

OBSERVATION OF COMPONENTS OF THE ACOUSTIC SPECTRUM OF SUBHARMONICS

PHYSICS

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Abstract

Full Text

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G. D. MIKHAILOV

OBSERVATION OF COMPONENTS OF THE ACOUSTIC SPECTRUM OF SUBHARMONICS

(Presented by Academician M. A. Leontovich, February 24, 1969)

The existence of harmonics with fractional frequencies, or, in other words, subharmonics, was first discovered in the study of electrical and mechanical nonlinear systems (¹). As far as we know, there are no works indicating the possibility of the existence of subharmonics in acoustics. However, our calculations, for the propagation of an intense acoustic wave in a liquid, make it possible to predict the existence of a subharmonic spectrum of second order. The frequencies constituting this spectrum belong to the sequence

$$\frac{1}{2}\nu_1, \frac{3}{2}\nu_1, \frac{5}{2}\nu_1, \dots, \frac{2k-1}{2}\nu_1.$$

To observe the components of the subharmonic spectrum in a liquid, we selected the first two of them.

Fig. 1. Diagram of the device for observing components of the subharmonic spectrum

Fig. 2. Left: *a*—oscillograms of the time variation of the amplitude P_m of the acoustic pressure of the fundamental wave $\nu_1 = 500$ kHz, *b*—of the subharmonic $\nu_{1/2} = 250$ kHz. Right: *a*—oscillograms of the time variation of the amplitude P_m of the acoustic pressure of the fundamental wave $\nu_1 = 500$ kHz, *b*—of the subharmonic $\nu_{3/2} = 750$ kHz.

Fig. 3

Figure 3: Fig. 3

The diagram of the device on which the existence of acoustic subharmonics in a liquid medium was detected is presented in Fig. 1. The generator of electrical oscillations ω with frequency $\nu_1 = 500$ kHz excited in the bath B

standing acoustic waves between the radiator and the sound receiver. The bath was filled with turpentine. The emf developed by the sound receiver was fed to a resonant amplifier-analyzer U , and then to an indicator oscilloscope O .

In order to prevent possible subharmonics of the generator ω from reaching the radiator, a rejection filter suppressing the generator subharmonic was placed between the radiator and the generator. In addition, to improve observation of the subharmonics arising in the turpentine, a second rejection filter, suppressing the generator frequency in the receiving path, was inserted between the sound receiver and the amplifier. As the radiator, a barium titanate plate of diameter 30 mm with natural frequency $\nu_1 = 500$ kHz was used. For the sound receiver, a plate likewise made of barium titanate, of diameter 30 mm, with frequency $\nu_{1/2} = 250$ kHz, was used. The intensity of the radiator was of the order of 1 W.

Fig. 3. Variation with distance of the amplitude P_m of the acoustic pressure in turpentine for the subharmonics $\nu_{1/2} = 250$ kHz (1) and $\nu_{3/2} = 750$ kHz (2)

The oscillograms obtained are shown in Fig. 2. Comparing the number of periods of the fundamental frequency with the number of periods of the frequencies found, we are convinced that we have subharmonics.

In order to leave no doubt that the subharmonics obtained arise in the liquid (turpentine), and not in the material of the radiator, a control experiment was carried out: curves were recorded for the variation of the amplitudes of the subharmonics with distance (see Fig. 3).

From the curves for both subharmonics it is seen that, as the distance from the radiator increases, the amplitude of the acoustic pressure first increases and reaches a maximum. These curves show that the effect of generation of subharmonics is due to the acoustic wave excited in the liquid medium. Thus, when an intense acoustic wave is excited in a liquid medium, a spectrum of subharmonics arises.

In conclusion, the author expresses his deep gratitude to M. A. Savinkina for assistance in the work.

Moscow Institute of National Economy
named after G. V. Plekhanov

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1. J. Stoker, *Nonlinear Oscillations in Mechanical and Electrical Systems*, IL, 1952.

Note: Figure translations are in progress. See original paper for figures.

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