

XIII. PHYSICAL ACOUSTICS*

Prof. U. Ingard
Prof. R. D. Fay

L. W. Dean III

G. C. Maling, Jr.
H. L. Willke, Jr.

A. DISTORTION OF LARGE-AMPLITUDE SOUND WAVES IN LIQUID HELIUM

Recent measurements indicate that nonlinear mixing effects become significant in the normal reflection of large-amplitude acoustic wave trains in liquid helium at an acoustic level that is approximately 10 times higher than that previously suspected.

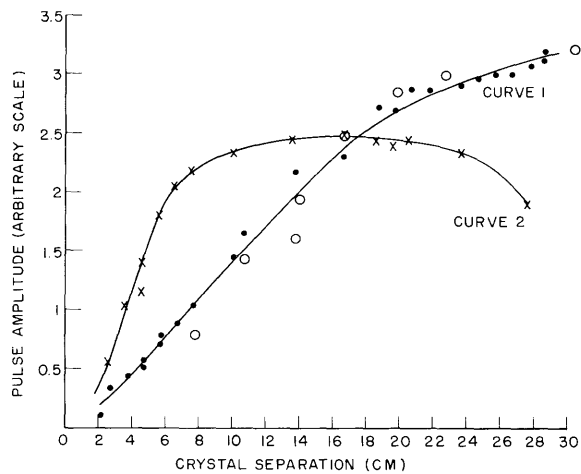


Fig. XIII-1. Amplitude of second harmonic in wave train plotted against separation distance between source and pickup transducers. $T = 1.9^{\circ}\text{K}$; voltage on source transducer, 8 volts rms.

Curve 1 of Fig. XIII-1 shows the amplitude of the second harmonic in a wave train as a function of distance of travel from the source transducer; at the transducer, the wave is constrained to be sinusoidal. The source is driven with an 8-volt rms signal, at 1 mc/sec.

After being reflected from the pickup crystal, and again from the source, the wave train arrives a second time at the pickup crystal. The amplitude of the wave at its second reflection is shown by curve 2 of Fig. XIII-1.

If the nonlinear effects of the reflection of the wave are truly negligible, it should be possible to bring the two waves into coincidence after allowance is made, in the case of curve 2, for ordinary reflection losses. In Fig. XIII-1, the large circles represent

*This research was supported in part by the U. S. Navy (Office of Naval Research) under Contract Nonr-1841(42). Reproduction in whole or in part is permitted for any purpose of the United States Government.

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curve 2 after it has been expanded three times horizontally (since the actual acoustic path is three times that of curve 1), and has been adjusted vertically by a factor of 1.37.

The set of circles, within its larger range of scatter, may be said to agree with curve 1. Of course, the correctness of the scaling factor of 1.37 should be checked by measuring the third return of the pulse to the pickup transducer and comparing it with the first two curves. Then a vertical scaling factor of $(1.37)^2$ and a horizontal factor of 5 should be applied.

When the input voltage to the source transducer is increased to 80 volts rms, the wave envelope becomes so seriously distorted under the conditions of reflection that the wave amplitude is no longer well defined. It is possible that, when the experimental apparatus is altered to accommodate larger pulse trains, the structure of the distorted wave envelope will become more clear.

The present data (Fig. XIII-1) refutes some of the hypotheses derived from the data of Fig. XII-1 of Quarterly Progress Report No. 55, p. 139, which represents similar experimental conditions. To account for the disparity between the two figures, it is sufficient to assume that the gain of the signal amplifier drifted during the taking of the earlier data. The present curves have been repeated many times, and may be assumed to be free of such errors. The earlier indications of anomalous reflection at relatively low source strengths are thus invalid; however, certain anomalies are noted when the strength is increased by one order of magnitude.

H. L. Willke, Jr.