Department of Physics
Condensed Matter Physics
Clarendon Laboratory, Parks Road, Oxford OX1 3PU

UNIVERSITY OF OXFORD

CONDENSED MATTER SEMINAR

Thursday 23 May at 2.15pm

"Controlling light down to the single-photon level with on-chip nanostructured devices"

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Light-matter interactions allow exploring new physics and adding functionalities to nanostructured on-chip devices, thus enabling developments in classical (nano-lasers) and quantum (single-photon emitters) light sources, energy harvesters and sensors. These advances have been facilitated by unprecedented control in growth and fabrication techniques that have opened new pathways to the design and realization of semiconductor devices where light emission, trapping and guidance can be efficiently controlled.
In this context, I will show the implementation of quantum dot nanostructures in nano-photonic cavities that can create simultaneously bright and pure, triggered single-photon sources [1, 2], critical for quantum information applications. I will then present different photonic geometries for controlling light propagation, brightness and spontaneous emission rate, based on plasmonic nanostructures [3,4] and photonic crystal waveguides [5]. Finally, I will discuss novel designs based on bio-inspired aperiodic and disordered photonic crystals, showing efficient light confinement [6] and optical sensing [7] at visible wavelengths.

References:
[1] L. Sapienza, M. Davanco, A. Badolato, K. Srinivasan, Nanoscale optical positioning of single quantum dots for bright and pure single-photon emission, Nature Communications 6, 7833 (2015).
[2] M. Davanco, J. Liu, L. Sapienza, C.-Z. Zhang, J.V. De Miranda Cardoso, V. Verma, R. Mirin, S. W. Nam, L. Liu, K. Srinivasan, Heterogeneous integration for on-chip quantum photonic circuits with single quantum dot devices, Nature Communications 8, 889 (2017).
[3] O.J. Trojak, S.I. Park, J.D. Song, L. Sapienza, Metallic nanorings for broadband, enhanced extraction of light from solid-state emitters, Applied Physics Letters 111, 021109 (2017).
[4] O.J. Trojak, C. Woodhead, S.I. Park, J.D. Song, R.J. Young, L. Sapienza, Combined metallic nano-rings and solid-immersion lenses for bright emission from single InAs/GaAs quantum dots, Applied Physics Letters 112, 221102 (2018).
[5] L. Sapienza et al., Cavity quantum electrodynamics with Anderson-localized modes, Science 327, 1352 (2010).
[6] T. Crane, O.J. Trojak, J.P. Vasco, S. Hughes, L. Sapienza, Anderson localisation of visible light on a nanophotonic chip, ACS Photonics 4, 2274 (2017).
[7] O.J. Trojak, T. Crane, L. Sapienza, Optical sensing with Anderson-localised light, Applied Physics Letters 111, 141103 (2017) - "Editor's pick".

Host: Prof Robert Taylor

Simpkins Lee Room, Beecroft Building