

# Coupled Electronic and Nuclear Dynamics of Dissociative Electron Attachment Revealed by Anion Fragment Momentum Imaging

Daniel Slaughter<sup>1</sup>, Cynthia Trevisan<sup>2</sup>, Ali Belkacem<sup>1</sup>, Thomas Rescigno<sup>1</sup>  
and C William McCurdy<sup>1,3</sup>

<sup>1</sup>Chemical Sciences, Lawrence Berkeley National Laboratory, Berkeley CA 94720, USA

<sup>2</sup>Department of Sciences and Mathematics, California Maritime Academy, Vallejo, California 94590, USA

<sup>3</sup>Department of Chemistry, University of California, Davis, California 95616, USA  
[DSSlaughter@lbl.gov](mailto:DSSlaughter@lbl.gov)

Anion fragment momentum imaging experiments employing reaction microscopes [1] or velocity-slice imaging spectrometers [2-3], enable the highly differential, momentum imaging of multiple fragment ions over large collection angles up to  $4\pi$  steradians. These capabilities allow precise measurements of dissociative electron attachment (DEA) cross sections and the analysis of fragment ion kinetic energy and angular distributions for polyatomic targets. Thus, information on the dissociation dynamics with respect to the incident electron momentum relative to the stationary target (i.e. the laboratory frame) is captured by momentum imaging. *Ab initio* electron scattering calculations provide the crucial added capability to predict the angular dependence of the electron attachment probability, connecting the laboratory frame measurements to the molecular body frame. This combination of momentum imaging and electron scattering theory reveals the dynamics of the dissociating anion formed by electron attachment.

We present recent results on the dynamics of DEA to small polyatomic molecules, addressing the chemistry of transient anions formed by electron attachment. For systems where several negative ion resonances exist, there may be only one bound anion state of an atomic or molecular fragment. So how can two or more resonances produce the same anion and neutral products in the same states? Anion fragment momentum imaging reveals details about intramolecular charge transfer or conical intersections that are implicated in these phenomena. In other systems we observe that one anion resonance can produce two product channels, indicating nonadiabatic transitions between excited electronic states of the transient anion. Preliminary results for formic acid will be reported, where two resonances result in site-selective hydride loss, and key aspects of the dissociation dynamics are revealed.

## References

- [1] D S Slaughter, A Belkacem, C W McCurdy, T N Rescigno and D J Haxton, *Journal of Physics B: Atomic, Molecular and Optical Physics*, **49**, (2016), 222001.
- [2] B Wu, L Xia, H K Li, X J Zeng and T S Xi *Rev. Sci. Instrum.*, **83**, (2012), 013108.
- [3] E Krishnakumar, V S Prabhudesai and N J Mason, *Nature Physics*, **14**, (2018), 149-153.