Curriculum vitae – Jérôme Kasparian

Born 11/04/1973 - Paris

Citizenship : French

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Education

2005	**Habilitation**, University Lyon 1 (France)
1997	**PhD** in Physics, Université Lyon 1 (France)
1995	Magistère *Sciences de la Matière*, École Normale Supérieure de Lyon
1994	DEA (**Master**) *Chemistry of atmospheric pollution and physics of the environnement*, Université Joseph Fourier Grenoble 1

Employment

Oct. 2013 –	Associate Professor, University of Geneva. Leader of the GAP – Nonlinear Group
2007 – 2013	Researcher at University of Geneva, GAP - Biophotonics
2000 – 2007	**Researcher at** CNRS, Laboratory for ionic and Molecular Spectroscopy (LASIM, Lyon, France), in charge of the *Téramobile* project
1999-2000	**Post-doc,** Institute for optics and Quantum Electronics, F. Schiller University, Jena, Germany, in charge of the *Téramobile* project
1999	**Post-doc**, Laboratory for structural electronic microscope, Institute for Structural Biology Jean-Pierre Ebel (CEA/CNRS), Grenoble, France
1997-1999	**Scientific animator,** Radio Pluriel - Fréquence Écoles, Lyon-St Priest, France
1994-1997	**Assistant** at LASIM « *Spectroscopie linéaire et non-linéaire d'aérosols atmosphériques* », University Lyon 1

Responsibilities

- Leader of the French-German-Swiss project *Teramobile* (2000 - 2012)
- Member of the Pedagogic innovation commission, University of Geneva (2016 -)

Approved research projects

- French National Research Agency, « Teramobile », (2006-2008)
- FNS project « From non-linear optics to oceanic rogue waves », project 200021_155970 (2015-2018)

Supervision of junior researchers

- (Co)-supervision of **10 PhD students**: Didier Mondelain, Guillaume Méjean, Rami Salamé, Roland Ackermann, Pierre Béjot, Stefano Henin, Nicolas Berti, Elise Schubert, Jean-Gabriel Brisset, Debbie Eeltink
- (Co)-supervision **of 8 master students**: Guillaume Méjean, Rami Salamé, Pierre Béjot, Pierre Joly, Pierre-Marie Gassin, François Pommel, Nadège Marchando, Lorena de la Cruz

Teaching activities (current)

- General physics for first-year medical students (700 students)
- Non-linearity in physics (master of Physics, University of Geneva)

Panels and expertise

- 2005-2007: Member of the hiring commission, physics department, University Lyon 1
- Referee for various reviews (typically 25/year) : Physical Review Letters, Scientific Reports, Optics Express,…
- Referee for funding agencies : NSF (USA), ANR (France), DFAE (Switzerland)

Conference organisation

Conference co-chair of the *Conference on laser, weather, and Climate* (WMO, Genève, www.laserweatherandclimate.org, 2011 2013, and 2015)

Prizes and awards

Prize La Recherche 2005, section Environnement

Prize Aimé Cotton 2008, French Physical Society

Medal of the French Ministry for Youth and Sports, 2011

5 representative publications

1. **J. Kasparian**, M. Rodriguez, G. Méjean, J. Yu, E. Salmon, H. Wille, R. Bourayou, S. Frey, Y.-B. André, A. Mysyrowicz, R. Sauerbrey, J.-P. Wolf, et L. Wöste, *White-Light Filaments for Atmospheric Analysis.* Science. **301**, 61-64 (2003)
2. M. Brunetti, N. Marchiando, N. Berti, **J. Kasparian**. *Nonlinear fast growth of water waves under wind forcing*, Physics Letters A **378**, 1025--1030 (2014)
3. Brunetti, M. & **Kasparian, J**. *Modulational instability in wind-forced waves.* Physics Letters A **378**, 3626–3630 (2014)
4. D. Eeltink, N. Berti, N. Marchiando, S. Hermelin, J. Gateau, M. Brunetti, J. P. Wolf, and **J. Kasparian**, *Triggering filamentation using turbulence*, Physical Review A **94**, 33806 (2016).
5. D. Mongin, E. Schubert, N. Berti, **J. Kasparian**, and J.-P. Wolf, *Gas-solid phase transition in laser multiple filamentation*. Phys. Rev. Lett. **118**, 133902 (2017)

Major scientific achievements

Since my hiring as a professor at the University of Geneva, I developed my research at the interface between physics and climate science. In particular, I develop analogies between non-linear physical and natural systems, many of which being described by the nonlinear Schrödinger equation. This analogy allows to transfer results from a field to another one, and to perform experimental studies of various regimes (bistability, solitons) in the most appropriate physical system. These fields cover nonlinear optics, fluid flows (oceans or atmosphere), Bose-Einstein condensates, cosmology, or superfluids. I focused in particular on the ability of nonlinear optics to model climate or weather phenomena, like rogue waves.

