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Title: Understanding light-matter interactions in 2D materials

Abstract:
Two-dimensional (2D) materials like the transition metal dichalcogenides (TMDs) and their van der Waals bonded layered structures, present exciting opportunities for creating new types of quantum states that can be manipulated with unprecedented accuracy and efficiency. I will present our recent theoretical/experimental results on dielectric engineering of excitons in TMD monolayers [1] and electrical tuning of mixed interlayer excitons in TMD bilayers [2,3]. The spontaneous radiative emission from electronic transitions in 2D materials can be controlled by engineering the electromagnetic vacuum field. We show that record high Purcell enhancements of up to 10^7 can be achieved by coupling intersubband transitions in van der Waals quantum wells to the acoustic plasmons in a graphene sheet [4]. Finally, I will provide a brief update on the Computational 2D Materials Database (C2DB), which provides open access to a variety of physical properties of more than 4k monolayer materials [5].

References:

[1] Anomalous Non-Hydrogenic Exciton Series in 2D Materials on High-κ Dielectric Substrates, A. C. Riis-Jensen et al. arXiv:2009.12317
[2] Interlayer Excitons with Large Optical Amplitudes in Layered van der Waals Materials, T. Deilmann and K. S. Thygesen, Nano Lett. 18, 2984 (2018)
[3] Electrical tuning of optically active interlayer excitons in bilayer MoS_2, N. Peimyoo *et al.*, Nature Nanotechn., accepted
[4] Combining density functional theory with macroscopic QED for quantum light-matter interactions in 2D materials, M. K. Svendsen *et al.*, arXiv:2103.09501
[5] Recent Progress of the Computational 2D Materials Database (C2DB), M. Gjerding *et al.* arXiv:2102.03029