Πανεπιστήμιο Κύπρου

The Department of Physics at the University of Cyprus
is organizing a seminar on

Wednesday, 12 September 2018, time 14:30 p.m.

Room B228, Building 13, New Campus

Speaker:

Dr. Carlos Antón
CNRS, Univ. Paris-Sud,

" Towards ideal single photon sources and deterministic photon gates in the solid-state"

The development of scalable quantum photonic networks relies on the technological means to implement: (i) bright and deterministic sources of single and indistinguishable photons [1] and (ii) deterministic photon gates capable to manipulate and process efficiently the photonic information [2,3]. We present our advances on these two milestones: (i) the fabrication of near-optimal single photon sources of deterministically coupled quantum dots (QDs) in electrically-controlled pillar microcavities [1,4] [scheme in Fig. (a)] and (ii) first steps towards the implementation of photon gates using these devices as routers in path- [2] and polarisation-encoding [3].

Under resonant excitation we retrieve near-unity indistinguishability between single photons, and we measure a single photon purity of $g^{(2)}(0)=0.0028\pm0.0012$. Most remarkably, the deterministic emission of our single photon sources is evidenced by the brightness (defined as the probability to obtain a single photon per pulse before the first collection lens), with a value of 0.154±0.015. This makes our sources more than one order of magnitude brighter than parametric down conversion sources with the same photon purity [1].

Going towards the implementation of photon gates in path-encoding, we demonstrate the single-photon Fock state filtering by a QD-cavity device [scheme in Fig. (b)] [2]. The device is probed with a pulsed laser and we collect the total reflected signal in the same polarization. The system presents a nonlinearity threshold for an average incident photon number as low as ~0.3. The $g^{(2)}(0)$ measure of the reflected light evidences that it is mostly constituted by single-photons (80% single-photons of the total output intensity) and that the multi-photon components of the field are efficiently suppressed.

Finally, going towards the implementation of photon gates in polarisation-encoding, we have also investigated the polarization rotation of coherent light interacting with a QD-cavity device by analysing the reflected photonic polarization state in the Poincaré sphere [3]. The superposition of emitted single photons (H-polarized) with reflected photons (V-polarized, Fig. (c)) leads to a large rotation of the output polarization by 20º both in latitude and longitude [3]. This result sets a proof-of-concept experiment to engineer photon routers in polarisation-encoding with charged excitons [5].

[1] N. Somaschi, et al., Nat.Photon. **10**, 340 (2016).
[2] L. de Santis, et al., Nature Nano. **12**, 663 (2017).
[3] C. Antón, et al., Optica **4**, 1326 (2017).
[4] A. K. Nowak, et al., Nat. Commun. **5**, 3240 (2014).
[5] I. Shomroni, et al., Science **345**, 903 (2014).

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