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Vortical structures in the wake of an undulating fin PETER A. DEWEY, Princeton University, ANTOINE CARRIOU, Ecole Superieure de Physique et de Chimie Industrielles, ALEXANDER J. SMITS, Princeton University
— Batoid fish such as the manta ray propel themselves through the water by producing a traveling wave motion along the chord of their pectoral fin. Such a motion produces thrust through the development of an unsteady vortex street that results in a jet-like average flow. Digital particle image velocimetry (DPIV) is used to characterize the vortical patterns and structures developed in the wake of a manta ray-like fin. A DC servo motor powers a gear train to produce the traveling wave motion; whose frequency and wave length can be varied. The amplitude of the traveling wave motion linearly increases along the span of the fin. Wake morphologies for a wide spectrum of oscillation frequencies and traveling wave wavelengths are identified. A bifurcation from a 2S wake structure to a 2P wake structure is observed as the traveling wave wavelength is decreased, which corresponds to a decrease in efficiency as reported by Clark and Smits (2006). Alteration of the oscillation frequency, and thus Strouhal number, affects vortex interaction and is found to significantly modify the resulting velocity profiles in the wake of the fin. Notably, increasing the Strouhal number beyond optimal conditions, reported by Clark and Smits, corresponds to a reduction in the extent that the jet-like average flow is observed downstream of the fin.

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