SPACE PROPULSION SYMPOSIUM (C4)
Hypersonic and Combined Cycle Propulsion (5)

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EVALUATING HEAT RELEASE EFFECTS IN A SUPRSONIC REACTING MIXING LAYER WITH DENSITY FLUCTUATION MULTIRESOLUTION ANALYSIS

Abstract

Due to the difficulties in measuring supersonic density field, the multiresolution analysis of supersonic mixing layer based on experimental images is still a formidable challenge. By utilizing the recently developed nanoparticle based planar laser scattering method, the density fields of reacting and nonreacting supersonic mixing layer were measured at high spatiotemporal resolution. According to the dynamic behavior of coherent structures, the multiresolution characteristics of density fluctuation signals and density field images in the reacting and nonreacting supersonic mixing layers were studied based on Taylor's hypothesis of space-time conversion and wavelet analysis. The wavelet coefficients reflect the characteristics of density fluctuation signals at different scales, and the detailed coefficients reflect the differences of approximation at adjacent levels. The density fluctuation signals of supersonic mixing layer differ from the periodic sine signal and exhibit similarity to the fractal Koch signal. The similarity at different scales reveals the fractal characteristic of mixing layer flowfield. The two-dimensional wavelet decomposition and reconstruction of density field images extract the approximate and detailed signals at different scales, which effectively resolve the characteristic structures of the flowfield at different scales. Comparing the results in the reacting and nonreacting supersonic mixing layers, the effects of heat release were evaluated.