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High-Fidelity Simulations and Low-Order Modeling of Agile Flight

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Abstract:
The development of flight vehicles that match the remarkable agility of flying creatures requires flight control strategies that work robustly in the regime of separated flows. This regime, generally avoided by human-engineered vehicles, is often exploited by airborne creatures in order to achieve rapid maneuvers or tolerance to gusts. But recent human strategies based on flapping wings or managed separation are limited to slow maneuvers because they rely on linearized and/or quasi-steady models of aerodynamics with limited bandwidth. I will report on our recent progress in developing unsteady non-linear (vortex-based) models of separated flows. The premise is to construct a low-degree-of--freedom template model, with the simplest description of the flow that still contains the non-linear vortex-vortex and vortex-wing interactions. The model is then closed with empirical data from sensors. I will demonstrate progress on several canonical problems in two dimensions, and discuss our extensions to fully three-dimensional flows. I will also discuss the development of a numerical library for conducting high-fidelity simulations of flows with dynamical coupling with systems of rigid bodies.

Bio:
Jeff Eldredge is an Associate Professor in the Mechanical & Aerospace Engineering Department at UCLA. His research interests are in computational and theoretical studies of problems in fluid dynamics, including those in unsteady aerodynamics, bio-inspired locomotion, micro-particle manipulation, and biomedical and physiological flows. He has received the NSF CAREER Award and is an Associate Fellow of AIAA. Prior to starting at UCLA, Prof. Eldredge was a research associate at the University of Cambridge. He received his Ph.D. at Caltech and his B.S. at Cornell, both in mechanical engineering.