

Q 42 Gruppenbericht Anwendung ultrakurzer Lichtimpulse und Attosekundphysik

Zeit: Mittwoch 10:40–11:10

Raum: HIV

Gruppenbericht

Q 42.1 Mi 10:40 HIV

Attosecond entanglement of protons and electrons in condensed matter: Neutron scattering in the eV and keV energy range —
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Several experiments on liquid and solid samples containing protons show a striking shortfall in the intensity of epithermal neutrons scattered by the protons [1-3]. E.g., neutrons colliding with water for just attoseconds (as) will see a ratio of H to O of roughly 1.5 to 1, instead of 2 to 1 [1,3]. Due to the large energy and momentum transfers applied in these neutron Compton scattering (NCS) experiments, the duration of a neutron-proton scattering event is about 50-500 as. Recently [2,3] this effect has been confirmed using electron-proton Compton scattering (ECS) from a solid polymer [2,3]. Very recently, neutron scattering from water in the incident energy range about 25-150 keV was reported [4]. The correct data treatment of these results exhibits a similar intensity shortfall from H (relative to D) of ca. 20%. Theoretical considerations (scattering from open quantum systems) support the presence of attosecond quantum entanglement in the dynamics of the protons and adjacent electrons. Note also that the time window of NCS and ECS is equal to the characteristic time of 'electron motion', so that the widely used Born-Oppenheimer approximation is not applicable here.

[1] C. A. Chatzidimitriou-Dreismann et al., *PRL* **79**, 2839 (1997). [2] C. A. Chatzidimitriou-Dreismann et al. *PRL* **91**, 057403 (2003). [3] Cf.: *Physics Today*, sect. 'Physics Update', p. 9, Sept. 2003; *Scientific American*, p. 20, Oct. 2003. [4] R. Moreh et al., *PRL* **94**, 185301 (2005).