Phase and momentum-resolved imaging of an attosecond electron wavepacket

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Imaging and controlling an electron wavefunction is one of the major aims of attosecond science and quantum mechanics. A photoelectron (momentum) spectroscopy with an attosecond high-harmonics is a possible approach to realize a direct imaging of an electron wavefunction. However, in general, the photoelectron momentum distribution is a coherent or incoherent sum of the momentum-spaced wavefunctions with different angular momentums, making the analysis become complicated. Recently, we have developed a new method to disentangle the angular components from the ejected photoelectrons by using an attosecond pulse trains synchronized with an IR laser pulse [1]. We found that an almost pure f-wave with the magnetic quantum number of 0 is generated in the ionization continuum of neon by tuning a photon energy of the attosecond pulse trains and the IR laser intensity. Furthermore, adding another one-photon ionization pathway, we resolve the phase of the ejected photoelectrons. In principle, this approach allows us to measure the relationship between the phase and momentum of the photo-ionized electrons.

In the seminar, we will show the experimental details and the models that have not been fully discussed in the paper [1] and the further developments to apply this method to another atom.

[1] D. Villeneuve, P. Hockett, M. J. J. Vrakking and Hiromichi Niikura, Science 356, 1150 (2017).