NANOSCIENCE COLLOQUIUM

Moiré minibands, dense exciton ensembles and hybridization in vdW stacks from optical spectroscopies

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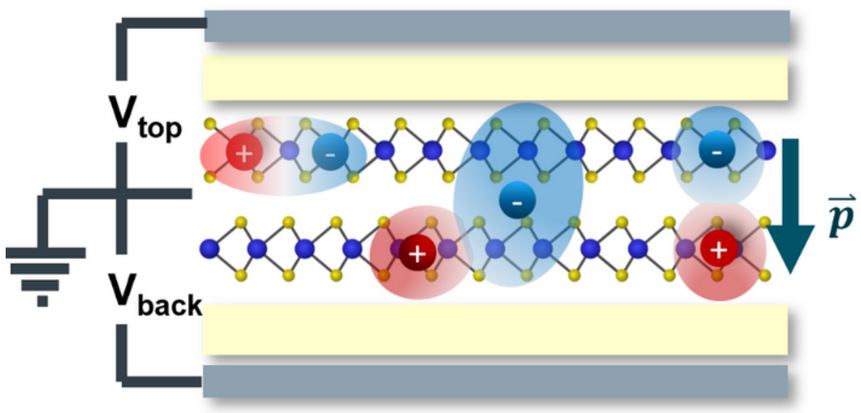
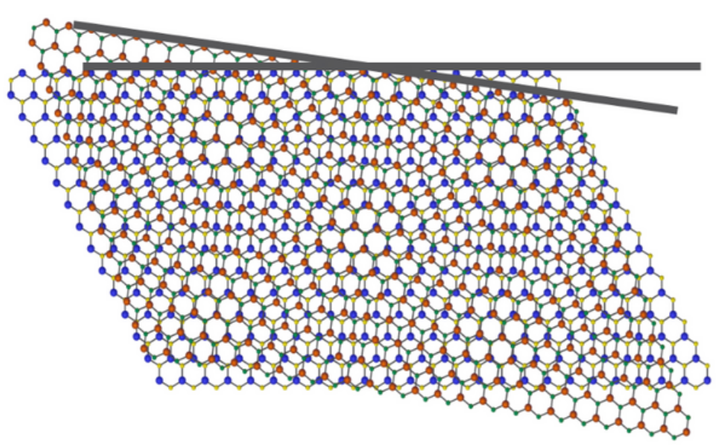
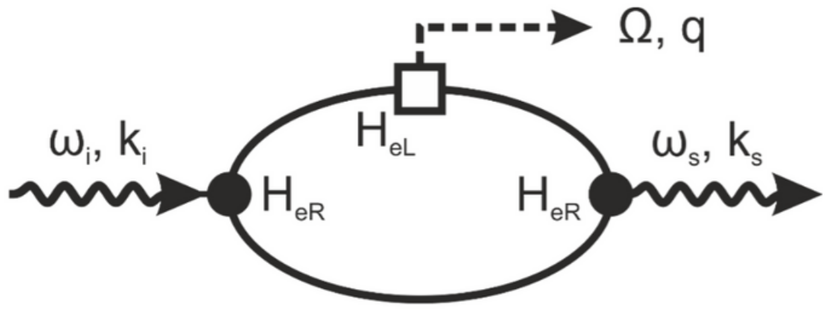
Abstract: Two-dimensional (2D) materials exhibit unique properties due to their atomically thin structure and weak van der Waals (vdW) coupling between layers. This vdW nature allows for the precise engineering of 2D quantum systems through stacking, twisting, and inducing defects. External stimuli, such as electric or magnetic fields and charge doping, enable in-situ control of these systems. Those vdW stacks can have properties individual layers or conventional 3D solids do not reveal: (i) twist-angle dependent moiré superstructure with periodic potential profiles and the formation of minibands [1] and (ii) momentum dependent hybridization of electronic state resulting in the competition between interlayer (IX) and intralayer (X) excitons [2,3]. In particular, we will discuss the low-temperature emission properties of dense interlayer exciton ensembles in MoSe2/WSe2 hetero-bilayers featuring several criticalities [4] and drastically reduced dipolar blueshift together with extended spatial coherence [5]. These findings are in agreement with the occurrence of a coherent many-body state of IX. Moreover, we demonstrate that studying collective charge excitations between moiré-minibands in twisted WSe2 bilayers by means of resonant inelastic light scattering spectroscopy provide unique experimental access to the modulated bands in twisted bilayers structures [1].







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