

Nonlinear Optics in Hollow Core Waveguides

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Abstract

Generation and frequency conversion of ultrashort laser pulses are of critical importance for fundamental research and various applications in physics, chemistry and biology. In this talk, current research activities performed by my team with collaborators at the Advanced Laser Light Source of INRS-EMT will be presented. First, pulse compression of high-energy ytterbium laser systems using self-phase modulation in hollow-core fibers (HCF) will be discussed.

Our goal is to generate multi-Terawatts, sub-30 fs pulses at a 100 Hz repetition rate for laser-based electron acceleration. Second, pulse compression combined with frequency conversion via stimulated Raman scattering (SRS) will be presented. Using an HCF filled with linear molecules, we have demonstrated pulse compression from the picosecond regime down to sub-20 femtosecond durations through rotational Raman transitions and the formation of multidimensional solitary states in the fiber [1,2]. Building on the same physical mechanism, we are now scaling this approach to high-repetition-rate, low-energy pulses using hollow-core photonic crystal fibers.

Finally, I will present results on pulse compression and frequency conversion based on vibrational SRS, as well as UV-VIS generation of single-cycle pulses using multimodal nonlinear optical propagation in hollow core capillaries.

References: [1] R. Safaei et al. High-energy multidimensional solitary states in hollow core fiber, *Nature Phot.* 14, 733-739 (2020).

[2] M. Arshadipirlar et al. Efficient generation and extreme compression of multidimensional solitary states in molecular gas-filled hollow-core fibers driven by picosecond Yb lasers, *APL Photonics* 10, 046112 (2025).

When: Oct 30th 2026 10:30 – 11:30

Where: SRIS Building, Entrepreneur Hall