

Transcript of the movie “Bouncing of a Jet off a Newtonian Liquid Surface”

2007 Gallery of Fluid Motion, <http://pof.aip.org/pof/gallery>

A Newtonian liquid jet can bounce off the surface of a moving bath. On top of a rotating table, we mount an acrylic tank holding a bath of silicone oil several hundred times more viscous than water. A stream of liquid falls to the surface of the rotating bath and is imaged from the side. The surface of the bath is a dark, horizontal line. The bath is moving to the left and the jet is entraining a thin, cylindrical film of air. The jet will spontaneously bounce when the flow rate is decreased rapidly. Playback is slowed eight times.

Let’s watch that again, and I’ll describe what is happening. Surface tension pulls the cylindrical film of air into bubbles. As the flow rate decreases, the jet prefers to bounce above the surface rather than plunge below it. It is important that the thin layer of air separates the jet and the bath. Any small irregularity in the jet will disturb the bounce, but the bounce is stable. The jet and the bath do not mix while bouncing.

The jet can even bounce twice. The stream is perturbed by a plastic cable tie and the disturbance starts the jet bouncing. If the stream is perturbed again, it can bounce a second time. As the bath velocity is decreased, the jet obtains less and less horizontal momentum from the bath. At very slow bath speeds, the rebound is vertical. The bouncing is sometimes unsteady.

This experiment can easily be done at home by pouring mineral oil into a pan of the same oil. The bouncing jet is stable for a large range of viscosities, velocities, and flow rates.