COLLEGE OF ENGINEERING
MECHANICAL ENGINEERING
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ME Department Seminar

Flutter instabilities with application to energy harvesting

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Abstract

We discuss recent computational, experimental, and theoretical modeling of fluttering cantilevers (flags) parallel to internal and external flows. Fully-coupled flow-structure interaction is computed for two-dimensional flows, and the computational framework is also used to perform global stability analyses. These analyses, performed for both conventional and inverted plates (clamped leading and trailing edges, respectively), provide insights into the onset and regimes of flapping, and, for the conventional flag, the effects of confinement, and geometry of the flow path. For internal flows, a quasi-one-dimensional analytical model is developed which replicates the directly computed flutter boundary, and which therefore allows a wider parameter space to be considered. The model is also generalized to three-dimensional flows and can predict the flutter boundary and modes of oscillation observed in companion experiments. Finally, the results are applied to a novel flow energy harvesting device based on attaching a cantilever beam to a flextensional piezoelectric actuator.

Bio

Tim Colonius is the Frank and Ora Lee Marble Professor of Mechanical Engineering at the California Institute of Technology. He received his B.S. from the University of Michigan in 1987 and M.S and Ph.D. in Mechanical Engineering from Stanford University in 1988 and 1994, respectively. He and his research team use numerical simulations to study a range of problems in fluid dynamics, including aeroacoustics, flow control, instabilities, shock waves, and bubble dynamics. Prof. Colonius also investigates medical applications of ultrasound, and is a member of the Medical Engineering faculty at Caltech. He is a Fellow of the American Physical Society and the Acoustical Society of America, and Editor-in-Chief of the journal Theoretical and Computational Fluid Dynamics. He won the 2018 AIAA Aeroacoustics Award.