Experiments in Multiphase Flows: Bubbles, Cavitation and X-Rays

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Date: Friday, April 29, 2016
Time: 9:00 – 10:00 AM
Location: 358 Willard Blg.

Coffee and donuts will be provided

Abstract:

Multiphase flows are encountered in almost every aspect of modern life; including energy production, biological flows, chemical industry, aerospace sciences and naval hydrodynamics. Measurement of the dispersed phase’s void fraction distribution is often of critical importance, as we seek to better understand the flow dynamics and develop physics-based models to predict the flows. However, measurement of even the local time-dependent volume fraction is quite a challenge, especially in flows where an intrusive probe is likely to significantly perturb the flow. And, often it would be preferable to measure the full two- or three-dimensional spatial distribution of the time-dependent phase fractions without disturbing the flow, and with no a-priori knowledge of the topology. This can be accomplished by radiation based techniques, such as two-dimensional x-ray densitometry and computed tomography.

The basic principles and some of the technical challenges of x-ray techniques for multiphase flows will be discussed, and results from experiments carried out in the University of Michigan’s 210 mm cavitation tunnel will be presented. First, we review results from an experiment designed to validate the x-ray measurements via comparison to measurement data yielded by optical probes. Second, we review select results from an experiment intended to improve the physical understanding of a canonical cavitating flow, quantify the effect of non-condensable gas injected into the cavity, and to provide validation quality data for accompanying CFD Verification & Validation efforts. During this experiment x-ray densitometry enabled the identification of an unexpected flow regime where a condensation shock is dominant, as opposed to a re-entrant jet as
often assumed. Third, we conclude with an introduction to recent work to develop an improved time-resolved computed tomography system, and with a brief discussion of the future prospects of x-ray techniques for multiphase flow research.

**Bio:**

Dr. Mäkiharju is an Assistant Professor and Director of the FLOW Laboratory in the Mechanical Engineering Department at UC Berkeley. His undergraduate studies were in Energy Technology at the Lappeenranta University of Technology, Finland. In 2005 he received his Mechanical Engineering M.Sc. from the Ohio State University and his Ph.D. in 2012 from the University of Michigan. His graduate research focused on the reduction of hydrodynamic drag by gas injection and the development of a time-resolved x-ray densitometry imaging system for the study of multiphase flows. He continued at the University of Michigan as a Post-Doctoral Research Fellow (2012-2014) and as an Assistant Research Scientist (2014-2015) investigating single- and multiphase flow mixing in channel flows while continuing the development of x-ray based 2D and 3D flow measurement techniques. Starting as an Assistant Professor at UC Berkeley in January of 2016, he is continuing to pursue his research interest in advancing the physical understanding of high-Reynolds number single- and multiphase flows through experimental research, primarily through the development and use of advanced experimental techniques.