CINTRA
UMI 3288
CNRS-NTU-THALES

CENTRE FOR DISRUPTIVE PHOTONIC TECHNOLOGIES
Nanyang Technological University, Singapore
www.nanophotonics.sg

CINTRA-CDPT Joint Seminar Presented by:
Dr Alberto Bramati
bramati@spectro.jussieu.fr

Title: Quantum optics with semiconductors: polariton quantum fluids and single photons sources

Date: Wednesday, 20th November 2013
Time: 11:00 - 12:30
Venue: SPMS MAS Executive Classroom 1 (SPMS-MAS-03-06)

Abstract

Polaritons, half-light half-matter mixed states arising from the strong coupling between excitons and photons in semiconductor microcavities, are composite bi-dimensional interacting bosons. They can manifest macroscopic quantum coherence effects at high temperatures (5-300 K) due to their very low mass. In particular, polaritons behave like a quantum fluid with specific properties coming from its intrinsic out of equilibrium nature, determined by the short polariton lifetime (some picoseconds).
In the first part of the talk, I will briefly review the superfluid and Cerenkov regimes [1] in these systems, then I will discuss the formation of quantized vortex and dark solitons in a polariton quantum fluid interacting with a large obstacle [2, 3]. Finally, the possibility to generate vortexantivortex lattices in a confined geometry will be discussed.
These results demonstrate that the polaritons are an ideal system for the study of the quantum fluid properties.
In the second part of the talk I will present our recent results on efficient room temperature single photon emitters based on core/shell colloidal semiconductor nanocrystals.
In such structures, the competition between radiative and non-radiative recombination channels induces photoluminescence fluctuations between on and off states known as blinking. The shell engineering is a suitable strategy to control recombination paths and has been used to produce almost non-blinking nanocrystals [4], although accompanied by undesired increasing of multi-excitonic emission probability [5].
By using asymmetric core/shell nanoparticles (dots-in rods) with a spherical CdSe core surrounded by a rod-like CdS shell, blinking effects, multi-excitonic emission and polarization of the emitted photons can be separately controlled by tuning the shell dimensions [6, 7]. This allows an unprecedented capability in radiative channels engineering, making dot-in-rods very efficient blinkingfree sources of polarized single photons on-demand.

[1] A. Amo, J. Lefrère, S. Pigeon, C. Adrados, et al., Nature Phys. 5, 805 (2009).
[2] A. Amo, S. Pigeon, D. Sanvitto, V.G. Sala, R. Hivet, et al., Science, 332, 1167 (2011).
[3] D. Sanvitto, S. Pigeon, A. Amo, D. Ballarini, et al, Nature Photonics, 5, 610 (2011)
[4] B. Mahler, P. Spinicelli, S. Buil, X. Quélin, J. P. Hermier, B. Dubertret, Nature materials 2008, 7, 659.
[5] Y. S. Park, A. Malko, J. Vela, Y. Chen, Y. Ghosh, F. García-Santamaría, J. Hollingsworth, V. Klimov, H. Htoon, Physical Review Letters 2011, 106, 187401.
[6] F. Pisanello, L. Martiradonna, G. Leménager et al., Appl.Phys.Lett. 96, 033101 (2010)
[7] F. Pisanello, G. Leménager, L. Martiradonna et al, Adv. Mat. 25, 1974 (2013)

About Speaker

Alberto Bramati received his PhD in physics from the University Pierre et Marie Curie (UPMC), Paris, France in 1998. In 2007 he was appointed professor at the UPMC where he is currently carrying out his research activity at the Laboratoire Kastler Brossel of the Ecole Normale Supérieure. His main research topics are in the framework of Quantum Optics, Quantum Information and Nano-Photonics. In the last years he concentrated on the study of polariton systems and semiconductor nanocrystals obtaining several pioneering results: among them are the first demonstration of polariton superfluidity, hydrodynamic dark solitons and polarized single photon sources.