Excitonic quantum interference in 2D semiconductors

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Few solid-state systems exhibit optical phenomena related to quantum interference such as electromagnetically induced transparency (EIT). We identify a cascaded excitonic three-level system in monolayer transition metal dichalcogenide (TMDC) system [1], which allows us to demonstrate a cavity-free, atom-like EIT effect in the optical transitions of strongly bound excitons [2]. The valley-selective second-harmonic generation (SHG) unveils the EIT as an unusual spectral split, whose number relates directly to the number of Rabi flops the strongly driven system undergoes within a single laser pulse. We show a wide tuning of the energy for quantum interference through the dielectric effect by placing various polymers on top of monolayer WSe_2 [3]. We demonstrate the control over quantum interference through twist angle in artificially stacked bilayer WSe_2 and $MoSe_2$ [4]. In contrast to quantum interference in atomic-gas systems, two-dimensional semiconductors offer routes to tuning quantum-optical phenomena with application potential in compact solid-state optical mixers and quantum nonlinear optoelectronics.

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[2] Lin, K.-Q., Bange, S., Lupton, J. M., *Nat. Phys.* **15**, 242 (2019).
[3] Lin, K.-Q., Martin, R., Bange, S., Lupton, J. M., *ACS Photonics* **6**, 3115 (2019).
[4] Lin, K.-Q. et al., *Nat. Commun.* **12**, 1553 (2021).