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Hydrodynamics and Acoustics of a Drop Impact: Sensitive High Frequency Measurements

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Experimental study of the sound generation by drops free-falling onto the undisturbed water surface are carried out in laboratory tank filled with degassed tap water under room temperature. Solitary drops of 0.4 cm in diameter and their regular sequences are created by special doser. Height of fall of the drops varies from 8 to 110 cm. Sizes of drops and cavities produced by the drops are measured on the photographs taken with high-resolution camera at exposer 1/4000 s. Evolution of the flow are traced with the help of high-speed video-camera CR3000x2 at frame rate up to 10000 f/s. Disturbance of the free surface are recorded with an optical (laser) system whose temporal resolution is 0.001 ms. Sound signals produced by the falling drops are recorded both in the air and in the water. Sound in the air is registered by accurate microphone. Underwater acoustic signals are measured by special probe hydrophone with frequency band 2÷200000 Hz and sensitivity 30 mV/Pa. Outputs from optical and acoustical probes are supplied to the special interface where they sampled at frequency 1 MHz and transmitted to the PC.
Specialized software provides measurements of absolute values of acoustic pressure and their spectral and temporal characteristics. In both media (the air and water) a stable sequence of two acoustic signals is traced. The first one (initial sound packet) is characterized by sharp pressure pulse adjoined with high-frequency (40÷140 kHz) oscillations and the second (main sound packet) whose frequency varies within 4÷30 kHz. Time delays needed for the sound to propagate in the air and water are measured, and their values are equal to those calculated from geometry of the experiment provided that sound source is placed at the free surface. Also, ratio of microphon/hydrophon signals is much greater of transient attenuation at the air/water boundary. This can be explained if the sound source is localized at the water surface.
Under certain velocity of the impact the stable sequence of two sound packets is supplemented with third signal whose frequency is higher the one in the second packet. Analysis of video records shows that the third packet appears during return motion of the cavity and timed to the moment when velocity of the motion is jumping.