



MECHANICAL ENGINEERING PhD SEMINAR

Thursday, December 4 2025 , D. Dan and Betty Kahn Building, Room 217

10:00 (Jerusalem time), 16:00 (GTIIT, China), Zoom link:

<https://gtiit.zoom.us/j/94193727156?pwd=Kigs7nKpnrSsnMDei2szfEYMZdaRW8.1>

Experimental and numerical investigation of primary breakup dynamics in Close-Coupled Gas Atomization (CCGA)

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The generation of a spray of small droplets by gas-assisted atomization of a liquid jet is widely used in many applications such as combustion, agriculture, medical therapies, and powder fabrication, among others. The initial stage of liquid jet breakup in which relatively large drops and ligaments are formed is called "primary breakup". This stage is not well understood especially in close-coupled gas atomization (CCGA) used to atomize complex fluids such as liquid metals. Primary breakup of a liquid water jet in CCGA was studied experimentally using digital inline holography (DIH) and numerically with the Volume-of-Fluid (VOF) method. In the experiments, different nozzles with a constant liquid protrusion length and characterized by three different apex angles, $\theta = 14^\circ, 24^\circ$ and 34° were used. Measurements were conducted at four Weber numbers, $We_g = 13.2, 40.2, 57.5$, and 82.5 and VOF simulations at $We_g = 40.2, 82.5$ and 360 for a single apex angle. At each We_g , a range of momentum flux ratios, M , were studied. A detailed analysis of the instantaneous liquid jet interfaces and droplet size distributions was performed. Distributions of droplet diameters spanned a broad size range up to 3 mm and were well described by least-squares fitted power laws, including an exponential cut-off. For the contiguous liquid jet interface, fractal dimensions increased with downstream distance. A spectral analysis of the liquid interfaces revealed in many cases distinct frequency bands coherent in the axial direction, associated with the radial movement of the jet interfaces. Based on analysis of (i) reconstructed snapshots, (ii) JPdFs of instantaneous jet positions, and (iii) spectral analysis, four different "flow" regimes were proposed, namely "no-filming", "filming", periodic "flapping" and intermittent "switching". High-fidelity, fully 3D VOF simulations were performed and validated against the experimental data. Advanced data processing using Proper Orthogonal Decomposition combined with Dynamic Mode Decomposition analysis, indicated distinct characteristic modes governing primary breakup, enabling reduced-order analysis of sprays.

Note: the seminar will be given in English