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Microgravity Experiments from Sub-Orbital to Orbital Platforms (3)

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PERWAVES: TOWARDS A SPACEFLIGHT EXPERIMENT TO REALIZE DISCRETE COMBUSTION WAVES

Abstract

Study of the propagation of reactive waves in suspensions of fuel particulates in an oxidizing atmosphere has long been a motivation for microgravity combustion research, due to the necessity of microgravity both to create the suspensions without settling and to eliminate buoyancy-induced disruption of the flame. Recent theoretical and experimental investigations, however, have suggested that a novel mode of propagation, namely, discrete combustion waves, can be realized in microgravity at the limit of rapid heat release from point-like energy sources. In this mode, the propagation of the wave is limited by particle-to-particle diffusion rather than the global energy release rate, giving rise to statistical, percolation-like waves ("PerWaves"). This model of reactive wave propagation has been conjectured to occur in a variety of settings, from biological to astrophysical, yet a simple experimental realization of a system that can be directly visualized has yet to be demonstrated. The system studied here is a fuel that reacts predominately in the condensed phase (iron) in a gaseous oxidizer with low thermal diffusivity (oxygen/xenon mixture). This paper will review progress on the study of discrete combustion waves, including recent parabolic flight data and development of hardware and diagnostics in preparation for a sounding rocket flight that should permit the first unambiguous realization of the discrete mode of reactive wave propagation.