Stony Brook University
The Graduate School

Doctoral Defense Announcement

Abstract

Ionic Dynamics in Molecular Strong Field Ionization

By

Arthur Zhao

Microscopic electron motions are responsible to many of physical, chemical and biological phenomena observed in nature, such as light absorption/emission, changes in molecular bonds and chemical composition, and bioinformation storage and transportation. Therefore, the understanding of electron dynamics in atoms and molecules can provide means of manipulating these processes which ultimately lead to technological innovations.

This thesis studies the dynamics in strong field ionization of small molecules, with a focus on the removal of electrons from multiple molecular orbitals, especially the mechanisms underlying the population of excited ionic states. To do this, we ionize molecular systems with ultrafast intense laser pulses (~10 fs, >10 TW/cm2) and measure photoelectrons and photoions in coincidence with velocity map imaging (VMI) detection. Due to the highly non-linear nature of the reaction, intense laser pulses provide adequate temporal resolutions at the time scale of typical molecular dynamics. VMI measures the momentum distribution of charged particles, and together with coincidence detection design, the full kinematics of an ionization event can be recovered. This facilitates detailed studies of ultrafast spectroscopy, and allows us to discriminate two different pathways in producing excited ionic states – either direct removal of an inner orbital electron or post-ionization excitation. For the latter, we carry out an experiment on a series of molecules to study its dependence on electronic structure, and comparing the importance of resonant transition due to nuclear dynamics and non-adiabatic transition due to field dressing.

We also describe an upgrade on the coincidence VMI design utilizing a time-resolved 2D detector, and its application in molecular double ionization.

Date: June 14th, 2017
Time: 1pm
Place: Physics s-141

Program: Physics
Dissertation Advisor: Thomas Weinacht