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Attosecond resonance dynamics in XUV-pump IR-probe simulations

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Short lived resonance states play an important role in many atomic and molecular charge changing processes where they can act as crucial intermediate steps towards ionization or recombination. The recent advances in the generation of attosecond pulses open a way to study, and perhaps control, the population and decay of such states in the time domain. We have investigated these possibilities by simulating an experiment focussing the He($n = 2$) ionization threshold. An attosecond XUV pulse excites a breathing metastable wave-packet, formed by a coherent superposition of doubly excited resonance states. When probed with an intense and short IR pulse, the breathing motion is reflected in asynchronous quantum beats in the yields of excited He^+ ($2s$) and He^+ ($2p$) ions, as functions of the time delay between the two pulses [1]. XUV excitation to doubly excited states followed by ionization by the IR probe-pulse interfere with direct XUV ionization, resulting in prominent interference fringes in the photoelectron angular distribution. Encoded is not only the accumulated phase difference, but also the path to ionization through absorption of several IR photons. Such fringes has also been demonstrated experimentally in a pump probe experiment targeting the He($n = 1$) threshold [2], were the authors suggest a interferometric technique aiming for amplitude and phase characterization of the packet created by an attosecond pulse.

[1] Luca Argenti and Eva Lindroth, Phys. Rev. Lett. **105**, 053002 (2010)
[2] J. Mauritsson *et al.*, Phys. Rev. Lett. **105**, 053001 (2010)