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High-Speed XPCS Studies of Critical Fluctuations in Liquids

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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 T_c , 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 T_c . 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).

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Primary author: STEPHENSON, Gregory Brian (Argonne National Laboratory)

Co-authors: SHEYFER, Dina (Argonne National Laboratory); RAHMAN, Tasnim (Argonne National Laboratory); LAL, Jyotsana (Argonne National Laboratory/Northern Illinois University); ZHANG, Qingteng (Argonne National Laboratory); SERVIS, Michael (Argonne National Laboratory)

Presenter: STEPHENSON, Gregory Brian (Argonne National Laboratory)

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