Fiber Amplifier Gain Dynamics

Jonathan Musgrave

**Abstract:** Optical amplifiers based on lengths of rare-earth doped optical fibers are a ubiquitous tool to amplify optical signals across a wide range of wavelength bands. Although predominantly leveraged for low noise amplification in the C and L bands for optical telecommunications that have showed great promise for compact and high energy scaling for ultrafast optical pulses ranging from femtoseconds up to nanoseconds. When considering such high peak power and broad bandwidth systems it becomes increasingly important to consider the dispersive nature of the gain media itself. In this work we present a broadly applicable model for simulating ultrafast optical amplification. Our work considers not only the standard Kerr and Raman nonlinearities but also the shape of the gain curve by coupling the Generalized Nonlinear Schrodinger Equation to a set of rate-equations which govern the gain dynamics during propagation. This work is especially targeted for studying the quickly developing and designing gain-managed nonlinear fiber amplifier for pulses around 1um range.