Job title	**Thesis in Physics: Spatiotemporal nonlinear dynamics and wave turbulence in multimode fibers**
Ref	2018-04-MIRCOM
Job type (PhD, Post-doc, Engineer)	**PhD**
Salary	1421€ net minimum
Contract duration (months)	36 months
Qualifications (Master degree, PhD…)	Master
Job hours (full time/ part time)	Full time
Employer	UBFC – Université de Franche-Comté
Host Laboratory	ICB UMR 6303 CNRS
URL Host Laboratory	http://icb.u-bourgogne.fr/en/
Address Host Laboratory	9 avenue Alain Savary, 21078 Dijon, France
Job description	One important challenge of the thesis is to provide a deep understanding of spatiotemporal nonlinear dynamics of pulse propagation in silica or mid-Infrared multimode fibers. Silica multimode fibers have recently become a hot research topic from both fundamental and application viewpoints. In particular our goal is to study both experimentally and theoretically the new concept of Kerr-induced spatial beam self-cleaning [Krupa1] which manifests itself as a concentration of optical power from higher order modes of the fiber toward the low-order modes and leads to a well-defined bell-shaped beam profile confined in the fiber core. An attempt to explain beam self-cleaning was based on the nonreciprocal nature of intermodal nonlinear coupling processes [Krupa1]. However, much deeper investigations are required to clearly understand, control, and exploit this spectacular phenomenon. In particular, the relationship between self-cleaning and wave condensation [Picozzi] remains a key issue not yet elucidated. The project also aims at exploiting the very broadband frequency conversion obtained by nonlinear intermodal wave mixing in multimode fibers [Dupiol, Krupa2] to generate compact, tunable and broadband light sources and frequency combs in the mid-Infrared. Indeed, mid-Infrared sources are currently largely missing, but their availability is of paramount social importance for non-invasive medical diagnostics based, for example, on dual-comb spectroscopy [Millot].

The thesis also aims at studying turbulence of optical waves in the presence of a structural disorder of the medium in the weakly nonlinear regime. Wave turbulence theory has found applications in diverse fields including oceanography, plasma physics, condensed matter physics and more recently in optics [Zakharov, Nazarenko]. This latter field allows one to study wave turbulence within rather simple nonlinear optical experiments, such as the the propagation of partially incoherent light waves through nonlinear optical fibers. Various phenomenologies have been uncovered on the basis of different wave turbulence formalisms, such as the thermalization and condensation of optical waves [Picozzi, Santic] (in analogy with the quantum Bose-Einstein condensation [Klaers]), the spontaneous formation of large scale collective incoherent structures [Picozzi, Xu] (in analogy with gravitation and the formation of galaxies in the Universe), or the formation of strong correlations [Guasoni] (in analogy with superconductivity).

Until now the wave turbulence theory has been developed under the assumption of perfect homogeneity of the medium [Nazarenko]. Here we plan to extend different aspects of the theory to account for a structural disorder due to inherent imperfections and external perturbations of conventional silica fibers or specially designed mid-Infrared fibers [Kaminow]. In the thesis the theoretical developments will be analyzed through elaborated numerical simulations, which in turn will be used to conceive and perform the optical experiments. In particular, we will study the impact of disorder on the formation of non-equilibrium localized incoherent structures in single-mode and multimode fibers, in analogy with weak Langmuir turbulence in plasma. The impact of disorder on light condensation will also be studied in different fibers, in relation with the recently observed beam self-cleaning effect [Krupa1]. From a broader perspective, the thesis will contribute to the understanding of spontaneous organization phenomena in nonlinear disordered incoherent systems.

Possible external collaborations: J. Garnier (Ecole Polytechnique, France), A. Tonello, V. Couderc, A. Barthelemy (Univ. Limoges, France), K. Krupa, S. Wabnitz (Univ. Brescia, Italy), R. Kaiser (Univ. Nice, France).

References:

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Supervisor(s)	MILLOT Guy (Professor of the Université de Bourgogne) ; Guy.Millot@u-bourgogne.fr PICOZZI Antonio (Director of Research of the CNRS); Antonio.Picozzi@u-bourgogne.fr
Candidate profile	Applicants should have a master degree in physics or optics. Some background in nonlinear pulse propagation in optical fibers and ultrafast optics is expected but not mandatory. A scientific interest in numerical methods will be very useful. The candidate will be directly involved in nonlinear optics experiments and associated wave turbulence theory so that a real motivation for both experimental and theoretical physics is expected. Good english and well-developed team working skills are required.
Keywords	Spatio-temporal nonlinear dynamic, Wave turbulence, Multimode fibers, Spatial beam self-cleaning, Intermodal wave mixing.
Application deadline	15th May 2018. Following the deadline, candidates will be rapidly informed of their status.
Application	Please send the following documents (all in one PDF file) by e-mail to job-application@ubfc.fr , Guy.Millot@u-bourgogne.fr and Antonio.Picozzi@u-bourgogne.fr 1) For EU candidates: Copy of your national ID card or of your passport page where your photo is printed. For non-EU candidates: Copy of your passport page where your photo is printed. 2) Curriculum Vitae (1 page). 3) Letter of motivation relatively to the position (1 page). 4) Copy of your Master degree if already available. 5) Copy of your educational grades, marks and ranks (at university level). 6) Coordinates of reference persons (maximum 3, at least your master internship supervisor): Title, Name, organization, e-mail. If you have questions regarding the application, please contact the supervisors.