Imaging transient states of matter and non-equilibrium dynamics with nanometer spatial and (sub-?) femtosecond temporal resolution

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Free-electron lasers are a new class of light sources that deliver extremely intense, coherent short-wavelength flashes with femtosecond and potentially even attosecond pulse lengths. The unprecedented brightness of these x-ray lasers opens the door for imaging transient states of matter and non-equilibrium dynamics in nanoparticles with the single-particle – single-shot approach. I will present opportunities in AMO and nanoscale physics arising from ultrafast imaging. Single-shot imaging of individual superfluid helium nanodroplets allows the unambiguous identification of quantum vortices [1]. Ultrafast scattering of highly excited nanoplasmas carries information about their transient electronic states [2]. Two-pulse two-color operations allow the probing the structural changes of massively excited systems at the solid-to-plasma interface [3]. The combination of optical with x-ray lasers opens door for investigations of dynamically evolving systems with femtosecond time and nanometer spatial resolution [4]. In the future, when shorter pulses become available, potentially even light-induced electron density modulations can be imaged.

References

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