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Femtosecond electron diffraction on organic crystals

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Abstract content
   (Max 300 words)
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Femtosecond electron diffraction is an exciting field in experimental laser physics which allows to direcly look at structural changes of matter on an atomic scale. More specifically, we look at changes in structural atomic assembly of crystals as they undergo a metal-to-insulator transition under photo-excitation. Real time movies of atoms moving in crystals are acquired within a picoseconds (10ˆ-12s) timescales.

Ultrashort timescales and molecular resolutions are achieved by using an 150fs (10ˆ-15s) short pulsed laser beam. We divide our beam into a 'pump' and 'probe' path. The pump directly irradiates the crystal under investigation, initiating the metal-to-insulator transition. The 'probe' takes snapshots of the atomic structure at a time resolution that is determined by the duration of the probe pulse.

A suitable candidate for such a probe is an 30keV kinetic energy electron beam, which can resolve diffraction patterns of the crystal, revealing its structural composition. Short electron pulses are accelerated towards the crystal from an -30kV thin film golden cathode after photo-excitation by the pump beam. Diffraction patterns are observed on our detection system after Coulomb interaction with the crystal. Patterns are acquired for the whole timescale of the transition by simply tuning the path length between pump and probe pulse.

Our current organic Cu(DCNQI)2 crystal demands improvements in our experimental techniques due to condensation of matter onto the sample when at its phase transition temperature (78K). Secondly, this crystal takes relatively long to relax back to its ground state after excitation, demanding us to perform the experiments on a low 'repetition rate'. To maintain feasible signal-to-noise ratios, the electron number per electron probe pulse needs to be increased drastically, destroying our temporal resolution due to Coulomb repulsion within such a pulse. Improvements to our current system are a new ultra high vacuum chamber and electron pulse recompression.

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Level for award
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MSc

Main supervisor (name and email)
and his / her institution

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No

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