# Ultrafast Radiation Chemistry and the Development of Laser Based Electron Sources[†]

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The interaction between ionizing radiation and molecules (and atoms) initiates and drives all of the chemical processes in radiation chemistry. A fundamental understanding of these interactions is relevant to such diverse areas as environmental chemistry, astrochemistry, medical radiotherapy, stability of nuclear waste repositories and to a wide variety of technologically important processes such as plasma enhanced vapor deposition. The outcomes of radiation induced chemical reactions are determined by ultrafast energy transfer, thermalization, solvation, and pre-cursor (pre-thermalization) chemistry.

Due to the current lack of a suitable femtosecond source of ionizing radiation, experimental studies on these ultrafast chemical reactions are virtually nonexistent. While ultrafast laser studies provide many new insights, the results show that lasers are not capable of reproducing the chemistry which is unique to ionizing radiation. This is primarily a result of different mechanisms of energy deposition in the condensed phase. Laser photo-ionization produces isolated ionization events of a specific energy. In pulse radiolysis large amounts of energy are deposited in small domains called spurs (1-5 nm diameter in water). Combined with the lack of selection rules and inhomogeneous nature of the energy deposition within the spur, an assortment of ions, radicals and electrons are produced in a variety of energetic states close to each other. Detailed knowledge of the ultrafast primary events within the spur is essential in order to produce a complete understanding of radiation chemistry.

The first part of this presentation presents ultrafast laser studies on liquid water, aiming to model the events that are believed to occur within the spur. In the second part of the talk, current efforts to develop and characterize a subpicosecond source of energetic electron and x-ray pulses based on a self modulated wakefield accelerator will be described.

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