

Department of Electronic Engineering

City University of Hong Kong
Department of Electronic Engineering,
IEEE Photonics Society Hong Kong Chapter, and IS-PALD Symposium
Present IEEE Distinguished Lecture on

Uncovering the Complexity of Light

by

Prof. Marc Sciamanna
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Date : 4 December 2018 (Tuesday)

Time : 9:10 am – 10:00 am

Venue: P4703, 4/F, Purple Zone, Yeung Kin Man Academic Building, City University of Hong Kong

Abstract

In many circumstances and in particular as a result of nonlinear interaction with matter, light exhibits complex nonlinear behaviors in space and/or time. Examples are numerous and include the self-organization of light in spatially extended laser media, spontaneous self-pulsation in lasers with optical feedback or injection and successive bifurcations leading to chaotic light dynamics. Understanding and harnessing complexity is crucial in applications that either need to stabilize laser light output, or that make use of such properties of light for innovative signal processing including secure communications, chaos-based sensing, random number generation, neuromorphic computing, etc.

In this talk I shall make a survey of the current knowledge regarding light complexity and applications. Recent contributions shall then be summarized. First, I shall discuss the possibility to significantly enhance the bandwidth of chaos generated from a laser diode by submitting the laser diode to a phase-conjugate feedback (PCF). PCF is obtained by four-wave mixing in a nonlinear optical material and shows interesting filtered optical feedback properties that determine the chaos bandwidth properties. Secondly, I will present recent results in which light polarization dynamics is set in a state that switches periodically between a steady polarization state and a chaotic very fast pulsing polarization state. That new dynamics is interesting in two ways: a) it unveils a new Hopf bifurcation on light polarization dynamics that shows pulsations at frequencies much larger than the relaxation oscillation frequencies, b) the coexistence of stationary and chaotic polarization states shows analogies with the so-called chimera states that may be observed in the synchronization of large populations of coupled nonlinear oscillators. In a different context I will emphasize the interesting application of polarization dynamics as a way to enhance the memory and computational capacities of a so-called photonic reservoir computer, i.e. an application of laser internal nonlinear dynamics to machine learning. Performance will be illustrated on specific tasks of increasing complexities (chaotic time series prediction, nonlinear channel equalization etc.). Finally, I will briefly illustrate the concept of accelerating light beams and in particular the family of Airy beams and how their nonlinear propagation properties in a photorefractive crystal enable analogies with gravitational lensing of light in an accelerating reference frame.

Biography

Marc Sciamanna graduated in Electrical Engineering (2000) and PhD in Applied Sciences (2004) from the University of Mons (Belgium) and received his "Habilitation à Diriger les Recherches" from the University of Lorraine (France) in 2009. In 2004 he has been appointed as an Assistant, then an Associate (2007) and since 2009 as a Full Professor at Supélec, today named as "CentraleSupélec". From 2013 to 2017 he has been the Deputy Director of the LMOPS Laboratory (Optical Materials, Photonics and Systems). He is coordinating the Master in Photonic and Communication Systems (SPC) at CentraleSupélec. Since 2017 he leads the Chaire Photonique (Chair in Photonics) at CentraleSupélec. Marc Sciamanna is a recognized researcher for his contributions to nonlinear dynamics of laser diodes, applications of optical chaos, and the physics of optical instabilities including the formation of optical patterns, the nonlinear propagation of non conventional beams including vortices and Airy beams, and the onset of optical rogue waves. He has published about 100 journal publications and over 150 publications in conference proceedings. He has been invited speaker at more than 25 international conferences including two plenary talks at IEEE Winter Topicals 2009 and SPIE Photonics Europe 2014. He has been awarded with the IEEE Photonics Society Graduate Student Fellowship Award in 2002, the SPIE F-MADE Scholarship Award in 2003, the MIT Technology Review TR35 award in 2007, and the IEEE Photonics Distinguished Lecturer Award in 2017. In his country he has been awarded with the Best Researcher Award from Lorraine Region. Since 2016 he is one of the Associate Editors for Optics Letters (Optical Society of America). Since 2017 he has been appointed as a member of the Scientific Council for the Office parlementaire d'évaluation des choix scientifiques et technologiques (OPECST) in France.

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