Nonlinear phase slip of optical solitons used in optical clocks

(Joint work with Mark Ablowitz and Steven Cundiff)

Recent breakthroughs in ultrashort-pulsed mode-locked lasers have made possible new kind of clocks, called optical clocks, whose frequencies and precision greatly surpass atomic clocks. Optical clocks have revolutionized frequency metrology, with application to several other areas in physics and technology. The carrier-envelope phase slip, which is the pulse-to-pulse change of the phase offset between the envelope and underlying carrier-wave of the pulses, plays a key role in optical clocks. In this study, the phase slip is analyzed using a dispersion and nonlinearity-managed nonlinear Schrödinger (P-NLS) equation, which models pulse propagation in the laser cavity. Asymptotic analysis of the P-NLS is used to derive formulas for the nonlinear phase slip, which are found to be in excellent agreement with direct numerical simulations of the P-NLS.