Department of Physics
Condensed Matter Physics
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UNIVERSITY OF OXFORD

CONDENSED MATTER SEMINAR

Thursday 28 April at 14.00

"EXCITON POLARONS IN RUDDLESDEN POPPER METAL HALIDES – LESSONS FROM COHERENT SPECTROSCOPY"

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Two-dimensional Ruddlesden-Popper metal halides (2D-RPMHs) are materials composed of quasi-2D layers of metal-halide octahedra separated by long (~1nm) organic cationic layers. The latter facilitate electron and hole quantum confinement within the metal-halide layers resulting in a quantum-well like structure. Properties of excitons (electron-hole bound states) in such structures are characterized by strong binding energy (>200 meV) arising from the dynamically screened Coulomb interactions [1]. We have experimentally observed that polaronic effects arising from the lattice dressing of the carriers, are not only active but that they fundamentally define excitons in 2D-RPMHs [2]. We thus refer to such excitons as the exciton-polarons, with properties that are measurably distinct from those of free excitons in semiconductors [1]. In this talk, I will discuss the quantum dynamics of exciton-polarons and provide spectroscopic insights into the peculiar phonon-phonon [3], exciton-phonon and exciton-exciton [4] interactions. I will present our perspective on how the coherent optical response of 2D-RPMHs can be effectively rationalized within the "exciton-polaron" framework, in which lattice dressing of photo-carriers constitute an integral component of excitonic wavefunction [1], with consequences on exciton recombination dynamics and diffusion.

[1] A. R. Srimath Kandada and C. Silva, J. Phys. Chem. Lett., 11, 3173-3184 (2020).
[2] F. Thouin, D. Valverde-Chavez, C. Quarti, D. Cortecchia, I. Bargigia, D. Beljonne, A. Petrozza, C. Silva and A. R. Srimath Kandada, Nature Materials, 18, 349-356 (2019).
[3] E. Rojas-Gatjens, C. Silva-Acuna and A. R. Srimath Kandada, Peculiar anharmonicity of Ruddlesden Popper metal halides: Temperature dependent dephasing, Materials Horizons (2022).
[4] A. R. Srimath Kandada, H. Li, F. Thouin, E. R. Bittner and C. Silva, Stochastic scattering theory for excitation-induced dephasing: Time dependent nonlinear coherent exciton lineshapes, J. Chem. Phys., 153, 164706 (2020).

Host: Silvia Genaro Motti
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