Abstract Submitted
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On the hydrodynamics of ray-like swimming[1] RICHARD G. BOTTOM II, IMAN BORAZJANI, University at Buffalo, ERIN BLEVINS, GEORGE V. LAUDER, Harvard University — There are substantial differences in body shape and motion of stingrays relative to other fish, which drastically affect the hydrodynamics of locomotion. Discovering the flow physics of ray-like locomotion is invaluable not only from a biological standpoint but also for practical application in the development of novel, bio-inspired, man-made vehicles. Here we first develop an analytical model for the stingray's body and fin motion based on experimental laser scan of body shape in the freshwater stingray Potamotrygon orbignyi, and on experimental 3D kinematic data of the wing and body surface obtained from freely-swimming stingrays. The accurate model for the stingray motion is constructed by Fourier analysis of the experimental data resulting in a traveling wave equation with an amplitude coefficient, which is spatially dependent across the fin. Based on this model, we carry out large eddy simulations of the stingray using the immersed boundary method, i.e., the motion of the stingray body is prescribed based on the model, and the motion of the center of mass is calculated. We validate our simulations against experimental data. The simulations reveal the 3D structure of the wake and quantify the swimming performance under different conditions.

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