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Exploring the ultrafast frontiers of condensed phase physics

Having the shortest optical[1,2,3] and soft x-ray fields[4] as a part of its repertoire, attosecond physics has recently opened up new avenues for exploring ultrafast electronic processes in atoms[5,6], molecules[7], surfaces[8] and nanostructures[9]. I will discuss how modern advancements of the "ultrafast toolbox" allow for the first time, the exploration and control of fundamental electronic phenomena in condensed media. Electron motion in bulk media, driven by intense, precisely-sculpted, optical fields give rise to controllable electric currents, the frequency of which extends to the multi-Petahertz range[9-10], advancing lightwave electronics[10] to new realms of speed and precision. Coherent extreme ultraviolet radiation emerging by these coherent charge oscillations[9] offers direct insight into structural and dynamical properties of the underlying medium which were previously inaccessible to conventional solid-state spectroscopies. By endowing essential x-ray spectroscopies of solids with attosecond temporal resolution, optical half-cycle fields, combined with extreme ultraviolet pulses, offer for the first time, access into the attosecond dephasing of electronic excitation of highly-correlated condensed phase electronic systems[11]. We anticipate these new capabilities to result in far reaching implications to fundamental and applied, electronic and photonic sciences.

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Einlader: Prof. Fennel