**Ultrafast Electron-Molecule Interactions: From Fragmentation Dynamics to H3+****Formation**

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This talk explores how high-energy electrons interact with complex molecules, triggering ultrafast processes such as ionization, fragmentation, and intramolecular rearrangement [1,2]. These electron-driven reactions are central to a wide range of environments, from astrochemistry, to biological tissues exposed to ionizing radiation, to the fabrication of advanced semiconductor devices, yet many aspects remain poorly understood.

Our research led us to discover the mechanism by which organic molecules generate H3+ [3-5], the most important hydrogen donor in the universe. The combination of ultrafast laser techniques with advanced computational modeling, allowed us to capture these rapid dynamics in real time, shedding light on how energy redistributes within a molecule, when bonds form or break, and what transient structures emerge before fragmentation.

By isolating the primary molecular events before secondary processes obscure them, this work provides a clearer picture of energy flow and bond dynamics under highly non-equilibrium conditions. These insights have broad implications, from gaining a better understanding of the interaction between strong laser fields and matter, to improving materials processing, and strategies to mitigate radiation-induced damage.

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