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Optoelectronics of supported and suspended 2D semiconductors

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Two-dimensional semiconductors, materials such monolayer molybdenum disulfide (MoS_2) are characterized by strong spin-orbit and electron-electron interactions. However, both electronic and optoelectronic properties of these materials are dominated by disorder-related scattering. In this talk, we investigate approaches to reduce scattering and explore physical phenomena arising in intrinsic 2D semiconductors. First, we discuss fabrication of pristine suspended monolayer MoS_2 and use photocurrent spectroscopy measurements to study excitons in this material. We observe band-edge and van Hove singularity excitons and estimate their binding energies. Furthermore, we study dissociation of these excitons and uncover the mechanism of their contribution to photoresponse of MoS_2. Second, we study strain-induced modification of bandstructures of 2D semiconductors. With increasing strain, we find large and controllable band gap reduction of both single- and bi-layer MoS_2. We also detect experimental signatures consistent with strain-induced transition from direct to indirect band gap in monolayer MoS_2. Finally, we fabricate heterostructures of dissimilar 2D semiconductors and study their photoresponse. For closely spaced 2D semiconductors we detect charge transfer, while for separation larger than 10nm we observe Forster-like energy transfer between excitations in different layers.