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Mode switching of combustion instabilities associated with flame transfer function non-linearities

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Studies of combustion instabilities indicate that the frequency of oscillation changes during the growth of oscillations before a limit cycle is reached. It is also found that a system can switch from one mode to another when the amplitude exceeds a certain threshold. It is shown that these features can be linked to the flame response non-linearity. The analysis is carried out by examining combustion instabilities appearing on a multipoint injection burner, placed a the end of a cylindrical manifold. This element acts like a resonator and its length can be modified easily. Experiments indicate that mode switching takes place between two resonant modes of the cavity and this is shown to be caused by the non-linearity of the flame response. The phenomenon can be analyzed by considering the non-linear evolution of the flame transfer function. It is possible to combine this information with a stability analysis of the burner, and define conditions which give rise to mode switching. It is found that this behavior is related to a change in phase difference between heat release rate fluctuations and velocity perturbations at the burner outlet. This phase shift takes place as the amplitude of oscillation increases.