



Date: Wed., March 5<sup>th</sup>

Time: 12:30 PM

Location: Room 231, Engineering

*Refreshments*

## AERTC Distinguished Lecture Series



**Capturing Diesel and Biodiesel Spray Breakup  
with Single-Shot Ultrafast X-ray Phase Contrast Imaging**

***Dr. Jin Wang***

Advanced Photon Source, Argonne National Laboratory,  
Argonne, IL 60439, USA

Fuel sprays are essential energy sources for propulsion and transportation systems including internal combustion engines, where the fuel breakup and atomization are the first and crucial step for combustion. Despite their longstanding multitude of use, the fundamental physics that governs the spray formation in high-speed fuel jets is not well understood. Most importantly, the U.S. is likely to utilize alternative fuels, such as biodiesel from non-petroleum and renewable sources after traditional fuels (gasoline, diesel) are exhausted and before hydrogen can be utilized. The different precombustion properties of alternative fuels require systematic studies to design next-generation engines. However, the physical breakup mechanism of high-pressure high-speed liquid fuel jets has remained largely unknown due to the dearth of experimental methods for effectively probing the in-nozzle flow and the liquid jets near the nozzle exit, and due to the lack of realistic multiphase hydrodynamic models. With high-brilliance x-ray beams available at the third-generation synchrotron sources such as the Advanced Photon Source (APS), ultrafast x-radiography and phase-contrast imaging were developed as a host of unique techniques to visualize the internal structure of high-pressure fuel sprays through dense droplets surrounding the liquid jet. Here, high-pressure diesel and biodiesel sprays have been visualized, for the first time, with an unprecedented temporal ( $< 150$  ps) and spatial resolution ( $< 5$   $\mu\text{m}$ ), in the optically opaque near-nozzle region. We detected the details such surface waves associated with the fuel jets and clearly observed the entire breakup process, which have not possible with conventional visible-light-based visualization techniques. For the first time, it has been demonstrated that the morphology and dynamics of the diesel and biodiesel sprays are extremely sensitive to the fuel physical properties. These results represent a major breakthrough in fuel spray research. Which will lead to a better understanding fuel combustion, and result in an optimized design of injection and combustion systems with lower emissions.

---

This work has been performed in collaboration with K. Im, K. Fezzaa, Y. Wang, Z. Liu and W. K. Lee of the APS, X. Xie, M.-c. Lai of Wayne State University.

This work and the use of the Advanced Photon Source are supported by the U. S. Department of Energy, Office of Science, Office of Basic Energy Sciences, under Contract No. DE-AC02-06CH11357

---