école doctorale **sciences pour l'ingénieur et microtechniques**

Titre de la thèse/Thesis title : Unifying optical wave breaking and dispersive wave generation in parabolic dispersion fibers

Laboratoire d'accueil / Host Laboratory : Institut FEMTO-ST CNRS - Optics Dept. - UBFC

Spécialité du doctorat préparé/Speciality : Optics and Photonics

Mots-clefs / Keywords : Optics, Photonics, Nonlinear Optics, Laser, fibers, Supercontinuum

Descriptif détaillé de la thèse / Job description

The physics and applications of fiber-based supercontinuum (SC) broadband sources have been a subject of intense 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 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 1 shows a survey of fiber SC spectral coverage from the UV to MIR ranges up to 20 µm using different fiber technologies. Among these, we recently demonstrated that all-normal dispersion (ANDi) fibers generate stable and coherent SC from self-phase modulation (SPM) and optical wave breaking (OWB) [2,3]. However, the latter effect has not been fully investigated and exploited for SC generation.

This thesis project aims to investigate, both numerically and experimentally, the effect of OWB in parabolic dispersion fibers and to provide a unified analysis with the four-wave mixing (FWM) process, the physics of solitons and dispersive waves in anomalous dispersion regime, 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.

Another topic covered by this thesis will be to explore the physics of SC generation in photonic gas cells using the evanescent field of sub-wavelength silica fiber tapers, as an alternative method to gas-filled hollow-core fibers [4]. We expect new strong nonlinear dynamics in the nanophotonic gas cells with strong potential for SC applications towards the UV range.

This thesis will be conducted in the optics department of the FEMTO-ST institute (UBFC) with several experimented researchers and in collaboration with NKT Photonics company and the Technological University of Danemark (TUD).

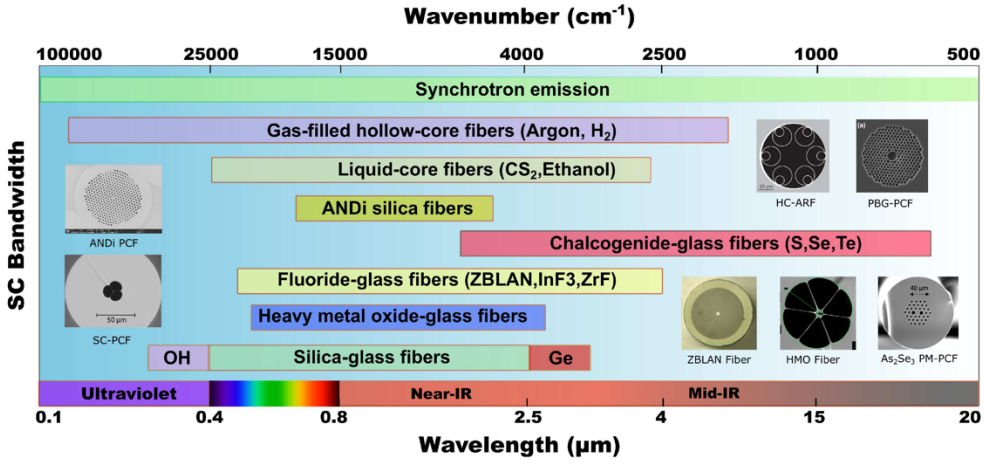

Figure 1: Survey of SC bandwidths in various specialty optical fibers from UV to MIR ranges.

Références bibliographiques / Bibliography

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. 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).

3. 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).

4. 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).

Profil demandé / Applicant profile

The applicants holding or preparing a Master or Engineer degrees in physics, electronics, optics, laser 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 (B2/C1 minimum) are required from the applicants. The candidate will have a high scientific curiosity and a strong motivation regarding the thesis. A basic level of French would be ideal to ensure effective communication.

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Dossier à envoyer pour le **25 Mai 2022**
Début du contrat : 1er Octobre 2022 – Durée 3 ans
Salaire mensuel brut : 1975 €

Direction de la thèse/Thesis Supervisor

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Encadrement de la thèse : **co-directeur(s) et co-encadrant(s)**

Applicants are invited to submit their application to the PhD supervisors.
Application must contain the following documents:

- CV
- Cover letter
- At least 1 reference letter