Researchers map the physics of Tibetan singing bowls

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Researchers have been investigating the connection between fifth century Himalayan instruments used in religious ceremonies and modern physics.

In a study published today, 1 July 2011, in IOP Publishing's journal *Nonlinearity*, researchers have captured high speed images of the dynamics of fluid-filled Tibetan bowls and quantified how droplets are propelled from the water's surface as the bowls are excited.

The first of five videos demonstrating the intriguing dynamics can be seen below:

A Tibetan bowl, generally made from a bronze alloy containing copper, tin, zinc, iron, silver, gold and nickel, is a type of standing bell played by striking or rubbing its rim with a wooden or leather-wrapped mallet. This excitation causes the sides and rim of the bowl to vibrate, producing a rich sound.

The unique singing properties of Tibetan bowls were utilised as a way of investigating a liquid's interaction with solid materials – a situation that arises in many engineering applications such as the wind-loading of bridges and buildings.

When a fluid-filled Tibetan bowl is rubbed, the slight changes in the bowl's shape disturb the surface at the water's edge, generating waves. Moreover, when these changes are sufficiently large, the waves break,

leading to the ejection of droplets.

The new findings could benefit processes such as fuel injectors and perfume sprays where droplet generation plays an important role.

The high-speed videos allowed the researchers, from Université de Liège and the Massachusetts Institute of Technology, to quantify how the droplets were formed, ejected, accelerated, and bounced on the surface of the fluid.

A similar phenomenon exists when rubbing the edge of a wine glass, which inspired the design of the glass harmonica by Benjamin Franklin. However, the Tibetan singing bowl is easier to excite than the wine glass, since its resonant frequency is much smaller.

In order to generate the waves and resultant droplets, a loudspeaker was set up adjacent to the bowls, which emitted sound at specific frequencies. Once the sound hit the resonant frequency of the bowl—a sound wave vibrating in phase with the natural vibration of the bowl—the waves would be generated.

A high speed camera was used to capture images of the droplets, from which measurements could be taken.

Senior author Professor John Bush said, "Although our system represents an example of fluid-solid interactions, it was motivated more by curiosity than engineering applications.

"We are satisfied with the results of our investigation, which we feel has elucidated the basic physics of the system. Nevertheless, one might find further surprises by changing the bowl or fluid properties."

More information: The published version of the paper "Tibetan

singing bowls" 2011 *Nonlinearity* 24 R51-66 will be freely available online from 1 July 2011. It will be available at iopscience.org/non/24/8/R01

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