Implementation of the Bilayer Hubbard Model in a Moiré Heterostructure

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Moiré materials provide a unique platform for studies of correlated many-body effects, implementing the two-dimensional Fermi-Hubbard model on a triangular spin-charge lattice. In that context, bilayer systems present particular interest concerning exotic states of matter, but their experimental implementation has so far remained elusive. here, we demonstrate the realization of a staggered bilayer triangular lattice of electrons in an antiparallel $MoSe_2/WS_2$ heterostructure. The bilayer lattice emerges due to strong electron confinement in the moiré potential minima and the near-resonant alignment of conduction band edges in $MoSe_2$ and WS_2. As a result, charge filling proceeds layer-by-layer, with the first and second electron per moiré cell consecutively occupying first the $MoSe_2$ and then the WS_2 layer. We describe the observed charging sequence by an electrostatic model and provide experimental evidence of antiferromagnetic spin correlations on the vertically offset and staggered bilayer lattice, yielding absolute exciton Landé factors as high as 600 at lowest temperatures. The bilayer character of the implemented spin-charge lattice allows for electrical tunability of the spin exchange coupling and establishes antiparallel $MoSe_2/WS_2$ heterostructures as a valuable system for studies of strongly coupled bilayer Hubbard model physics, enabling future studies of exotic magnetic phases in frustrated lattices.

References

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Figures

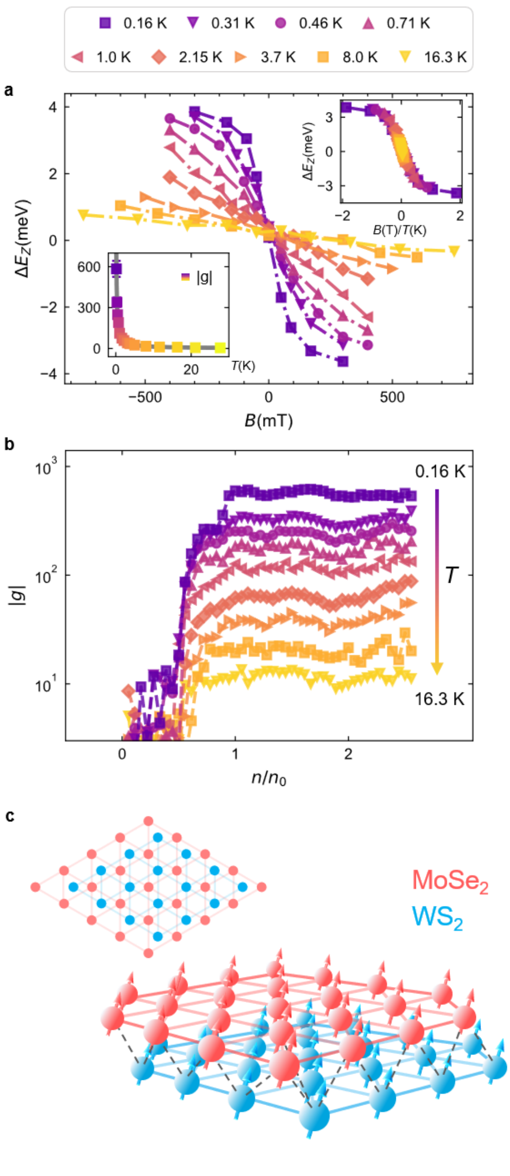

Figure 1: Electrically controlled, doping-dependent spin-susceptibility of a bilayer moiré heterostructure probed at mK temperatures.