Tackling Turbulent Atomization with First-Principle Computations

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Lower Level Auditorium, Geddes Hall

Refreshments served at 3:00 p.m. in the Geddes Hall Coffee House

To meet volume and weight restrictions, air transportation relies on the combustion of high energy-density liquid fuels. The efficiency of the conversion and the emission of harmful pollutants depend directly on the mixing of the fuel and oxidizer, which itself results from a cascade of mechanisms initiated by the atomization of a coherent liquid stream. The effects of nozzle design, surface tension, turbulence, and cavitation on atomizer performance are still poorly understood. The challenges met by experimental investigations, caused by the multi-scale and multi-physics nature of such flows, have motivated the development of numerical strategies to simulate the atomization process from first principles. In the presence of complex topologies, the underlying equations are stiff, causing the development of numerical methods to remain an area of active research. The first part of this work therefore focuses on a new generation of Volume-of-Fluid solvers, which rely on unstructured geometric transport schemes, an optimal interface reconstruction technique, and a tight integration with the discrete solution of the two-phase Navier-Stokes equations. The level of predictivity reached by the proposed framework, paired with the continuous development of High-Performance Computing technologies, enables the investigation of increasingly more complex two-phase flows. These capabilities are illustrated in the simulation of a realistic injector, whose performance is then compared with a fully developed turbulent pressure atomizer. Mesh resolution effects and computational efficiency are finally assessed, and an outlook for the future of atomization computations is proposed.

If you are interested in meeting individually with Dr. Le Chenadec, please contact Linda at 631-5431.