Carl von Ossietzky
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PHYSICAL COLLOQUIUM

INVITATION

Monday, 31.05.2021, 4.15 p.m.,
video conference: https://meeting.uol.de/b/anj-2vc-j6s-fwe

speaks

Dr. Carlos Anton-Solanas,

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about

"Quantum optics with quantum materials"

The investigation of *light-matter coupling* is fundamental to understand the electronic properties of materials, and also to control the emission of light resulting from the coherent interaction between photons and electrons. Going into the quantum regime of such interaction opens a wide spectrum of technology applications, such as quantum communications or quantum computation.

Semiconductor quantum dots (QDs), coupled to optical cavities, have recently become the leading material to generate coherent single photons[1]. As a natural consequence, many test-bed applications have immediately followed to demonstrate the encouraging potential of these devices in *quantum optical technologies* based on the solid-state[2–4].

In parallel, the recent discovery of *atomically thin crystals*, with unprecedented optical properties (absorption efficiency, valley coherence properties, Moiré physics), has triggered an intense research activity to investigate the quantum photonic properties of such novel excitons. The coherent coupling of these single excitons to optical cavities comes as a basic pre-requisite[5] for quantum optics applications.

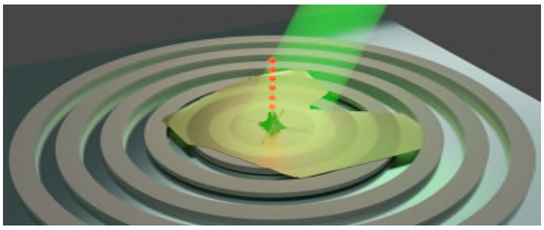

Figure caption. Representation of a bullseye grating cavity, with a nanopillar in the centre; an atomically thin monolayer of WSe_2 is deposited on top. The local strain around the nanopillar forms a WSe_2 quantum dot, coupled to the cavity. A green laser excites the quantum dot, emitting single photons efficiently. Credits: Oliver Iff.

Many fundamental questions around this new system are yet to be answered: How are these monolayer QD excitons formed? What are their main dephasing processes during the spontaneous emission? Which cavity configuration is best suited for quantum optics purposes? Can we control the formation of such QDs to harness dipole-dipole interactions or even create interacting QD lattices?

During my talk, I will present an overview of my research plans: (i) development of solid-state single-photon sources coupling optical cavities (bullseyes, open cavities) to single excitons in atomically thin crystals, (ii) deterministic generation of multipartite and high-dimensional photonic entanglement from solid-state single photon sources, and (iii) addressing interactions of single excitons in atomically thin crystals deterministically positioned in arrays: from dipole-dipole QD interactions to two-dimensional lattices of QDs.

References

1. Somaschi, N. *et al.* Near-optimal single-photon sources in the solid state. *Nature Photonics* **10**, 340–345 (2016).
2. Antón, C. *et al.* Interfacing scalable photonic platforms: solid-state based multi-photon interference in a reconfigurable glass chip. *Optica* **6**, 1471 (2019).
3. Loredo*, J. C., Antón*, C. *et al.* Generation of non-classical light in a photon-number superposition. *Nat. Photonics* **13**, 803–808 (2019).
4. Istrati, D. *et al.* Sequential generation of linear cluster states from a single photon emitter. *Nat Commun* **11**, 5501 (2020).
5. Iff, O. *et al.* Purcell-enhanced single photon source based on a deterministically placed WSe$_{2}$ monolayer quantum dot in a circular Bragg grating cavity. *arXiv:2102.02827 [cond-mat, physics:quant-ph]* (2021) (accepted in *Nano Letters*).

All interested persons are cordially invited.

Sgd. Dr. Carlos Anton-Solanas/Sgd. Prof. Dr. Christian Schneider