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Jumping on water

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Water striders can jump on water as high as they can jump on land. Quick jumps allow them to avoid sudden dangers such as predators attacks, and therefore understanding how they make such a dramatic motion for survival can shed light on the ultimate level of semi-aquatic motility achievable through evolution. However, the mechanism of their vertical jumping from a water surface has eluded hydrodynamic explanations so far. By observing movements of water strider legs and theoretically analyzing their dynamic interactions with deforming liquid-air interface, we have recently found that different species of jumping striders always tune their leg rotation speed with a force just below that required to break the water surface to reach the maximum take-off velocity (J.-S. Koh et al. Jumping on water: Surface tension-dominated jumping of water striders and robotic insects, Science, vol. 349, pp. 517-521, 2015). Here, we start with discussing the fundamental theories of dynamics of floating and sinking of small objects. The theories then enable us to analyze forces acting on a water strider while it presses down the water surface to fully exploit the capillary force. We further introduce a 68-milligram at-scale robotic insect capable of jumping on water without splash, strikingly similar to the real strider, by utilizing the water surface just as a trampoline.