Poster

Multiple Dynamical Transitions in Turbulent Annular Combustor

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Transition to thermoacoustic instability is a plaguing problem in gas turbine and rocket engines. Thermoacoustic instability is the high amplitude acoustic oscillations which is the result of nonlinear interactions between the acoustic field, hydrodynamics and unsteady heat release rate fluctuations in the combustion chamber [1,2]. The combustion chamber in gas turbine engines has multiple burners arranged

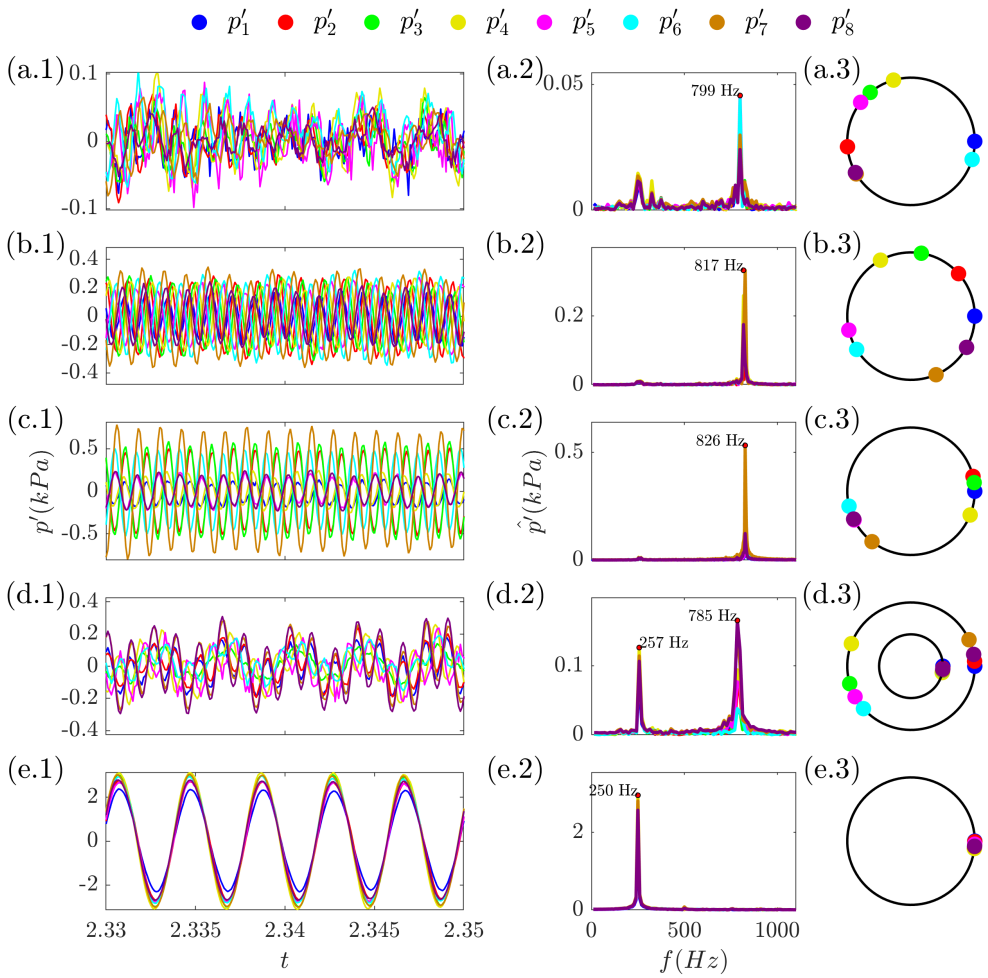

Figure 10: Representation of time series (1), amplitude spectrum (2), and relative phase difference (3) of pressure fluctuations recorded at eight locations around the combustor. Upon varying the control parameter, the system exhibits an incoherent state (a), splay state (b), two cluster state (c), amplitude-modulated two cluster state (d), and the in-phase state (e).

circumferentially, resembling a ring of coupled oscillators [3]. The interaction between multiple flames and the acoustic field in the combustion chamber results in

transition to different collective dynamical states. To study the transitions to the dynamical states in gas turbine engines, we use a lab-scale turbulent annular combustor, where we use the global equivalence ratio as the control parameter and record the acoustic pressure fluctuations to study the dynamics of the combustor. When we vary the equivalence ratio of the combustor, we observe various collective dynamical behaviours such as a splay state, two-cluster state, amplitude-modulated two-cluster state and an in-phase state similar to the dynamics of a ring of coupled oscillators. The system undergoes a primary transition from an incoherent state to a splay state, then a secondary transition from the splay state to a two-cluster state and subsequently a tertiary transition from the two-cluster state to an in-phase state through an amplitude-modulated two-cluster state.

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References

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