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Understanding Combustion in the Blue Whirl using Optical Diagnostics SRIRAM BHARATH HARIHARAN, University of Maryland; Texas A&M University, YEJUN WANG, Texas A&M University, PAUL M. ANDERSON, US Army Research Laboratory, WARUNA D. KULATILAKA, Texas A&M University, MICHAEL J. GOLLNER, University of Maryland, ELAINE S. ORAN, Texas A&M University — The blue whirl is a soot-free flame that evolves from a traditional fire whirl in a regime close to the extinction limit for fire whirls. Previous work considered the physical and thermal structure of the flame and scaling approaches to predict transition to the blue whirl. To better understand the exact nature of combustion in the blue whirl, the present work uses chemiluminescence and planar laser-induced fluorescence (PLIF) techniques to visualize the reaction zone and distribution of radicals in the flame. Chemiluminescence images of excited-state OH* and CH* were obtained at 1 kHz and converted into a radial map using Abel inversion and the OH*/CH* intensity ratio was computed for the region around the bright blue vortex rim. A relationship between this ratio and the local equivalence ratio ($\Phi \in [0.7,1.3]$) was obtained by extrapolating from adiabatic methane-air flames stabilized over a Hencken calibration burner. In addition, PLIF images show that ground-state OH exists in high concentrations in the region of the bright blue ring and diminishes gradually into the post-flame region. Negligible presence of OH was observed in the blue conical region below the ring.

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