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Surpassing the energy method for nonlinear fluid stability DAVID GOLUSKIN, University of Victoria, FEDERICO FUENTES, University of Texas at Austin — A basic question in fluid stability is whether a laminar flow is nonlinearly stable to all perturbations. The typical way to verify stability, called the energy method, is to show that the energy of a perturbation must decay monotonically. The energy method is known to be overly conservative in many systems, particularly when turbulence arises subcritically, such as in parallel shear flows. The energy method is a special case of a Lyapunov function method in which the Lyapunov function is the perturbation energy. This talk will present a more general approach in which the Lyapunov functions (1) are not restricted to being quadratic but instead are higher-degree polynomials, and (2) can depend explicitly on the spectrum of the velocity field in the eigenbasis of the energy stability operator. The optimal construction of such Lyapunov functions is complicated but can be done with computer assistance by formulating a polynomial optimization problem, which in turn is formulated as a semidefinite program. This talk will describe the general framework of the method. A companion talk by Federico Fuentes will illustrate its application to planar Couette flow, where we have verified nonlinear stability at larger Reynolds numbers than is possible using the energy method.

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