# Nanoparticles in strong laser fields: ionization control, dynamics and imaging

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Atomic clusters and nanoparticles in intense laser fields are a nice playground to study the non-linear coupling of electromagnetic radiation into matter. The availability of intense ultrashort laser pulses has been key to study exceptional light-matter phenomena in the strong-field regime. Exposed to strong laser fields, atomic clusters transform into a transient nanoplasma at near solid density.

The talk will focus on (a) controlling the strong-field ionization dynamics in clusters. Several means are taken to steer the electron emission, including the delay between dual fs pulses, optimized pulse shapes, and the phase control in ω/2ω and few cycle excitation. (b) Using intense XUV and Xray free electron laser fs-pulses, nanoparticles and microjets can be transformed into dense plasmas. The corresponding ultrafast kinetics is a subject of current interest [1]. With silver nanoparticles in a beam, i.e., without any interaction with an environment, single particle scattering images can be achieved. Highly symmetric and anisotropic features are observed, reflecting the regular shape of metal particles even with radii larger than ≈ 50 nm [2]. A variety of cluster morphologies can be identified, including truncated octahedrons, decahedrons, twinned tetrahedrons, and dodecahedrons. Excellent agreement is obtained between simulated and measured scattering images.

## References

[1] Zastrau et al., Ultrafast electron kinetics in short pulse laser-driven dense hydrogen. *J. Phys. B* **48,** 224004 (2015).

[2] Barke et al., The 3D-architecture of individual free silver nanoparticles captured by X-ray scattering. *Nat. Commun.* **6,** 7187 (2015).