Abstract Submitted
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Lift-optimal aspect ratio of a revolving wing at low Reynolds number[1] THIERRY JARDIN, Institut Supérieur de l'Aéronautique et de l'Espace (ISAE-Supaero), Université de Toulouse, 31055 Toulouse Cedex 4, France, TIM COLONIUS, Division of Engineering and Applied Science, California Institute of Technology, Pasadena, CA 91125, USA — Lentink & Dickinson (2009) showed that rotational acceleration stabilized the leading-edge vortex on revolving, low-aspect-ratio wings, and hypothesized that a Rossby number of around 3, which is achieved during each half-stroke for a variety of hovering insects, seeds, and birds, represents a convergent high-lift solution across a range of scales in nature. Subsequent work has verified that, in particular, the Coriolis acceleration is responsible for LEV stabilization. Implicit in these results is that there exists an optimal aspect ratio for wings revolving about their root, because it is otherwise unclear why, apart from possible physiological reasons, the convergent solution would not occur for an even lower Rossby number. We perform direct numerical simulations of the flow past revolving wings where we vary the aspect ratio and Rossby numbers independently by displacing the wing root from the axis of rotation. We show that the optimal lift coefficient represents a compromise between competing trends where the coefficient of lift increases monotonically with aspect ratio, holding Rossby number constant, but decreases monotonically with Rossby number, when holding aspect ratio constant. For wings revolving about their root, this favors wings of aspect ratio between 3 and 4.

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Tim Colonius
Division of Engineering and Applied Science, California Institute of Technology, Pasadena, CA 91125, USA

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