Book of Abstracts

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On the sound of snapping shrimp: 
the collapse of a cavitation bubble

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Abstract - The snapping shrimp, Alpheus heterochaelis, (figure to the right; actual size) produces a snapping sound by an extremely rapid closure of its large snapper claw. It generates sound so loud that it disturbs submarine communication. Hydrophone measurements in a large artificial seawater pond indicate intensities of up to 180 dB re 1 µPa at a distance of 1 m. It was commonly believed that the sound is generated when the two claw surfaces hit each other. In this work we show that the sound originates, in fact, from the collapse of a cavitation bubble. When rapidly closing its snapper claw (figure to the left; angular speed exceeding 3000 rad/s !), a high-velocity water jet (25 m/s) is emitted from the claw which exceeds cavitation conditions. Hydrophone measurements, in conjunction with time-controlled ultra high-speed imaging of the claw closure, demonstrate that the sound is emitted at the cavitation bubble collapse, i.e. at the time where the bubble size is at minimum. The ultra high-speed images were recorded with digital monochrome video cameras at a frame rate of up to 40500 frames per second (fps).

Below a sound pressure recording of the snap is displayed. The dots indicate when a high-speed image is captured. The first dot to the left corresponds to the time when the claw is fully closed. To the bottom, five high-speed side-view images of the tip of the snapper claw are shown. From the time correlation with the sound pressure signal one can see that none of the sound is associated with the mechanical clw contact, while a very prominent signal is observed during the collapse of the cavitation bubble.