

Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Mechanics and Hydrodynamics of Acrobatics and Aquabatics by Whales and Dolphins¹ FRANK FISH, West Chester Univ — Cetaceans (whales, dolphins) are extremely energetic, fast swimming, and highly maneuverable in both water and air. Behaviors that cross the interface include breaching, porpoising, tail stands, and spin-leaps. The mechanics of breaching and porpoising entails propulsive movements of the caudal flukes to accelerate the animal vertically through the water surface to become airborne. Porpoising is beneficial to reduce the energetic cost of swimming at high speeds. Tail stands have a vertically oriented dolphin with half or more of its body out of the water. Bubble DPIV was used to quantify the propulsive force matching the weight of the animal supported above the water surface. The propulsive movements produced a jet flow and associated vorticity directed downward. Spin-leaps require a rapid vertical ascend from underwater by a rolling dolphin. Out of the water, the spin rate increases due to conservation of angular momentum and an imbalance between driving and resistive torques. The spin rate is associated with the moment of inertia of the animal's morphology. The physics of these high-energy maneuvers have engineering application for understanding ballistic performance across the air/water interface.

¹Funded from ONR-MURI grant N0001141410533

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Date submitted: 23 Jul 2017

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