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Applying Fourier transform spectroscopy to ultrafast measurements

Chathurangani Dilrukshi Jayalath Arachchige B.Sc.
University of Windsor, jayalat@uwindsor.ca

Thomas John Hammond Ph.D.
University of Windsor, Tj.Hammond@uwindsor.ca

Nathan Gregory Drouillard
University of Windsor, droui116@uwindsor.ca

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Student: J. A. C. Dilrukshi

Supervisor: TJ Hammond

ABSTRACT

This research involves understanding the effects of ultrashort laser pulses, which are generally of the order of femtoseconds (1 fs = 10^{-15} s) or attoseconds (1 as = 10^{-18} s), on a material and modeling light-material interaction. Attosecond time resolution is necessary to measure electron wave packet motion, with shorter pulses being important because they give us better temporal resolution. Ultrashort pulses can resolve electron motion and electronic transport properties, which have applications in telecommunications, quantum materials, and protein folding. We aim to create ultrashort laser pulses to excite and measure the electron wave packet motion in a femtosecond (or attosecond) time scale.

We perform the measurement with an experimental setup similar to Fourier transform infrared spectroscopy (FTIR), a well-developed high-resolution spectroscopic technique. FTIR can measure weak absorption bands in materials; we will combine this idea with ultrashort laser pulses to measure transient absorption properties. We introduce a semiconductor material (or a metal) in to one arm of the Michelson Interferometer to measure the electronic motion inside or off the surface of the material. Measuring and controlling electronic properties at these timescales (which is 6 orders of magnitude faster than what is currently possible) is a crucial step in developing next generation technologies.