Dipolar excitonic insulator in a moiré lattice

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Abstract

Two-dimensional (2D) moiré materials provide a highly-controllable solid-state platform for studies of correlated quantum phenomena. To date, experimental studies have focused on the correlated electronic states; the correlated bosonic states in moiré materials have remained practically unexplored. Here, we report a correlated dipolar excitonic insulator--a charge insulating state driven by exciton formation--in a Coulomb-coupled WSe2 monolayer and WSe2/WS2 moiré bilayer at total hole doping density equal to the moiré density. The system is a Mott insulator when all the holes reside in the moiré layer. Under an out-of-plane electric field, the holes can be continuously transferred to the WSe2 monolayer, but remain strongly bound to the empty moiré sites. This is effectively an interlayer exciton fluid in the moiré lattice under a particle-hole transformation. We identify the phase space and determine the charge gap energy of the excitonic insulating state by optical spectroscopy and capacitance measurements, respectively. We further observe the emergence of local magnetic moments in the WSe2 monolayer induced by the strong interlayer Coulomb correlation. Our result paves the path for realizing correlated bosonic quantum phenomena described by the Bose-Hubbard model in a solid-state system.

Full Text

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