Understanding the mechanism(s) underlying the interaction of electromagnetic (laser, thermal, short-pulse electric) energies with biological systems is integral for development of technologies interfacing these energies with biology. We aim to understand the biophysics of how electromagnetic exposure affects cellular and sub-cellular components and how this interaction can drive changes in cellular physiology. Of particular interest is the mechanism(s) underlying infrared (IR) stimulation of neuronal action potentials and the possibility that thermodynamic effects (thermal, pressure, electrical) can increase the probability for spontaneous formation of lipid ion channels in the plasma membrane. These channels may allow the influx of ions into the cytosol to initiate the observed cellular effects.

This presentation will focus on using optical methods to explore the cellular effects of electromagnetic exposure. Approaches such as confocal and multiphoton-excited-fluorescence microscopy, second-harmonic-generation, high-speed wide-field fluorescence microscopy, and coherent Raman scattering are used to monitor the effects on the plasma membrane and intracellular organelles upon exposure. The effects of IR stimulation are compared with other stimuli, such as of nanosecond pulsed electric fields, to determine whether the consequences on the cell are the result of a general interaction of electromagnetic energy with cellular components or if the observed effects are more modality-specific.

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