European XFEL Science Seminar

Tuesday, 10th January 2017, 17:00 (Tea/Coffee at 16:45)
Campus Schenefeld, main building (XHQ) room E1.173

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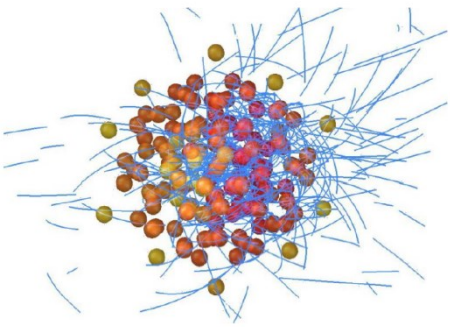
Nanoscale plasmas meet x-ray imaging

The interaction of intense laser light with condensed matter leads to the ultrafast generation of finite plasmas. Understanding the underlying processes promises a fundamental route towards realizing active control of the plasma generation and evolution via appropriately structured light fields – with implications for a broad spectrum of applications, ranging from nanomachining over medical treatment to particle acceleration. Atomic clusters provide ideal systems to explore the relevant correlated and collective electron and ion dynamics [1]. New pathways in nanoplasma science have been opened up recently with the availability of intense XUV and x-ray laser fields - two of them will be discussed in detail in this talk.



In the first part I will discuss how the combination of IR and XUV fields enables steering of ultrafast electron and ion dynamics in laser-driven nanoplasmas via seeded avalanching [2]. The resulting control capabilities mark a new frontier in ultrafast nanoscience.
The second part will be focussed on a major promise of current x-ray science at free electron lasers - the imaging of ultrafast structural dynamics with nanometre spatial and femtosecond temporal resolution (or even better) via single-shot x-ray diffraction [3]. Laser-driven atomic clusters and nanoparticles provide an ideal platform for developing and demonstrating the required technology to extract the dynamics from diffraction images. With our microscopic particle-in-cell simulations (MicPIC) the complete description of IR pump x-ray probe imaging experiments has become possible [4], offering the simulation-assisted reconstruction of experimental data. Possible routes towards reaching attosecond time resolution in the visualization of complex dynamical processes in matter by x-ray diffraction will be discussed.

References

[1] T. Fennel, K.-H. Meiwes-Broer, J. Tiggesbäumker, P.G. Reinhard, P. M. Dinh, and E. Suraud, “Laser-driven nonlinear cluster dynamics”, Rev. Mod. Phys. 82, 1793 (2010)
[2] B. Schütte, M. Arbeiter, A. Mermillod-Blondin, M.J.J. Vrakking, A. Rouzee, and T. Fennel, “Ionization avalanching in clusters ignited by extreme-ultraviolet driven seed electrons”, Phys. Rev. Lett. 116, 033001 (2016)
[3] T. Gorkhover et al., “Femtosecond and nanometre visualization of structural dynamics in superheated nanoparticles”, Nature Photon. 10, 93 (2016)
[4] C. Peltz, C. Varin, T. Brabec, T. Fennel, “Time-resolved x-ray imaging of anisotropic nanoplasma expansion”, Phys. Rev. Lett. 113, 133401 (2014)

Host: Karen Appel