Title: Delivery of high Power ultra - short optical pulses in mid-infrared wavelength range

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Project Instructor (PI): Dr Somanth Ghosh

Brief description:

Our objective is to design a range of application specific microstructured optical fibers (MOF) for mid-infrared wavelength range, which could deliver high power and stable optical pulses. In this context, optical pulses with parabolic temporal intensity profile and linear frequency chirp across its width are the only solution that are capable of delivering higher power and tolerate larger nonlinearity before wave-breaking. Therefore, we have been designing MOFs which would generate/form and transmit stable high power parabolic pulses at suitable mid-IR wavelength for applications in defense, biomedical surgery, molecular fingerprint spectroscopy, and micro-machining. We also plan to study the stability of the parabolic pulses under the influence of finite loss-window of the fiber and higher-order dispersion effects. Moreover, existence and dynamics of parabolic pulses in the background of parameter dependent nonlinear effect of modulation instability, generation of parabolic pulses with a continuous wave nature, dynamics of mutually interacting parabolic pulses, and existence of “dark similaritons” (like “dark solitons”) are several interesting issues we plan to explore under this research.

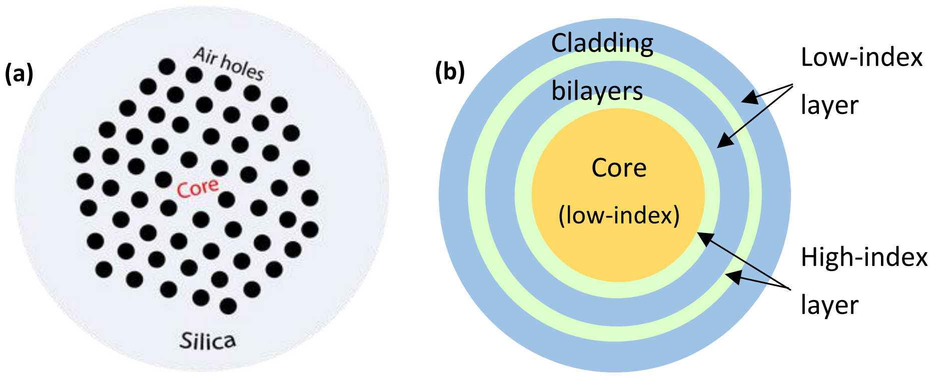

FIG. 1: (a) Schematic of the microstructured optical fiber (MOF) in which the air-holes (black dots) are embedded in a silica matrix with a particular periodic arrangement, reducing the effective index of the certain part of the silica. Thus, the center region forms a high-index core surrounded by a low-index region and light will be guided by modified index guiding method; (b) Schematic of the Bragg fiber which is a kind of photonic crystal fiber. Here, the core is a low index material surrounded by several bilayers of alternate high/low index material, giving rise to a photonic bandgap. Light is guided through such geometry by photonic bandgap method.

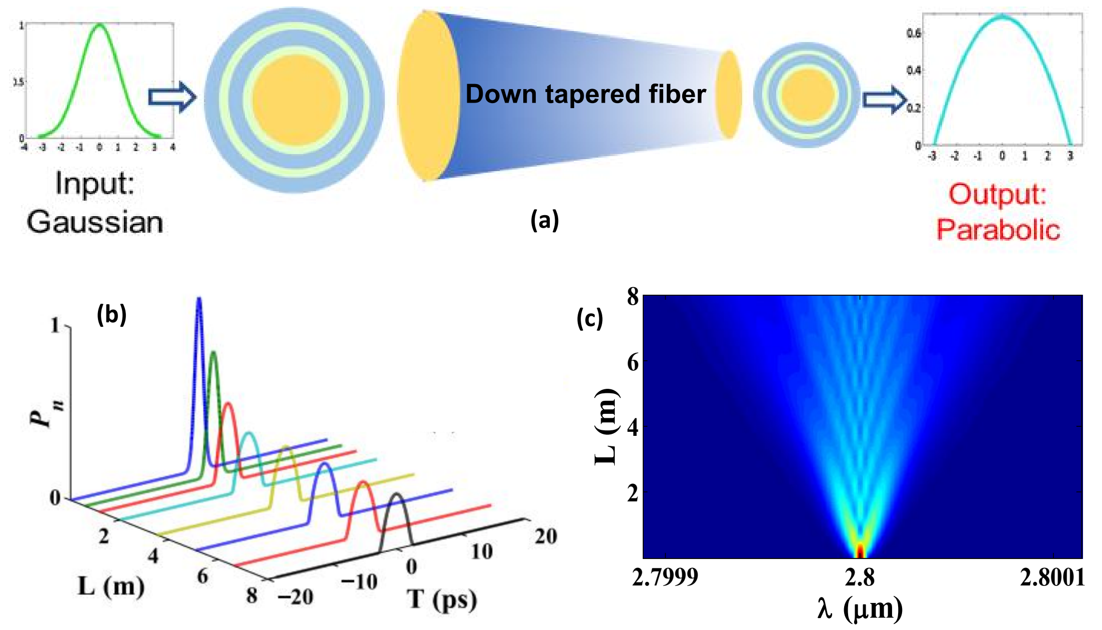

FIG. 2: (a) Schematic of a tapered fiber in which the cross-section is Bragg type. In a tapered fiber, the fiber parameters namely dispersion and nonlinearity vary along the fiber length in such a way that it reshapes an input Gaussian pulse into a parabolic pulse in an asymptotic limit; (b) The evolution of the input Gaussian into the parabolic one through a 8 m long fiber is shown; (c) The corresponding spectral evolution of the pulse centered at 2.8 μm has been depicted.

Publications:

[1] P. Biswas, P. Adhikary, A. Biswas, and S. Ghosh, “Formation and stability analysis of parabolic pulses through specialty microstructured optical fibers at 2.1 μm,” *Opt. Commun.* **377**, 120–127 (2016).

[2] P. Biswas, S. Ghosh, A. Biswas, B. P. Pal, “Toward Self-Similar Propagation of Optical Pulses in a Dispersion Tailored, Nonlinear, and Segmented Bragg-Fiber at 2.8 μm,” *IEEE Photon.* **9**(4), 7104412 (2017).