Influence of wind on rogue wave formation

I first focused on the impact of wind in the nonlinear propagation of waves and its influence on the formation of rogue waves. For the first time, we took into account the effect of a strong wind, inducing a gain of the same order of magnitude than the wave steepness. Introducing this term in the propagation equation accelerates the wave growth [11] [1], but also allows the emergence of an a modulational (Benjamin-Feir) instability band of infinite bandwidth [14].

In order to experimentally check these predictions, we performed an experimental campaign in collaboration with Hubert Branger at IRPHE (University Aix-Marseille, France), in a 40 m long wavetank equiped with a wavemaker and a wind turbine. We showed that the coupling of wind with higher-order (Dysthe) nonlinear terms of the propagation equation results in a frequency upshift rather than a downshift as previously expected[2]. This work also illustrated the need to precisely define frequency up-and downshift, as definitions based on the spectral peak or the spectral mean may yield contradicting conclusions.

To provide more intuitive interpretations to wind and viscosity effects on the wave spectrum, we developed a truncated model considering only the central and first side frequencies of the wavepacket. It allowed us to discuss the respective contributions of the non-linear terms and to properly define the temporary spectral upshift occurring in the nonlinear stage of Benjamin-Feir instability[3].

Extreme events in randomly perturbed laser filamentation

Investigating the propagation of ultrahshort pulses close to the power threshold for filamentation, we have evidenced a new regime of turbulence-pulse interaction. While at high incident laser power turbulence reduces the filamentation property, we observed that a strongly turbulent environment can trigger filamentation for a laser beam that does not have enough power to filament in a calm atmosphere [25]. From a microscopic point of view, local pulse front perturbations induced by the turbulence give rise to local

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[1] References numbers in brackets refer to the peer-reviewed articles in the attached Research results list

[2] D. Eeltink, A. Lemoine, H. Branger, O. Kimmoun, C. Kharif, J. Carter, A. Chabchoub, M. Brunetti, and J. Kasparian, *Spectral up- and downshifting of unstable Stokes waves under wind forcing*, submitted to J. Fluid Mechanics (2017)

[3] A. Armaroli, M. Brunetti, J. Kasparian, *Recurrence in the high-order nonlinear Schrödinger equation: a low dimensional analysis*. Submitted to Phys. Rev. E (2017)

focusing and create inhomogeneities in the transverse intensity profile. These inhomogeneities seed transverse modulation instability (MI), i.e. the rapid growth of a transverse perturbation in the beam which leads to the onset of single filaments for a beam that is below the power threshold to filament.

The random perturbation due to turbulence induces sparse filamentation events can also be understood as transient explorations of the high-intensity (filamenting) regime by the system. Observing the filament probability (or the associated peak intensity across the beam profile) therefore provides an indication on how close to the threshold power the system lies. It can therefore be expected to provide an early warning for this transition.

Laser filamentation and atomspheric applications

In collaboration with J.-P. Wolf, I investigated filamentation and its applications to weather modulation. We developed several approaches aiming at improving the triggering of high-voltage discharges by using pulse trains [24] or high-average power beams (≥ 100 W, which also improve the propagation through perturbed atmosphere [26,29]) in order to maximize thermal effects. We also sought for the optimal wavelength for discharge triggering, from the ultraviolet to the mid-infrared [27]. In this effort, we also identified a regime of DC electric field, where the laser filament prevent sparking discharges instead of triggering them [22], opening the prospect for lightning mitigation. In parallel, we investigated the physico-chemical mechanism driving laser-assisted condensation [21], and showed that mid-infrared filaments [9] offer in that regard a promising alternative to those produced by Ti:Sa pulses at 800 nm.

This work on filamentation also allowed us to develop analogies between the multiple filamentation patterns and phase transitions similar to percolation [19,20] or solid-gas transitions [30], in a statistical physics approach. These analogies could help the analysis of rare events close to the phase transition, as described above. They also evidence the relevance of laser filamentation as a model for many non-linear systems that are less accessible experimentally.

PlanetSolar DeepWater Expedition

My interest for the atmosphe and the climate also led me to lead the analysis of the results of the PlanetSolar Deepwater expedition. In Spring and Summer 2013, together with several groups of the Group of Applied physics and Instute for Environmental Sciences of the University of Geneva, we relied on the zero-emission solar boat PlanetSolar to naveigate along the Gulf Stream. We simultaneously characterized the ocean surface properties and the atmospheric aerosols, in order to better understand the impact of the latter on climate. Using a specifically designed single-particle fluorescence spectrometer, we showed, for the first time, that characteristics of the water masses, like their temperature and salinity, can constitute a proxy for the relative abundance of organic aerosols. Considering the specific action of the latter in terms of condensation nuclei and radiative properties, these results may help refine the role of aerosols in climate models, where they are a major factor of uncertainty [31].