Attosecond physics and the dream of an electron movie

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Advances in laser technology have made it possible to produce light-pulses with a duration as short as around hundred attoseconds. Since this is the time scale of electron dynamics it opens the exciting possibility to follow electron motion in the time domain. Interesting scenarios could be to follow it during a chemical reaction, or for a molecular break-up processes, during the charge-migration that is taking place before nuclear motion sets in. The methods to make this dream come true are still in a rapid development phase.

The dynamics, during for example a photoionization process, is encoded in the amplitude and *phase* of the released electron wave packet. A key quantity is the spectral derivative of this phase, the *group delay*. It reflects the delay or advance of the electron when it travels through the atomic potential to eventually emerge in the continuum: attosecond interferometric techniques have made such phase information obtainable.

During the last decade a number of photo-emission delay studies have been done showing for example distinct delay differences for different atomic orbitals [1-2], or for different bands in solids [3]. In the latter case these differences are giving information on the electron-transport dynamics towards the surface. More recently structures in the continuum such as Cooper minima and resonances [4-6], with rapid spectral phase variations, have been under investigation. In the talk I will discuss some of the experimental methods that have been developed, the role of theory[7], and how we can understand the time-domain measurement that has been performed for a basic processes such as photoionization.

References

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