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High-coherence Electron Bunches Produced by Femtosecond Photoionization

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With the development of ultrafast electron and x-ray sources it is becoming possible to study structural dynamics with atomic-level spatial and temporal resolution (i.e. 0.1 nm and 0.1 ps). Because of their short mean free path, electrons are particularly well suited for investigating surface and thin films, such as the challenging and important class of membrane proteins. However, current electron sources have insufficient intensity or coherence to perform single-shot experiments on protein crystals.

We developed an *ultracold* electron source, based on near-threshold photoionization of laser- cooled atoms, for producing electron pulses of high intensity *and* high coherence. We show that high-coherence electron pulses can be produced by *femtosecond* photoionization, opening up a new regime of single-shot ultrafast structural dynamics experiments. The transverse coherence turns out to be much better than expected on the basis of the large bandwidth of the femtosecond ionization laser. This result can be explained by analysis of classical electron trajectories. Furthermore, results of recent diffraction experiments will be presented.