Intertwined quantum confinement effects in charge-density-wave nanostructures

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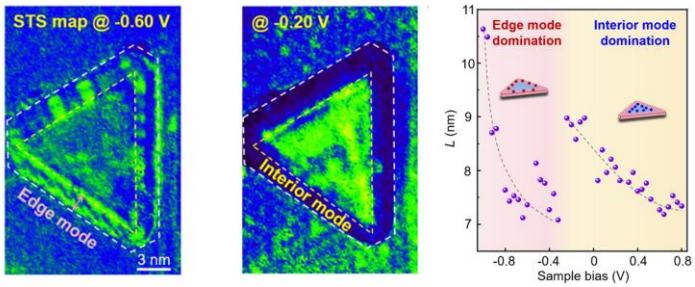
Charge carriers confined into a geometrical configuration approaching the nanoscale are expected to show remarkable confinement phenomena that depart from the intrinsic ground states. Especially for the many-body interacting systems, understanding the underlying physics of quantum confined behaviors at the atomic scale is critical for the advancement of nanoscience and nanotechnology. Here we report anomalous quantum confinement effects and modulation effects of the substrates in triangular-like nanostructures of monolayer H-$NbSe_2$ by scanning tunneling microscopy experiments. The monolayer H-$NbSe_2$ nanostructures on graphene substrates usually generate domain boundaries which disappear when the substrates are H/T-$NbSe_2$. Moreover, both H-$NbSe_2$ and T-$NbSe_2$ substrates can effectively induce striped charge states in monolayer H-$NbSe_2$ nanostructures. More importantly, our spectroscopic measurements reveal remarkable electron confinement behaviors in monolayer H-$NbSe_2$ nanostructures on H-$NbSe_2$ substrates, where the confined electrons can be visualized either along the nanostructure edges or within the nanostructures, dependent on the electron energies, resulting in intertwined quantum confinement effects, which are anomalous quantum confinement effects. Our results provide a fruitful playground for investigating the intertwined quantum confinement effects in charge-density-wave nanostructures under the two-dimensional limit.



Bibliography

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