Interaction-Driven Quadrupolar and Dipolar Excitons in a Moiré Superlattice

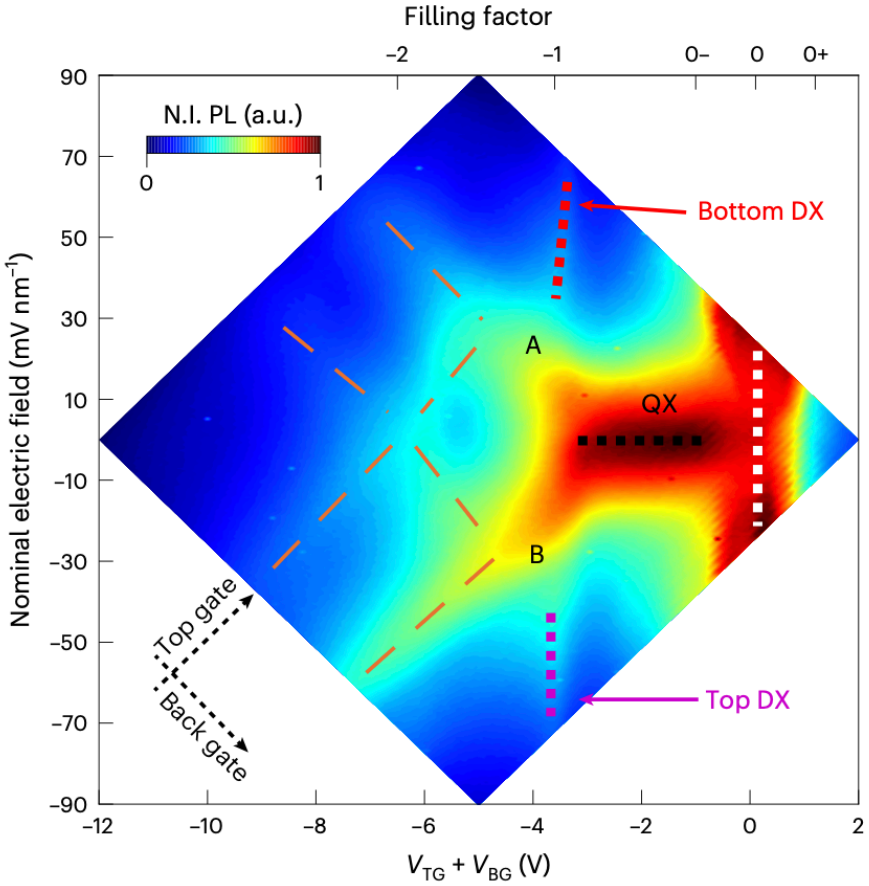

Figure: Integrated PL intensity at 7 K as a function of doping and nominal electric field with an excitation intensity of 1.3 μW/μm 2 .

Scientific Achievement

Demonstration of a new way to switch between quadrupolar and dipolar excitons — exotic light–matter particles — in a trilayer moiré superlattice.

Significance and Impact

This work reveals how strong interactions in layered semiconductors can be harnessed to engineer entirely new quantum phases of matter. The findings pave the way for designing next-generation devices that manipulate light and information with quantum precision.

Research Details

- Built trilayer $WSe_2/WS_2/WSe_2$ moiré device hosting quadrupolar excitons.
- Showed transitions between quadrupolar and dipolar excitons with light intensity (exciton density).
- Controlled exciton switching also via electrostatic doping.

Meng, Y.; Ma, L.; Yan, L.; Khalifa, A.; Chen, D.; Zhang, S.; Banerjee, R.; Taniguchi, T.; Watanabe, K.; Tongay, S. A.; Hunt, B.; Lin, S.-Z.; Yao, W.; Cui, Y.-T.; Chatterjee, S.; Shi, S.-F. Strong-Interaction-Driven Quadrupolar-to-Dipolar Exciton Transitions in a Trilayer Moiré Superlattice. *Nature Photonics.* 2025.

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