# Flat Quantum Light Sources for Quantum Communication

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Tremendous progress has been achieved in the field of quantum light generation in the solid-state for implementations of quantum information. Confined excitons in 2D quantum materials, including monolayers of transition metal dichalcogenides (TMDCs), emerged in recent years as novel types of quantum emitters [1]. Showing appealing prospects for large-scale and low-cost device integration, these materials have gained a rapid increase in interest – also in the context of quantum technologies. At the same time, nanophotonic devices based on semiconductor quantum dots (QDs) [2] reached a level of maturity that enables field-deployable applications of quantum technologies.

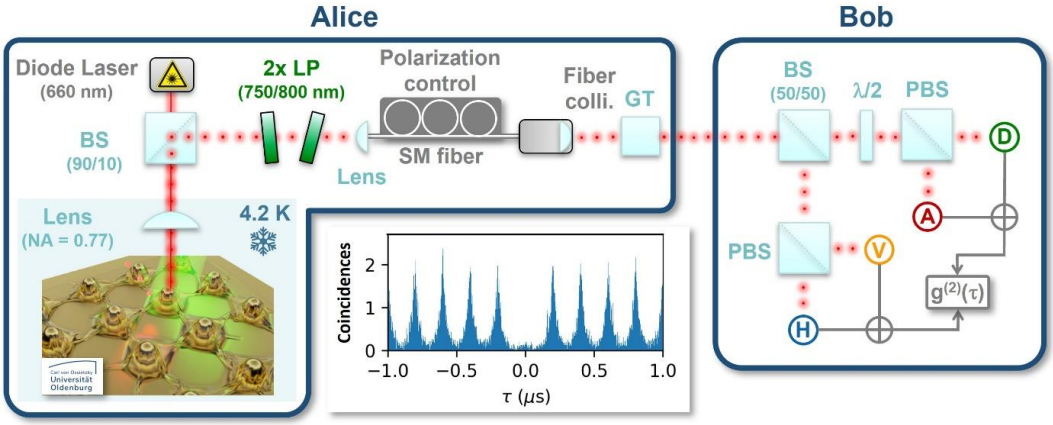


Fig. 1: BB84-QKD setup employing an atomically-thin single-photon source based on a strain-engineered $WSe_2$ monolayer emitting single-photon pulses statically prepared in four polarization states. Inset: $g^{(2)}(\tau)$ histogram of the $WSe_2$ device revealing pure triggered single-photon emission.

In this talk, I will review recent progress in the field of quantum light generation for quantum networking. One spotlight will be on pioneering efforts on the application of TMDC-based devices in quantum communication. Using a bright single-photon source (SPS) based on a strain-engineered $WSe_2$ monolayer emitting at a wavelength of 807 nm, we demonstrate the feasibility of quantum key distribution (QKD) with atomically-thin SPSs [3]. Employed in a QKD-testbed emulating the BB84 protocol (cf. Fig. 1) we conduct a thorough performance study and benchmark the TMDC device against previous single-photon QKD experiments. Our study reveals that already rather simple $WSe_2$ SPSs show a performance competitive with previous implementations of QKD using QDs or color centers in diamond. Our work thus sets the direction for wider applications of emerging materials in quantum information processing. Moreover, recent results from deterministically fabricated QD-devices based on hybrid circular Bragg gratings are presented. Consistently achieving Purcell factors >20 and state-of-the-art values for the single-photon purity in directly fiber-pigtailed device configuration, we pave the way for the deployment of quantum photonic devices in metropolitan-area and inter-city quantum networks.

[1] P. Tonndorf et al., *Optica* **2**, 347-352 (2015).
[2] D. A. Vajner et al., *Advanced Quantum Technologies* 2100116 (2022).
[3] T. Gao et al., *npj 2D Materials and Applications* **7**, 4 (2023).