Examples of coherence in atomic and molecular photoionization by a single photon (synchrotron radiation) and few photons (FEL)

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Coherence has been defined in a recent publication as “what makes a wave capable to produce observable interference and diffraction effects” [1]. In a radiation source it depends on the source size and angular spread of the emitted beam and therefore is directly related to the brightness of the source. The effort done in new synchrotrons and FELs to increase the brightness, up to the diffraction limit, will have as a by-product an increased coherence of the emitted radiation.

In the presentation two examples of how coherence can be exploited in atomic and molecular physics will be discussed.

**Inner shell photoionization of diatomic molecules and Young double slits experiments**

The photoionization cross section of the inner shell of diatomic molecules displays an oscillating behavior. This observation has led to the consideration that the photoemission from these highly localized core electrons can be regarded as a molecular Young’s double slit experiment. The development of experimental methods in which the energy and momentum of the ejected electron correlate with both the polarization of the incident radiation and the energy and momentum vectors of the ionic fragment has enabled detailed insights on the basic phenomena leading to the observed interference [2].

**Asymmetry parameters in two-photon photoionization at FEL**

Coherent control involves driving a quantum system via two pathways to the same final state and manipulating the phase and wavelength of the exciting source to favour this state. Seeded FELs, like Fermi are longitudinally coherent thus their beams can be used to extend towards short wavelength the coherent control experiments performed in the optical region by table-top lasers. In the proposed example [3] the coherence of the two-colour emission is demonstrated in the photoionization of the Ne 2p by measuring the asymmetry of the photoelectron angular distribution.