orders of anharmonicity [8]. The correlations of importance for solid and liquid helium, of the hard-core type, were taken into account on the basis of the approximate solution of the equation for the T-matrix described in [9]. As a result we obtained the following expressions for the longitudinal oscillation frequency:

$$\omega^2(Q) = \frac{2\pi\rho}{m} \int_0^\infty dR R^2 \int_{-1}^{1} dt \Phi(R) t^2 (1 - \cos QRt), \tag{1}$$

where m is the mass of the helium atom, $\rho = N/V$ the particle density, and $\Phi(R)$ the longitudinal component of the pseudoharmonic force constant:

$$\Phi(R) = g(R)\left(\frac{\partial^2}{\partial R^2} + \frac{1}{R}\frac{\partial}{\partial R}\right)\int \frac{d^3 r}{(2\pi/\alpha^2)^{3/2}} f(r) \exp\left[-\frac{1}{2}\alpha^2 (r - R)^2\right]\phi(r), \tag{2}$$

where g(R) is the distribution function of the equilibrium positions, and is assumed approximately to equal the radial distribution function obtained in