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Insect flight on fluid interfaces: a chaotic interfacial oscillator HARIPRIYA MUKUNDARAJAN, MANU PRAKASH, Stanford University — Flight is critical to the dominance of insect species on our planet, with about 98 percent of insect species having wings. How complex flight control systems developed in insects is unknown, and arboreal or aquatic origins have been hypothesized. We examine the biomechanics of aquatic origins of flight. We recently reported discovery of a novel mode of "2D flight" in Galerucella beetles, which skim along an air-water interface using flapping wing flight. This unique flight mode is characterized by a balance between capillary forces from the interface and biomechanical forces exerted by the flapping wings. Complex interactions on the fluid interface form capillary wave trains behind the insect, and produce vertical oscillations at the surface due to non-linear forces arising from deformation of the fluid meniscus. We present both experimental observations of 2D flight kinematics and a dynamic model explaining the observed phenomena. Careful examination of this interaction predicts the chaotic nature of interfacial flight and takeoff from the interface into airborne flight. The role of wingbeat frequency, stroke plane angle and body angle in determining transition between interfacial and fully airborne flight is highlighted, shedding light on the aquatic theory of flight evolution.

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