SEMINAR

Advances in Raman Spectroscopy for Combustion Applications
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ABSTRACT
Combustion is the leading energy conversion process for electricity production, transportation and propulsion. A sustainable combustion-driven economy requires engines and gas turbines that are more efficient while emitting fewer pollutants. Development of supersonic combustion ramjet engines (scramjet) is a promising route to achieve prompt global strike capabilities and to lower the cost of access to space. The design of these new engines requires predictive combustion models that correctly describe the coupling between turbulence and chemistry. Extensive experimental datasets, needed to develop and validate such models, are scarce because measurements in the harsh combustion environment are challenging. Therefore, the development of advanced laser diagnostics for combustion and the application of these diagnostics to the study of flames specifically designed for model development and validation are critical for advancements in combustion.

Coherent anti-Stokes Raman spectroscopy (CARS) and Spontaneous Raman scattering (SRS) are powerful diagnostic tools in combustion research because they provide temperature and major species measurements in flames. The development at NASA Langley Research Center of a dual-pump CARS instrument to measure temperature, N2, O2 and H2 absolute mole fractions in a series of supersonic combustion experiments is described. Strategies to improve the precision and accuracy of mole fraction measurements, extend dynamic range, and mitigate the loss of signal caused by beam steering are outlined, and highlights from measurements in supersonic combustion experiments at NASA Langley Research Center and at University of Virginia supersonic combustion facility are presented.

At Sandia National Laboratories 1D Raman/Rayleigh/CO-LIF (temperature and major species concentrations) and cross-planar OH-PLIF (flame orientation and curvature) are applied to study hydrocarbon-air flames. Two recent advancements that greatly extend the range of applicability of Raman diagnostics at Sandia are presented. The first is the implementation of polarization separation Raman scattering as a single-shot technique to mitigate the effect of high levels of fluorescence interference from polycyclic aromatic hydrocarbons, C2, and soot precursors. The second is the development of dual-resolution Raman spectroscopy to enable simultaneous measurement of multiple hydrocarbons, including major combustion intermediates, such as occur in flames of dimethyl ether.

BIO
Dr. Magnotti is a postdoctoral researcher at Sandia National Laboratories, in the Turbulent Combustion Laboratory, where he develops and applies advanced laser diagnostics to investigate turbulence-chemistry interactions in jet flames. He obtained his doctoral degree in mechanical and aerospace engineering from the George Washington University. During his graduate studies he conducted research at NASA Langley Research Center, in the Hypersonic Airbreathing Propulsion Branch, developing advanced laser diagnostics for probing supersonic combustion flows.