Two seminars on imaging of molecules with intense laser pulses and advanced particle detection

Thursday Oct 24 in The Sky Lounge 1520-737

14:15-14:55: *Imaging molecule with coincidence spectroscopy*
Reinhard Dörner, Goethe-Universität Frankfurt am Main, Germany

14:55-15:05 Discussion

15:05-15:20: Coffee + cake

15:20-16:00: *Spatiotemporal dynamics of the nuclear wave-packets of molecules in strong laser fields*
Jian Wu, East China Normal University Shanghai, China

16:00-16:10: Discussion

Henrik Stapelfeldt

Jian Wu

Reinhard Dörner

Imaging Molecules with Coincidence Spectroscopy

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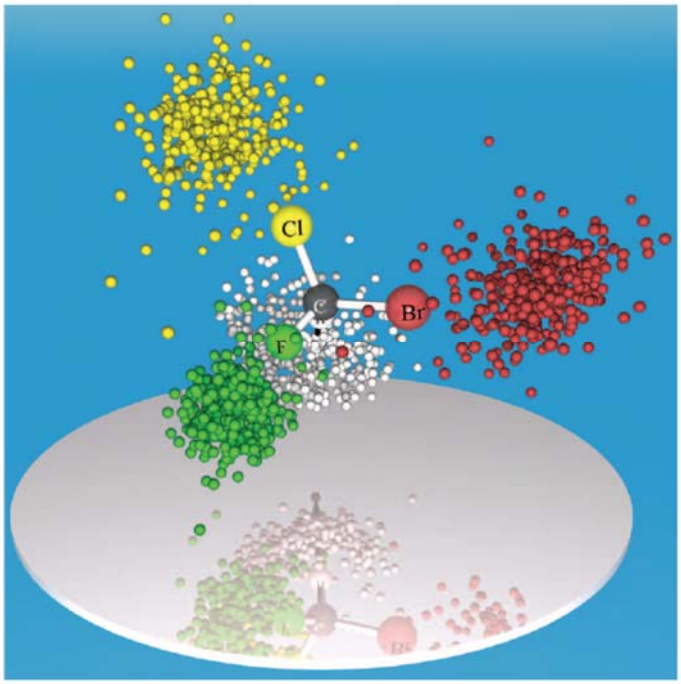
Photoabsorption is an exquisite tool to gently break small molecules into several pieces (photoelectrons, Auger electrons, ionic fragments). When the momentum vectors of all of these fragments are measured in coincidence, surprising details of the electronic and molecular wavefunction can be seen and their dynamical evolution can be imaged.



[1] S. Zeller, *Imaging the He_2 quantum halo state using a free electron laser*, P. Natl. Acad. Sci. USA, **113** 14651 (2016).
[2] M. Pitzer, et al. *Direct Determination of Absolute Molecular Stereochemistry in Gas Phase by Coulomb Explosion Imaging*, Science, **341** 1096 (2013).

Spatiotemporal dynamics of the nuclear wave-packets of molecules in strong laser fields

Jian Wu

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We visualize and control the rotational and vibrational dynamics of the nuclear wave-packets of molecules in intense femtosecond laser pulses. The Coulomb explosion technique by measuring the ejected nuclear fragments in coincidence is used to visualize the spatiotemporal dynamics of the nuclear wave-packets. We for the first time experimentally visualize the spatiotemporal dynamics of the unidirectional rotation [1] and alignment echoes of the wave-packets [2, 3]. As compared to the quantum revivals, the alignment echoes can be manipulated to probe ultrafast dynamics at a short time scale, for instance the collisional dynamics in high-pressure dense gases. We further experimentally demonstrate the echoes of the vibrational nuclear wave-packet in a single molecule [4]. Driven by orthogonal polarized two-color laser fields, we experimentally demonstrated the 3D all-optical orientation of top asymmetric molecules [5]. The demonstrated scheme paves the way for angular control over many asymmetric-top molecules by simply adjusting the intensity ratio and polarization axes between the two colors. This approach provides a new tool for 3D-molecular-imaging by means of X-ray free-electron laser beams with extremely high spatiotemporal resolution, and by ultrafast electron diffraction techniques.

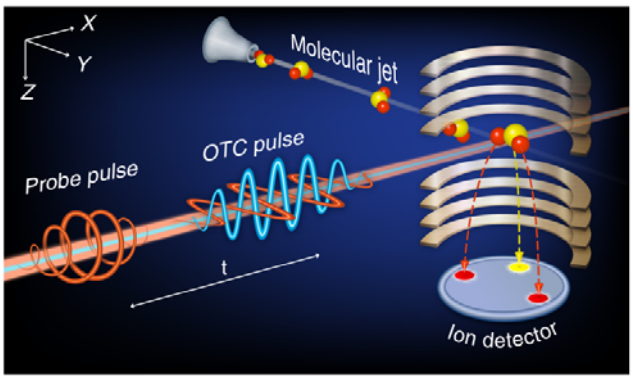

Figure 1. Schematic diagram of the experimental setup for orientating the asymmetric top molecules [5].

References

1. K. Lin et al., PRA 92, 013410 (2015).
2. K. Lin et al., Phys. Rev. X 6, 041056 (2016).
3. K. Lin et al., OE 25, 24917 (2017).
4. J. Qiang et al., Echo in a Single Molecule, arXiv:1903.08451.
5. K. Lin et al., Nat. Commun. 9, 5134 (2018).