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Scientists learn how to 'out run damage' with imaging technique

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Over the decades X-ray crystallography has been fundamental in the development of many scientific fields. The method has revealed the structure and function of many biological molecules, including vitamins, drugs, proteins and nucleic acids such as DNA. However, in order to obtain good data, large single crystals are required. These are often nearly impossible to grow. There also is the problem that X-rays damage delicate biological samples.

"From the beginning, the resolution of images recorded by biologists has been limited by damage due to the radiation used," said physicist John C. H. Spence, a Regents' Professor in physics at Arizona State University. "But what happens if a pulse of imaging radiation is used that terminates before damage begins, yet contains sufficient photons to generate a useful scattering pattern?"

Indeed, results of such a method are being reported by Spence at the American Association for the Advancement of Science annual meeting in Vancouver, Canada. Spence presented his findings today (Feb. 17) during a special session on "Imaging and Controlling Molecular Dynamics with Ultrashort Laser Pulses."

Many in the scientific community didn't believe such a method could work. Yet, said Spence "The experiments of Henry Chapman's (University of California, Davis) group using lithographed structures and soft (i.e. long wavelength) X-rays had shown that if we could 'out-run the damage,' this might indeed be a useful path to damage-free imaging at atomic resolution. In my lab we were thinking about the data analysis, and building the hydrated protein-beam injector device, a bit like an ink-jet printer, to spray the molecules across an X-ray laser. This snap-shot method should eventually allow us to make movies of molecular machines at work."

Spence joined forces with Chapman and many collaborators to recently demonstrate serial snapshot femtosecond (10-15 of a second) diffraction (SFX) from nanocrystals using the world's first hard X-ray laser. The photosystem I (PSI) nanocrystals came from Professor Petra Fromme's lab in ASU's Department of Chemistry and Biochemistry.

"These are early days for femtosecond diffractive imaging," noted Spence, who provided the theory and much of the data analysis. "But first indications are that high-resolution data can now be obtained at the nanoscale by this method. If we can indeed 'outrun' the many radiation-damage processes in this way, it will open the way to future experiments on laser-excited samples, 3-D image reconstruction and a host of other experiments on fast imaging, all directed to the grand challenge of obtaining movies showing molecules at work."

Provided by Arizona State University

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