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News Release

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Argonne awards Arthur Compton Award for X-ray science discoveries

ARGONNE, Ill. (May 13, 2009) — The U.S. Department of Energy's Advanced Photon Source (APS) at Argonne National Laboratory and the APS Users Organization announced the 2009 Arthur H. Compton Award was awarded jointly to Simon Mochrie, Mark Sutton, and Gerhard Grübel for their pioneering efforts in X-ray photon correlation spectroscopy (XPCS). This technique exploits the coherent properties of synchrotron X-rays to study the slow dynamics of condensed matter at short length scales.

"XPCS seemed like a heroic experiment only a decade ago," said APS Director Murray Gibson, "but it is now used routinely to do great science at APS and other sources. We are grateful for the pioneering vision of our winners in making this research possible."

The XPCS technique has evolved into a sophisticated tool for studying slow dynamics in inhomogeneous systems at length scales too small for other techniques. The wide range of systems studied includes block copolymers, micellar systems, colloidal suspensions, liquid surfaces, molten polymer films, membranes and binary alloys. The award winners have played a significant role in driving the evolution and application of this technique.

X-ray photon correlation spectroscopy makes use of the way coherent light scatters from irregular structures. The coherent portion at the center of a synchrotron undulator beam is selected with a pinhole aperture. When this coherent beam hits the sample, the scattered light bunches into spots, called speckles.

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As the structure of the sample changes, the intensity of light at each speckle changes. By monitoring how the intensity fluctuates across the whole pattern of speckles—like watching flames pass through a bed of embers—it is possible to learn how the structure of the sample changes with time.

Mochrie is currently Professor of Physics and Professor of Applied Physics at Yale University, New Haven, Connecticut; Sutton is Professor of Physics at McGill University in Montreal, Canada.

Grübel brought the technique to Europe, leading the development of the ID10 (Troika) beamline at the European Synchrotron Radiation Facility (ESRF) in Grenoble, France, and pioneered many innovative applications of XPCS. He is now a senior scientist at HASYLAB at the Deutsches Elektronen-Synchrotron (DESY) in Hamburg, Germany, where he is involved in the development of coherence based techniques for free-electron laser sources.

In addition to developing the "how" of XPCS, all three winners have used it to significantly advance the "what" of their own disciplines. The following are examples selected by the winners as illustrating the impact of XPCS in their work.

Mochrie studies the properties, phase behavior and phase transitions of soft matter. His work to characterize a sponge phase of a block copolymer marked a step forward in terms of both technique and science. The quality of the data showed that XPCS is useful for studying polymer dynamics; furthermore, as one of the first studies to use a fast X-ray area detector, this work has prompted further development of those detectors.

Sutton's group studies the time evolution of non-equilibrium systems. He and colleagues have since demonstrated a controllable way to combine a reference signal (heterodyning) with coherent small angle X-ray scattering.

Grübel and his group work primarily on the bulk and surface dynamic properties of complex fluids and more recently on glassy and magnetic systems. His work on colloidal silica suspensions illustrated the strength of XPCS in combination with small-angle scattering for the quantitative characterization of colloidal fluids.

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