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Correlated scattering: probing atomic structure of molecules and nanoparticles

D. Mendez[1], T. Lane[2], J. Sung[1], D. Ratner[3], H. Watkins[1], S. Doniach[1]

[1]Stanford University, Applied Physics, Stanford, USA, [2]Stanford University, Chemistry, Stanford, USA, [3]Stanford Linear Accelerator Center (SLAC), LCLS, Menlo Park, USA

In 1977, Z. Kam theorized that correlations of scattering patterns, measured by exposing a solution of randomly oriented identical particles to x-ray radiation, could yield detailed information on the internal structure of the individual particles [1]. During a single exposure (whose duration should be short compared to the particle rotational diffusion time), physical correlations arise whenever multiple photons scatter from the same particle into different directions. By averaging correlations from many exposures, we have demonstrated that one can extract this correlated signal from a background of uncorrelated single-direction scattering events from different particles [2]. This additional information can be used to place constraints on model structures of the particles under investigation, providing a method of structure refinement to atomic resolution. We recently observed correlated scattering from solutions of ~10^9 silver nanoparticles exposed to synchrotron radiation at a microfocus beamline at SSRL [2]. By auto- and cross-correlating the Bragg rings 111 and 200, five correlation peaks were resolved corresponding to the structure and symmetry of silver's reciprocal lattice. To transition from nanoparticles to biomolecule studies, we have performed several experiments at x-ray free electron laser centers (SLAC and SPring-8), and are working to refine analysis techniques.

[1] *Kam, Zvi 1977 Macromolecules 10, 927-934.,* ***[2]*** *D. Mendez, T.J. Lane, J. Sung, et al., Phil Trans Roy Soc B. to be published, "Observation of correlated x-ray scattering at atomic resolution")*

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