PhD Position / Thèse: Supercontinuum light generation in nanofiber gas cells

Host Laboratory / Laboratoire d'Accueil : Institut FEMTO-ST - CNRS - Optics Department

University Bourgogne Franche-Comté – Besançon, France

Keywords : Optics, Photonics, Nonlinear Optics, Fiber Optics, Laser, Supercontinuum physics

Job description

The physics and applications of fiber-based supercontinuum (SC) broadband light sources have been a subject of much interest over the last decade, with significant impact on both basic science and industry. New uses are constantly emerging due to their unique properties that combine high brightness, multi-octave bandwidth, fiber delivery, and single-mode output [1]. The last few years have also seen significant research efforts focused on extending the wavelength coverage of SC sources towards the 2 to 20 µm molecular fingerprint mid-infrared (MIR) region and in the ultraviolet (UV) down to 100 nm, while also improving stability, noise and coherence properties. Figure 1below shows a survey of fiber SC spectral coverage from the UV to MIR ranges up to 20 µm using different fiber technologies, including silica-glass fibers, fluoride and chalcogenide fibers, and gas-filled hollow-core fibers.

This thesis project is twofold. First it aims to investigate, both numerically and experimentally, the physics of SC generation in novel photonic gas cells using the evanescent field of sub-wavelength silica fiber tapers, as an alternative method to gas-filled hollow-core fibers [2]. We expect novel evanescently-induced nonlinear effects in nanophotonic gas cells with strong potential for SC applications towards both the UV range and the mid-IR ranges.

Another topic covered by this thesis will be to explore SC generation in all-normal dispersion (ANDi) fibers that provide ultra-flat, low-noise, and coherent SC spectra, from self-phase modulation (SPM) and optical wave breaking (OWB) [3,4]. The latter effect (OWB) has not been fully investigated and exploited for SC generation. This thesis aims to investigate, both numerically and experimentally, the effect of OWB in ANDi fibers and to provide an unified analysis with the four-wave mixing (FWM) theory and phase-matching conditions, and the dispersive shock wave formation in the time domain. The experiment will be based on a full-time/frequency analysis of femtosecond pulses propagating in parabolic dispersion fibers, both of which are already available in the lab. Ultimately, the main objective will be to improve the bandwidth and noise properties of SC sources based on parabolic dispersion fibers.

This thesis will be conducted in the optics department of the FEMTO-ST institute with several experimented researchers in a friendly and stress-free work environment and in collaboration with several photonics companies and foreign labs.

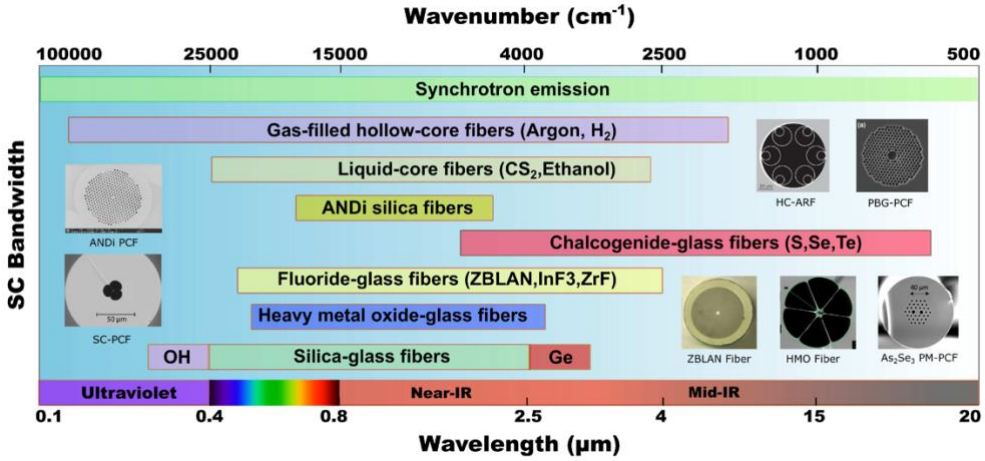

Figure 1: Survey of SC bandwidths in various specialty optical fibers from UV to MIR ranges [1].

References

1. T. Sylvestre, E. Genier, A. N. Ghosh et al., "Recent advances in supercontinuum generation in specialty optical fibers," J. Opt. Soc. Am. B 38, 90-103 (2021).

2. F. Belli, A. Abdolvand, W. Chang, J. C. Travers, and P. St. J. Russell, "Vacuum ultraviolet to infrared supercontinuum in hydrogen-filled photonic crystal fiber," Optica 2, 292–300 (2015).

3. E. Genier, S. Grelet, R. D. Engelsholm, P. Bowen, P. M. Moselund, O. Bang, J. M. Dudley, T. Sylvestre, "Ultra-flat, low-noise, and linearly polarized fiber supercontinuum source covering 670–1390 nm," Opt. Lett. 46, 1820 (2021).

4. E. Genier, P. Bowen, T. Sylvestre, J. M. Dudley, P. Moselund, and O. Bang, "Amplitude noise and coherence degradation of femtosecond supercontinuum generation in all-normal-dispersion fibers," J. Opt. Soc. Am. B 36, A161–A167 (2019).

Applicant profile/ Profil demandé

The applicants holding a Master or Engineer degrees in physics, electronics, optics, lasers and related area. The candidates will ideally have basic training and knowledge covering the fields of physics, nonlinear optics, fiber optics, laser physics, optoelectronics, signal processing, and spectroscopy. Prior hands-on experience in experimental fiber optics, pulsed lasers and/or optical instrumentation would be desirable. Strong numerical competences with Matlab are desired for numerical modeling and experimental interfacing. Open-minded, curious and interested in working with both computer scientists and physicists. Ability to take initiatives and work both in autonomy and in group. Good writing skills and English level are required from the applicants. A basic level of French would be ideal to ensure effective communication.

Funding details / Financement : MESRI (Public Funding)

Start : Early November 2022 (deadline 2023-01-01) – 3 years duration
Application deadline: 2022-10-31
Gross Salary : 2000 €/month (for 3 years)
Doctoral School : ED SPIM (Ingénierie et Micro-Techniques)

Thesis Supervisors / Contact

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Applicants are invited to submit their application to thibaut.sylvestre@univ-fcomte.fr
Application must contain the following documents:

- CV including grades, marks and lab internships
- Cover letter
- At least 1 reference letter

More informations about FEMTO-ST, Besançon, UBFC, and the University of Franche-Comté