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Dynamical behavior of lean swirling premixed flame generated by change in gravitational orientation HIROSHI GOTODA, TAKAYA MIYANO, Ritsumeikan University, IAN SHEPHERD, Lawrence Berkeley National Laboratory
— The dynamic behavior of flame front instability in lean swirling premixed flame generated by the effect of gravitational orientation has been experimentally investigated in this work. When the gravitational direction is changed relative to the flame front, i.e., in inverted gravity, an unstably fluctuating flame (unstable flame) is formed in a limited domain of equivalence ratio and swirl number (Gotoda. H et al., Physical Review E, vol. 81, 026211, 2010). The time history of flame front fluctuations show that in the buoyancy-dominated region, chaotic irregular fluctuation with low frequencies is superimposed on the dominant periodic oscillation of the unstable flame. This periodic oscillation is produced by unstable large-scale vortex motion in combustion products generated by a change in the buoyancy/swirl interaction due to the inversion of gravitational orientation. As a result, the dynamic behavior of the unstable flame becomes low-dimensional deterministic chaos. Its dynamics maintains low-dimensional deterministic chaos even in the momentum-dominated region, in which vortex breakdown in the combustion products clearly occurs. These results were clearly demonstrated by the use of nonlinear time series analysis based on chaos theory, which has not been widely applied to the investigation of combustion phenomena.

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