PHYSICAL MATH SEMINAR

From Pressure Impulse to Water Hammer: A Strouhal Number Framework for Impact-Driven Liquids



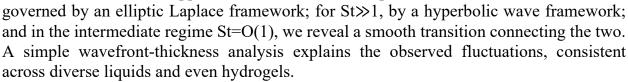
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ABSTRACT:

When a liquid is abruptly accelerated, its pressure field has traditionally been analyzed in two distinct limits: the incompressible pressure impulse theory, based on Laplace's equation for potential flow, and the compressible water-hammer theory, derived from the wave equation and the method of characteristics. Yet, the intermediate regime connecting these limits has remained unclear.

In this talk, I will present recent experiments on liquid columns under short-time acceleration, demonstrating that the Strouhal number, St=ct/L, measuring the ratio of acoustic to acceleration time scales, unifies these classical approaches. For St<1, the pressure field is



Finally, I will show how this perspective extends beyond fundamental dynamics: to cavitation onset in accelerating liquids [Pan et al., PNAS 114, 8470–8474 (2017)], granular jets, and biomedical microjets, including liposome generation by laser-induced jets [Jiajue et al., Lab on a Chip 25, 2644–2653 (2025)] and tissue interaction in needle-free injection [Miyazaki et al., Sci. Rep. 11, 14544 (2021)]. These examples highlight how a unified Strouhal framework connects elliptic and hyperbolic mathematics with real-world applications.

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TUESDAY, SEPTEMBER 23, 2025 2:30 PM – 3:30 PM Building 2, Room 449

