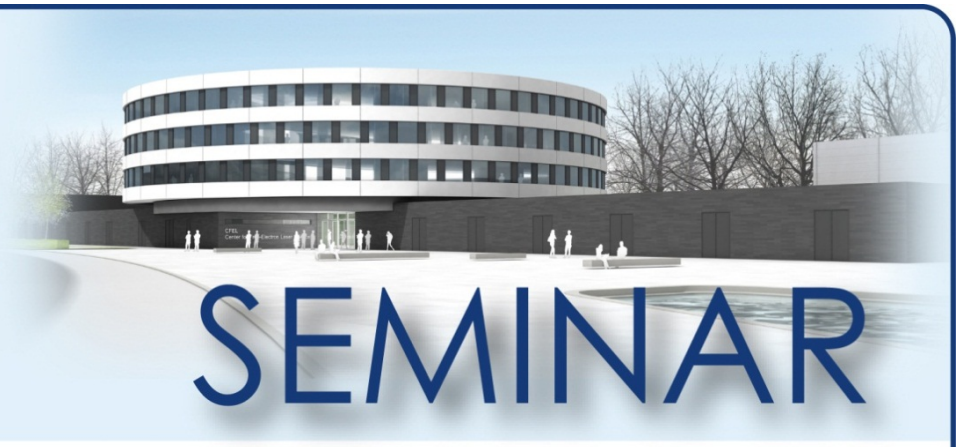
CFEL SCIENCE



SEMINAR

29th March 2023 - 2:00 p.m.

CFEL-bldg. 99, seminar room IV

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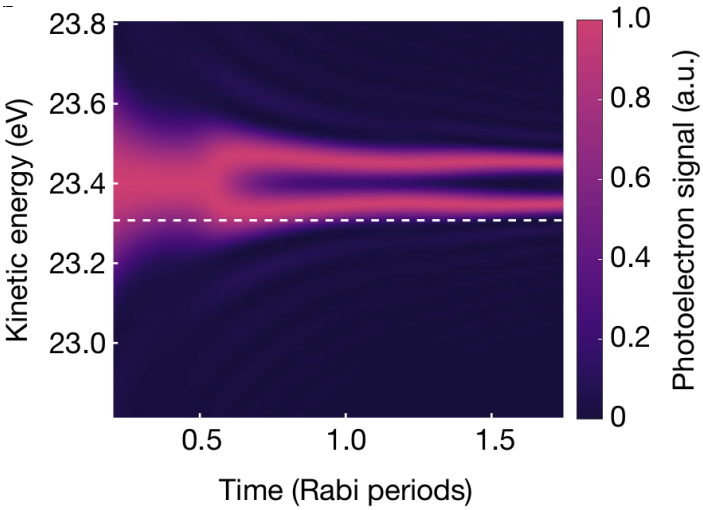
Understanding photoelectrons from XUV-driven Rabi dynamics

Two-level atoms that suddenly start to interact with a coherent field will “Rabi flop” with periodic modulations of populations over time. Recently, the development of seeded Free-Electron Lasers (FEL) with intense light (~10^{13} W/cm^2) at short wavelengths (~10 eV) have made it possible the observe ultrafast Rabi dynamics in helium atoms [1]. The measured photoelectron signal revealed an Autler–Townes doublet and an avoided crossing, phenomena that are fundamental to coherent atom–field interactions. Atoms that interact with such extreme fields require a description of electron dynamics beyond the two-level atom, due to non-linear photoionization losses and polarization effects [2]. We have performed numerical simulations, using the Time-Dependent Configuration-Interaction Singles method (TDCIS) [3], with infinite-time surface flux methods (iSURF) [4] to obtain realistic photoelectron spectra from Rabi-flopping atoms. Using an analytical model, we find that the ultrafast build-up of the doublet structure carries the signature of a quantum interference effect between resonant and non-resonant photoionization pathways, see Fig. 1. Further exploration of Rabi dynamics, in broader range of parameters, is conducted using the resolvent operator technique, with the aim to better understand atomic stabilization mechanisms of Rabi-flopping atoms [4].



Ultrafast formation of a symmetric Autler-Townes doublet from a Rabi flopping helium atom. The energetic shift is due to a quantum interference effect between resonant and non-resonant transitions [1].

[1] Nandi *et al.*, *Nature* **608**, 488 (2022).

[2] Beers & Armstrong, *Phys. Rev. A* **12**, 2447 (1975).

[3] Greenman *et al.*, *Phys. Rev. A* **82**, 023406 (2010).

[4] Morales *et al.*, *J. Phys. B* **49**, 245001 (2016).

Host: Robin Santra – CFEL-DESY Theory Division