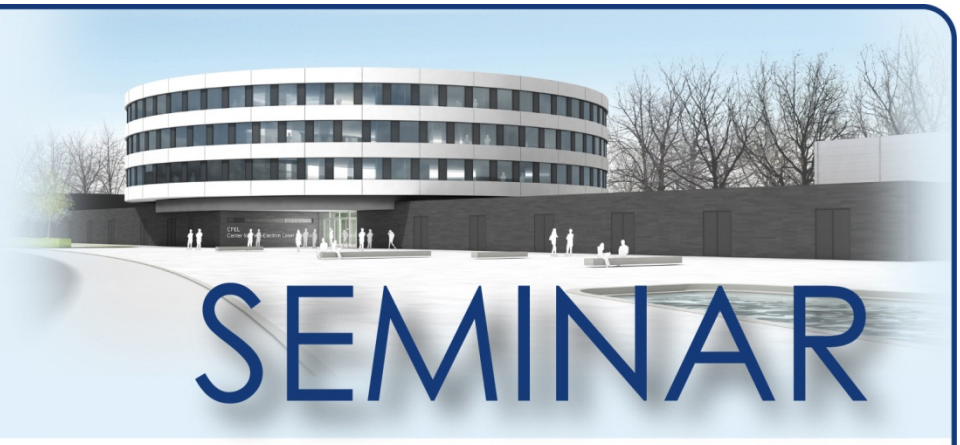
CFEL SCIENCE



SEMINAR

23rd November 2010 - 14:15

FLASH HALL (28c) - Seminar Room

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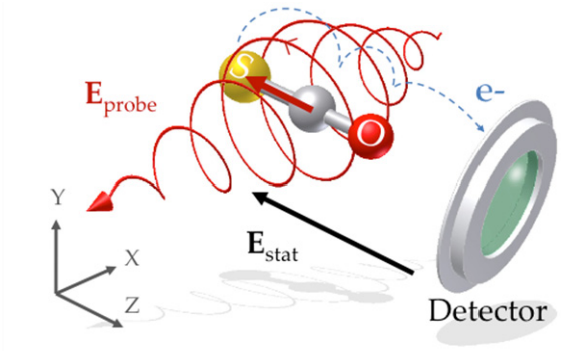
Laser induced alignment and orientation: Photoelectron Angular Distributions from Strong Field Ionization

Molecular properties and dynamics depend strongly on the direction from where they are "viewed" or probed and the spatial orientation of a molecule is of crucial importance in its interaction with other molecules, atoms or electromagnetic radiation. In normal gas-phase experiments molecules are randomly oriented and averaging over molecular orientations can lead to blurring and potential loss of information.

Here we show how molecular alignment (confinement of one or more molecular axes to the laboratory frame) is induced using the electric field from non-resonant, non-ionizing moderately intense laser pulses. In addition, orientation (directional confinement of the permanent dipole-moment of the molecule) of polar molecules is achieved by the combined action of the laser and a weak static electric field. By pre-selection of the lowest lying rotational quantum states by deflection of a cold beam of polar molecules in an inhomogeneous static electric field we have obtained unprecedented strong degrees of alignment and orientation.

The prospect of confining an ensemble of molecules to the laboratory frame opens the door to various experimental studies from the molecules point of view. As an application of strongly aligned and oriented molecules molecular frame photoelectron angular distributions (MFPADs) from strong field ionization are measured. For 1-dimensionally oriented OCS the MFPADs from tunnel ionization with intense, circularly polarized, 30 femtosecond laser pulses, exhibit pronounced anisotropies, perpendicular to the fixed permanent dipole moment, that are absent in PADs from randomly oriented molecules. For 3-dimensionally oriented benzonitrile additional striking structures appear due to suppression of electron emission in nodal planes of the fixed electronic orbitals.



Finally, emerging free-electron lasers have sparked the idea of novel approaches for studying ultrafast molecular dynamics. A key interest is to use strongly aligned and oriented molecules as targets in electron or X-ray diffraction experiments. We show the first adiabatic alignment measurement established at an X-ray Free-Electron Laser, the SLAC Linac Coherent Light Source (LCLS).

Host: J. Küpper, CFEL Coherent Imaging Division - CMI Group