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Increased Water Surface Skipping through Extreme Elasticity

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Many of us are familiar with the pastime of stone skipping. Parameters such as stone shape, incident angle with water surface, and angular velocity are critical parameters for gyroscopic stabilization and successful skips. Once the ideal, smooth, disk-like stone is located it is important to cast the stone with appropriate angle to the water surface, the correct amount of tilt and sufficient angular velocity to provide gyroscopic stabilization. If done correctly, the stone will skip several times across the surface of the water. In contrast, the Water Bouncing Ball (Waboba) can be skipped significantly more times with little effort to the details of throwing mechanics. This is primarily due to the extreme elasticity of the material from which the Waboba is made. We present the skipping dynamics of highly deformable elastic spheres. Impact angle, velocity, diameter and shear modulus are experimentally varied and the resulting impact phenomenon investigated using high-speed photography and image processing techniques. The data show that sphere impact initiates a material wave within the projectile sphere, dependent on the impact conditions. The relative time scales associated with these material waves and the contact time of the sphere with the water predict the efficiency of the skipping event. We present a theoretical model for the impact event with associated scaling laws. Additionally, we present how impact dynamics change with each successive skip, digressing from high-energy material modes to lower energy modes.