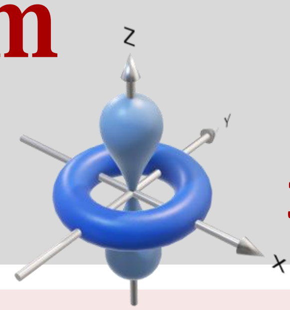
Department of Physics Colloquium



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Building a Quantum Trajectory Simulator for Studying Strong Field Physics

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Nearly thirty years ago, a simple and intuitive unified view of intense laser-atom interactions was introduced. The model is based on a semi-classical description where a bound electron is tunnel ionized by the strong optical field, followed by propagation under the influence of the strong field and finally driven back to interact with the core. This simple view has become known as the three-step or rescattering model and is responsible for the production of high energy electron & photons, multiple ionization and the formation of attosecond light pulses. The coherent process is started by the initial step of tunnel ionization which defines the physical observables for steps (2) and (3).

Feynman has taught us that the outcome of a quantum process is dictated by the sum over all the quantum trajectories that contribute to it. Naturally, when analyzing experiments, we often refer to these individual trajectories even though they have not been measured individually. In this talk I will describe a fully functioning Quantum Trajectory Simulator (QTS) which allows us to directly measure the outcome of single trajectories that summed together make up a quantum process. Our QTS operates in the strong field domain, where the simple semiclassical model described above is ubiquitously used to describe individual quantum trajectories.

The talk will first describe elements of the semi-classical 3-step model and attosecond pulse generation. I will then describe the construction of the simulator by reverse engineering using attosecond XUV pulse trains phase-locked to an intense infrared (IR) optical field. In essence we replace the tunneling step by single-photon ionization. I will show that (1) the QTS has indeed transitioned into the strong field regime and (2) double ionization of helium and argon supports the mechanism for (e,2e) field driven rescattering. Our analysis also confirms that the QTS approach is compatible with tunnel ionization when the QTS wave functions are coherently added. Thus, the QTS method is a powerful tool for studying recollision in a more diverse set of conditions than those produced by the tunnel ionization.

This colloquium will be held in-person, at SERC 116 unless announced otherwise.