Liquid jets and bouncing balls combine for surprising results

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A new study published in the American Institute of Physics' (AIP) journal *Physics of Fluids* reveals that the normal rebounding of a ball changes when it is partially filled with a liquid. Unlike an empty sphere or a solid rubber ball, which both rebound in a classical and well-understood fashion, a fluid-filled ball has its second bounce remarkably cut short.

A team of researchers from Brigham Young University in Provo, Utah, uncovered this phenomenon when they investigated what would happen if a sphere were partially filled with a liquid and how that would affect the way it bounces. To their surprise, they discovered that on the first bounce the sphere behaved rather predictably, but on the second bounce it produced more of a thud than a bounce.

The reason for the stalled second bounce is that a large portion of the energy of the ball-liquid system is transferred from a falling mass into a liquid jet, dampening the rebound force. This form of passive dampening was produced when two separate masses (sphere and liquid) that once behaved as one were suddenly separated, or decoupled.

As revealed in high-speed images, this decoupling didn't occur until the second bounce because the surface of the liquid first had to be perturbed by the initial bounce. The researchers hope to apply these insights to engineer better methods of mitigating violent motions, ranging from improved sport helmet designs to removing some of the force associated with waves slamming into boats.

Further research will also help answer additional questions about the scale of the phenomenon, as well as how other types of fluids (such as non-Newtonian fluids) might react under the same circumstances.

More information: "Rebound and jet formation of a fluid-filled sphere" is published in *Physics of Fluids*: pof.aip.org/resource/1/phfle6/v24/i12/p122106_s1

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