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Seeing atoms and electrons in motion

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Pump-probe electron diffraction and microscopy with ultrashort electron pulses allow directly observing the atoms and charges in motion on their fundamental length and time scales (picometers and femtoseconds/attoseconds). Such imaging is essential for understanding light-matter interaction from a fundamental perspective. My current research group has developed an all-optical control approach for compressing electron pulses to extremely short duration (Science 352, 429, 2016). With such pulses, we succeeded in measuring sub-light-cycle electromagnetic phenomena in photonic device structures (Science 353, 374, 2016). The next step in this endeavor is to establish our electron pulse control ideas into a commercial electron microscope, in order to combine our world-leading experience with ultrashort time resolution with the unprecedented spatial resolution capabilities of a state-of-the-art microscopy device.

This study involves design, simulation, realization and first characterizations of a transmission electron microscope in which the beam is modulated by a coherent laser beam. With this contribution, we will establish a novel type of electron microscopy facility that will for the first time be suitable for sub-cycle imaging of light-matter interaction in space and time.

Primary author: Mr IBRAHIM, Mohamed (Ludwig-Maximilians-Universität)

Presenter: Mr IBRAHIM, Mohamed (Ludwig-Maximilians-Universität)

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