

Single-photon non-linearity with telecom quantum dots

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The past decade has witnessed rapid advances in the semiconductor quantum dots (QDs) that emit at telecom wavelengths, both in the O-band (~1260-1340 nm) and the C-band (~1530-1560 nm). The quality of the photons produced by these telecom QDs, classified in terms of brightness, purity and indistinguishability, is approaching that of state-of-the-art near-infrared QD single-photon sources [1-3].

Here, we report the nonlinear interaction between photons and QDs at telecom wavelengths, a key capability for emerging applications in quantum simulation [4] and quantum neural networks. Such non-linearities have been reported on in near infrared quantum dots in waveguides [5,6] and microcavities [7].

The platform consists of O-band InAs/GaAs QDs embedded in a photonic crystal waveguide [8]. Grating couplers positioned on either side allow coupling light into the waveguide and collecting the transmitted signal. As the laser is tuned in resonance with the QD, the single-photon component of the coherent field is suppressed through resonant interaction with the emitter. This manifests as a clear dip in transmission at resonance (figure 1) and the emergence of photon bunching ($g^2(0) = 2.03(4)$) in the transmitted field (figure 2), reflecting coherent operation and high waveguide-emitter cooperativity.

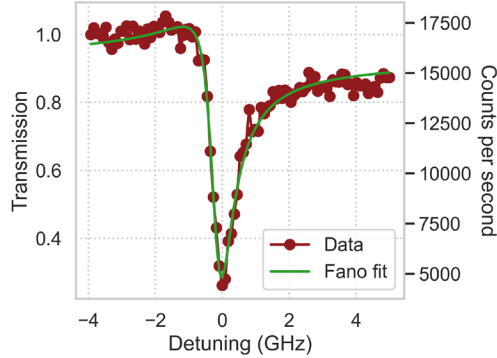


Figure 1 Resonance transmission dip as a function of detuning centered at 1296.028 nm. The fit returns a Fano line width of ~800 MHz.

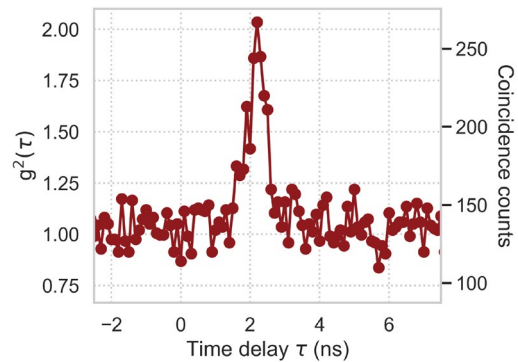


Figure 2 Second order autocorrelation at resonant wavelength (i.e. measured at the dip). The deviation of the peak from zero time delay is from the use of fiber based polarization control, which causes a slight time difference between the two channels.

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