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Forced response of self-excited thermoacoustic oscillations: lock-in, bifurcations, chaos and open-loop control KARTHIK KASHINATH, Lawrence Berkeley National Laboratory, MATTHEW JUNIPER, University of Cambridge — This study aims to identify synchronization phenomena in thermoacoustics and to explore the possibility of open-loop control of self-excited thermoacoustic oscillations using weak periodic perturbations. We examine the response of a self-excited system of a premixed flame in a duct to harmonic forcing. When the system oscillating periodically is forced, we find that: (i) at low forcing amplitudes, the system responds at the natural and forced frequencies and linear combinations of these; (ii) above a critical forcing amplitude, the system locks into the external forcing; (iii) the bifurcations leading up to lock-in and the critical forcing amplitude required depend on the proximity of the forcing frequency to the natural frequency. When the system oscillating quasi-periodically is forced, we find that (i) if the forcing frequency is the same as one of the two characteristic frequencies of the torus attractor, then lock-in occurs at a critical amplitude via a saddle-node bifurcation; (ii) if the forcing frequency is not equal to either of the two characteristic frequencies of the torus attractor, then the torus breaks down and more elaborate behavior is noticed. When the system oscillating chaotically is forced close to the most dominant frequency in its spectrum, we find that it is possible to establish a stable periodic oscillation. Finally, we find that in some cases low-amplitude forcing can achieve lock-in and the amplitude of oscillations in the system are decreased by up to 70% of the unforced amplitude.

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