Evidence of strong correlations and unconventional superconductivity in monolayer transition metal dichalcogenides 1H-NbSe2 and 1H-TaS2

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Unconventional superconductors, such as high temperature superconductors, heavy fermion superconductors and topological superconductors have been at the forefront of strongly correlated materials due to the existence of competing electronic interactions in these systems. These systems have non-S-wave pairing symmetry and possible pairing mechanism driven by magnetic excitations. Despite these advancements, unambiguous discovery of unconventional superconductivity in van der Waals (vdW) systems have remained elusive. In our work, we investigated MBE-grown monolayer vdW superconductors 1H-$NbSe_2$ and 1H-TaS_2 by low temperature STM and STS. In the first part [1], we demonstrate that by controlling the 1H-$NbSe_2$ island sizes and thereby enhancing the Coulomb repulsion, we can drive a superconductor to correlated insulator transition. We also show that superconducting proximity effect strongly impacts the ground state, pushing the system through the superconductor-correlated phase boundary. In the second part [2], we demonstrate that pristine monolayer 1H-TaS_2 realizes a nodal f-wave superconducting state showing many-body excitations. We observe that this nodal f-wave is driven to a conventional gapped s-wave state by inclusion of non-magnetic disorder. Our results demonstrate the emergence of unconventional superconductivity in vdW monolayers. Our results demonstrate the emergence of unconventional superconductivity in vdW monolayers and therefore opens possibilities to create designer unconventional superconductivity and strongly correlated material by artificial van der Waals heterostructures [3].

References:

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