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AN INVESTIGATION OF ROTATING He II NEAR THE λ-POINT USING SECOND SOUND

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EXPERIMENTAL studies recently carried out at Tbilisi have shown, on the one hand, that the central macroscopic vortex formed when He I is rotated and subjected to vigorous pumping persists for a certain time, even when a transition to He II takes place. [1] On the other hand, the Onsager-Feynman vortices generated by the rotation of He II survive in He I. [2] These facts clearly demonstrate the possibility of supercooling a form of motion subject to the laws of classical hydrodynamics, and of superheating a type of motion governed by quantum hydrodynamics.

The delay in the establishment of steady-state motion in He II following a transition from He I in rotation to rotating He II—i.e., the delay in the formation of Onsager-Feynman vortices—can be investigated using the scattering of second sound waves by the vortices. [3] In order to carry out a measurement of this sort, we conducted the following experiment. Liquid helium was introduced into an annular resonant cavity provided by the space between two coaxial cylinders. The resonator was capable of rotation about its axis of symmetry. The second sound source and detector were wound in bifilar fashion into a quadruple thread cut onto the inner cylinder. The source was of constantan wire $50\,\mu$ in diameter, and the detector, of $40\,\mu$ phosphor bronze. Uniform rotation of the resonator was achieved by means of a mechanical system using electromagnetic coupling which we had developed previously. [4] Electrical connections to the rotating resonator were made through mercury contacts situated within the cover of the cryostat. The second sound source was driven by an audio-frequency oscillator of high stability. The second-sound signals taken from the potential terminals of the detector were amplified by a tuned amplifier having a gain of 10^7, rectified, and fed into an ÉPP-09 recorder. An ÉO-7 oscilloscope provided a visual check on the tuning accuracy of the second sound resonances.

The initial experiments, in which the propagation of second sound in a radial direction was studied, provide a basis for the present preliminary communication.

The procedure which we used was as follows. The second-sound resonant frequency was determined with the helium at rest at temperatures near the λ-point (2.09 and 2.15°K). The pump was then shut off, and the temperature of the helium raised to 2.25°K. The resonator was set into rotation (with an angular frequency $\omega_0 = 0.98$ sec^{-1}), and, after 3—4 minutes, pumping was resumed on the helium vapor at a rate of 2 mm Hg per minute. As the previously-selected temperature was passed a measurement was made of the second sound amplitude. Similar measurements were also made with the resonator stationary.

The measurements made at 2.15°K showed that the peak amplitude of the second sound is virtually unchanged, which indicates the presence of a delay in the formation of the vortices. If, without stopping the rotation, the temperature is raised again (but not above the λ-point) and then lowered once more to 2.15°K, the second sound amplitude is then found to be reduced. A different situation is found in the measurements at 2.09°K. In this case, a clearly-marked decrease in the amplitude of the second sound, by approximately 20% relative to the initial value, is observed when the temperature is lowered the first time. Control measurements showed that the same reduction in the second sound amplitude is reached in 1.5—2 min, when the resonator is rotated at the same rate with the temperature held in the vicinity of 2.09°K. The difference in the times required to reduce the temperature from the λ-point to 2.15°K, in the one case, and to 2.09°K, in the other, makes it possible to estimate the time delay in the formation of the

Onsager-Feynman vortices at the He I—He II transition in rotating helium. From our preliminary data, which still need to be made more precise, this time is on the order of 4 min, for a temperature of 2.15°K.

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SEARCH FOR RESONANCES IN THE $K^0\bar{K}^0$ *PAIR-PRODUCTION REACTION*

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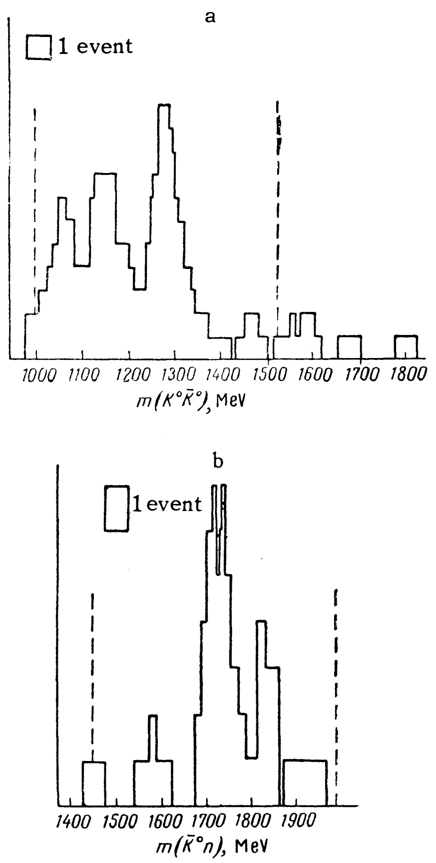
In the study of the process of production of $K^0\bar{K}^0$ meson pairs by negative pions with 2.8 BeV/c momentum, using a freon (C, Cl, F) [1] and xenon (Xe) [2] double chamber, in the reaction

$$\pi^- + (A, Z) \rightarrow K^0 + \bar{K}^0 + (A, Z)^* + n\pi, \qquad n = 0, 1, 2, \ldots \tag{1}$$

thirty-eight $K^0\bar{K}^0$ pair-production events were observed in freon and thirteen in xenon. The experimental procedure was described in detail previously[3,4]. In order to search for the possible resonances in the $K^0\bar{K}^0$ system, we have plotted the distribution of the obtained pairs by their effective masses (Fig. a). The accuracy with which the masses were determined is approximately ±25 MeV. The dashed lines indicate the limiting values of the mass $m(K^0\bar{K}^0)$. The distribution obtained has a noticeable peak at $m(K^0\bar{K}^0) = 475$ MeV,



Distribution of the $K^0\bar{K}^0$ and $\bar{K}n$ systems over the effective masses.

but its reliability is low in view of the scanty statistics.

Kobzarev and Okun'[5] predicted the existence of a pseudoscalar σ_0 meson, which decays in accord with the scheme $K^0 + \bar{K}^0 + \pi^0$. This decay could lead, in principle, to the appearance of a peak in the $m(K\bar{K})$ distribution, but in this case ten out of the twenty $K^0\bar{K}^0$ pairs, which fall in the peak, should be accompanied by at least one electron-positron pair (in accordance with the efficiency of registering π^0 mesons in our chambers). In fact, only one such event was observed (in the freon chamber), thus completely refuting the hypothesis that we are observing a σ_0 decay. It must be noted that for events that occur at the peak, $n = 0$ (in approximately 70% of the cases), while for events outside the peak $n = 1$ (also approximately in 70% of the cases).

The $K^0\bar{K}^0$ pairs can appear also during the production of some excited hyperons, which decay rapidly into a $\bar{K}$ and a nucleon, as was observed for example in [6]. We have attempted to observe a reaction of the type

$$\pi^- + p \rightarrow \underset{\substack{\downarrow \\ n + \bar{K}^0}}{Y^*} + K^0. \tag{2}$$