Exotic superconducting states in 2D materials and moiré engineering at oxide interfaces

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Inspired by surprising recent experiments on the superconducting state in twisted van der Waals moiré systems, we discuss, in the first part of the talk, two possible natural theoretical explanations. In one explanation [1], the 2D nature of these systems and thermal fluctuations are taken into account which naturally leads to interesting vestigial pairing states, yielding spectral functions that are consistent with experiment. In a second explanation [2], we ask the question whether similar spectral functions can also be obtained in a pure mean-field picture. The second part of the talk is motivated by another set of recent experiments demonstrating atomically sharp interfaces between twisted oxides with different Bravais lattices. We will discuss the general band theory for these types of moiré interfaces, uncovering novel forms of geometric magic angles, and explore the unprecedented possibilities of moiré band engineering provided by these systems.

[1] Poduval and Scheurer, Nature Communications 15, 1713 (2024).
[2] Christos, Sachdev, and Scheurer, Nature Communications 14, 7134 (2023).
[3] Putzer, Pupim, and Scheurer, arXiv:2404.12420.