

Thursday, 26 October 2023, 16:00

XHQ / E1.173

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Capturing the classical and quantum dynamics of nanoparticles by coherent diffractive imaging: Challenges for Theory

Single-shot coherent diffractive imaging (CDI) has become a powerful tool for exploring the structure and dynamics of unsupported nanoparticles. Depending on the excitation regime, very different structural or dynamical aspects are cast in the diffraction images, which can make their reconstruction to a great challenge for theory. In this talk I will discuss different modelling approaches that are applicable to specific scenarios. First, wide-angle CDI will be discussed, which allows one to extract three-dimensional structural information [1]. Examples and their modelling using a fast multislice method will be presented [1-3]. Second the ultrafast plasma dynamics following massive laser-driven ionization of SiO₂ nanospheres will be addressed, which can be traced via time-resolved coherent-diffractive imaging [4]. Third, the possibility to explore non-linear quantum dynamics will be discussed using superfluid helium droplets as model systems [5].

- [1] I. Barke, H. Hartmann, D. Rupp, L. Flückiger, M. Sauppe, M. Adolph, S. Schorb, C. Bostedt, R. Treusch, C. Peltz, S. Bartling, T. Fennel, K.-H. Meiwes-Broer and T. Möller, *The 3D-architecture of individual free silver nanoparticles captured by X-ray scattering*, Nat. Commn 6, 6187 (2015)
- [2] A. Colombo, S. Dold, P. Kolb, N. Bernhardt, P. Behrens, J. Correa, S. Düsterer, B. Erk, L. Hecht, A. Heilrath, R. Irsig, N. Iwe, J. Jordan, B. Kruse, B. Langbehn, B. Manschwetus, F. Martinez, K.-H. Meiwes-Broer, K. Oldenburg, C. Passow, C. Peltz, M. Sauppe, F. Seel, R. M. P. Tanyag, R. Treusch, A. Ulmer, S. Walz, T. Fennel, I. Barke, T. Möller, B. von Issendorff und D. Rupp, *Three-dimensional femtosecond snapshots of isolated faceted nanostructures*, Sci. Adv. 9, eade5839 (2023)
- [3] P. Tümmler, in preparation.
- [4] C. Peltz, J. A. Powell, P. Rupp, A. Summers, T. Gorkhover, M. Gallei, I. Halfpap, E. Antonsson, B. Langer, C. Trallero-Herrero, C. Graf, D. Ray, Q. Liu, T. Osipov, M. Bucher, K. Ferguson, S. Möller, S. Zherebtsov, D. Rolles, E. Rühl, G. Coslovich, R. N. Coffee, C. Bostedt, A. Rudenko, M. F. Kling and T. Fennel, *Few-femtosecond resolved imaging of laser-driven nanoplasma expansion*, New J. Phys. 24, 043024 (2022)
- [5] B. Kruse, B. Liewehr, C. Peltz and T. Fennel, *Quantum coherent diffractive imaging*, J. Phys. Photonics 2, 024007 (2020)

Host: Nils Brouwer

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