

RQ15-11

**1. Research Title:** *Supersonic Combustion Ramjet Research*

**2. Individual Sponsor:**

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**3. Academic Area/Field and Education Level:** Engineering Physics, Applied Physics, Mechanical Engineering, Aerospace Engineering (MS and/or Ph.D. level)

**4. Objectives:** To *i*) investigate critical aspects of the supersonic combustion ramjet (scramjet) engine, including fuel injection and mixing, combustion initiation and flame holding/propagation and *ii*) develop the diagnostic tools that support this investigation.

**5. Description:** Currently an inadequate science basis limits the development of the scramjet engine. This will continue to be a limiting factor as engineers try to design complex flowpaths such as turbine-based combine cycle engines. The need for better understanding of fundamental problems—such as fuel injection and mixing and flame holding and propagation—therefore shapes this thesis research program. The DAGSI masters or PhD student and faculty member will utilize the Aerospace Systems Directorate's (AFRL/RQ) wind-tunnel and diagnostic assets (described below) to study these critical phenomena. Topics could include the following:

- a. Study of fundamental aspects of fuel injection for supercritical and two-phase fluids. Work to date has included measurement of droplet sizes and mass distribution using X-ray techniques (at Argonne National Laboratories).
- b. Study of fundamentals of ignition and flameholding in a supersonic flow. Work to date has included the application of laser-induced fluorescence of the OH radical, to mark the flamefront location, within a cavity flame holder, and particle image velocimetry (PIV).
- c. Study of kHz-rate imaging diagnostics to support studies of ignition and flame propagation in high-speed flows. Work to date has included development of kHz-rate planar laser-induced fluorescence (PLIF) at rates up to 50 kHz.

Facilities at WPAFB include a variety of wind-tunnels (including direct-connect scramjet tunnels) and a variety of optical and laser components (including Q-switched Nd:YAG lasers, dye lasers, spectrometers, and specialized digital cameras). Optical measurement techniques such as PLIF, Raman and Rayleigh scattering, and PIV are routinely performed.

**6. Research Classification/Restrictions:** U.S. Citizens only.

**7. Interest in Summer USAFA Cadet:** No

**8. Eligible Research Institutions:**  Universities (DAGSI)       AFIT  USAFA