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ABSTRACT

Misfit Compounds as a Platform for Engineering Doping, Charge Density Waves and Ising Superconductivity

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In the current quest of innovative materials which combine two-dimensionality, strong spin-orbit, valley physics, superconductivity, charge density wave, quantum-spin Hall effect, the transition metal dichalcogenides (TMD) misfit materials appear as extremely promising. They are constituted by sandwiching rocksalt layers, such as LaSe, and TMD layers such as NbSe2. A very large combination of materials is achievable by playing on the stacking. TMD misfits are a new platform that allows achieving unprecedented high doping levels in TMD materials1-2. We will show how we have succeeded adjusting finely the chemical potential over a very wide range in NbSe2 using a PbxLa1-x rocksalt, and how this can used for stabilizing several charge density wave orders ( ) and tuning the superconducting transition temperature over a wide range2. Superconductivity in these compounds exhibits a huge in-plane critical field which is much higher than the paramagnetic limit3-4 due to a very strong Ising spin-orbit coupling. We will show some hint of non-conventional pairing in misfit compounds.

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[2] Layer Compounds as Ultratunable Field Effect Transistors: From Charge Transfer Control to Emergent Superconductivity, L Zullo, G Marini, T Cren, M Calandra, Nano Letters 23, 6658 (2023)
[3] Extreme in-plane upper critical magnetic fields of heavily doped quasi-two-dimensional transition metal dichalcogenides, P. Samuely et al., Phys. Rev. B 104, 224507 (2021)
[4] Protection of Ising spin-orbit coupling in bulk misfit superconductors, T. Samuely et al., Physical Review B 108, L220501 (2023)