# Ultrafast dynamics in clusters followed with Coherent Diffraction Imaging

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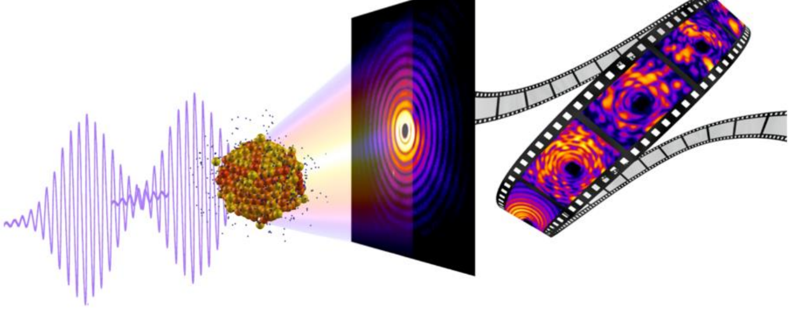
With coherent diffraction imaging (CDI), "snap-shot" images of single nanoscale structures can be recorded. In single-particle CDI, the intense pulses from short-wavelength free-electron lasers (FELs) or high harmonic generation (HHG) sources scatter off a free-flying nanoparticle and form an interference pattern on a large-area detector. With computer-based iterative phase-retrieval or forward-fitting methods, its structure can be retrieved from the pattern. Single-particle CDI has enabled the in-situ imaging of such fragile specimens as single viruses, aerosols, or peculiar structures formed in the extremely cold environment of doped superfluid helium nanodroplets. For cluster science, CDI has opened up a number of new opportunities.

In the field of laser-cluster interaction studies, the possibility to image a single cluster in a single laser pulse and to measure at the same time the residuals from the interaction, i.e. ions, electrons or fluorescence light, has enabled a new class of quantitative experiments. The usual averaging over cluster sizes and laser intensities in experiments on ensembles can be avoided. In post-processing, the single shot data can even be sorted for cluster size and X-ray intensity by the information gained from the CDI pattern.

Further, light-induced structural dynamics such as ultrafast melting and boiling of metal clusters, can be studied in a time-resolved manner using pump-probe schemes: The cluster is brought to an excited state by pre-irradiation with an optical laser before imaging with an X-ray pulse.

But not only structural changes can be observed with CDI. Also electronic processes which occur during irradiation with a sufficiently intense laser pulse, such as ionization and the formation and evolution of a nanoplasma, change the diffraction response. However, these processes happen so fast that they are not resolved with the typical pulses at FELs, having pulse durations of several tens or hundreds of femtoseconds. In this context, the current leap of FELs and HHG sources towards intense attosecond pulses is an extremely promising prospect for our research.

In this seminar I will discuss recent results on the light-induced dynamics in single clusters on different time scales from sub-femto- to picoseconds.



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