Coherence 2024



COHERENCE 2024 MAX1 11th International Conference on Phase Retrieval and Coherent Scattering

Contribution ID: 50

Type: Oral

High-Speed XPCS Studies of Critical Fluctuations in Liquids

Wednesday, 19 June 2024 09:55 (20 minutes)

High-speed XPCS using new coherent X-ray sources and fast detectors opens new avenues to explore fluctuation dynamics in fluids. We have been studying systems relevant to liquid-liquid extraction processes, where an organic solution of extractant molecules is used to separate ions from an aqueous solution by formation of nanoscale molecular complexes. The organic phase exhibits incipient phase separation, and critical fluctuations play a key role in the structure of the molecular complexes [1-5]. Here we present XPCS studies of microsecond timescale fluctuations within 5 K of the critical temperature Tc, carried out at APS beamline 8ID. With the 500 times higher coherent X-ray flux that will become available from the APS Upgrade, it should be possible to observe fluctuation dynamics much further away from Tc. This will enable exploration of the crossover from Ising to mean-field behavior, as well as the changes in dynamics expected at the Widom line (the locus of fluctuation maxima extending from the critical point into the single-phase region).

Work supported by U.S. Department of Energy (DOE), Office of Science, Office of Basic Energy Sciences, Chemical Sciences, Geosciences, and Biosciences Division, Separation Science Program, under Contract DE-AC02-06CH11357. This research used resources of beamlines 12-ID-C and 8-ID-I at the Advanced Photon Source, a DOE Office of Science User Facility operated by Argonne National Laboratory.

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Session Classification: XPCS and Polarised beams