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Oblique impact of water-skipping elastic spheres JESSE BELDEN, Naval Undersea Warfare Center, TADD TRUSCOTT, RANDY HURD, Brigham Young University, MICHAEL JANDRON, Naval Undersea Warfare Center, ALLAN BOWER, Brown University — Highly compliant elastic spheres possess remarkable water skipping capabilities. High-speed video reveals that, upon impact with the water, the balls create a cavity and deform significantly. The flattened spheres resemble skipping stones and this augmented geometry results in enhanced lift that causes the ball to launch back into the air. This deformation also excites elastic vibration modes within the sphere. A numerical model reveals that the vibrations are initiated by a stress concentration developed in the early moments of impact. In one mode, an elastic wave propagates around the sphere periphery and may impact the water surface, resulting in an energy loss from the sphere. Thus two timescales govern the success of skipping: the total collision time of impact must be less than the deformation time associated with material vibration. Using a simplified analytical model, we derive the expected scaling of each time in terms of a dimensionless ratio of material shear modulus to fluid inertia forces, $G/\rho U^2$. Experiments over a range of parameters validate this scaling and result in a regime diagram that distinguishes different types of skipping. We identify critical relations for the material properties and impact conditions to achieve skipping.

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