Purcell enhanced single photon emission from a quantum emitter in WSe_2 monolayer coupled to a high-Q tunable cavity

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Secure quantum communication relies on the intrinsic quantum properties of light and requires a single-photon source that is fast, highly efficient, and easily fabricated [1]. Apart from well-established GaAs-based systems, two-dimensional semiconductors have recently emerged as a promising scalable platform for quantum information processing [2, 3]. Here we show how the performance of quantum emitters (QEs) in atomically thin materials can be significantly enhanced by coupling to versatile tunable microcavity. The open plano-concave Fabry-Pérot resonator is integrated into a closed-cycle helium cryostat and does not require active stabilization. The system`s tunability enables independent fine-tuning of Q-factor and Purcell factor by choosing the microlens diameter and varying cavity length, which facilitates switching between different cavity QED regimes. We managed to deterministically modulate radiative decay rate of a stochastically created excitonic quantum emitter reaching five-fold shortening of the lifetime. High performance of the system let us observe quantum coherence via two-photon interference. In the limiting case when the cavity mirrors are in contact, additional strain causes splitting of the cavity modes and spectral shift of a QE resonance providing new degrees of freedom for manipulating of QE emission. Our findings open the path towards higher rates of quantum key distribution and generation of indistinguishable single photons in 2D semiconductors.

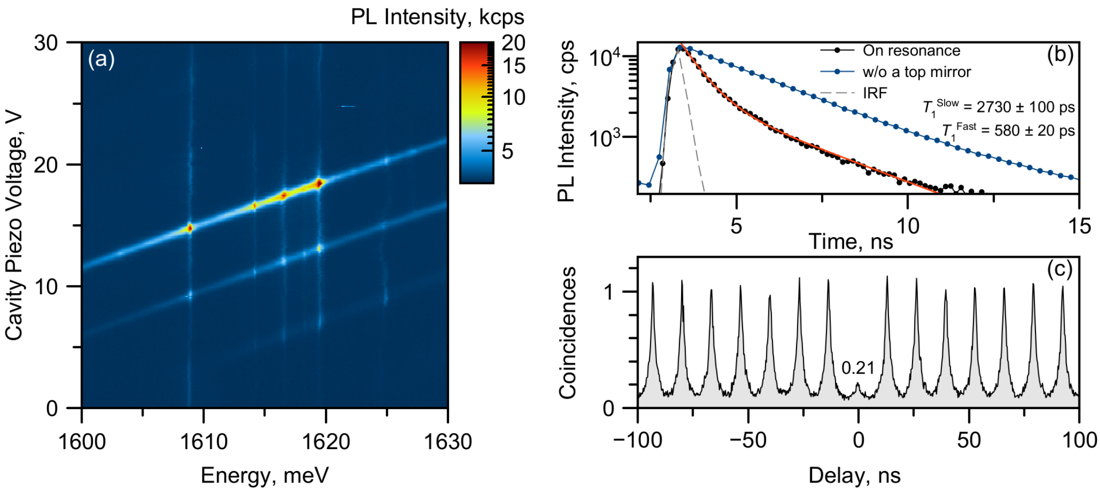

Figure 1: (a) Color map of photoluminescence (PL) spectrum as a function of cavity detuning under pulsed non-resonant excitation. (b) Time-resolved PL kinetics of the zero-phonon line (ZPL) of a QE when the cavity mode is resonant with the ZPL emission and when measured without the top mirror. Fitting of the Purcell-enhanced decay curve by double exponential function yields two decay times T_1^{Fast} and T_1^{Slow}. (c) Second-order autocorrelation function of single photons.

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