LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN | ARNOLD SOMMERFELD CENTER FOR THEORETICAL PHYSICS

Sommerfeld Theory Colloquium

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Experimental Observation of Small Fermi Pockets and the BCS-BEC Crossover in Multilayer Cuprates

Understanding how superconductivity emerges from a doped antiferromagnetic Mott insulator remains one of the central challenges in condensed-matter physics. While the electronic phase diagram of cuprates has been extensively investigated using single- and bilayer compounds, the CuO2 planes in these systems lie directly adjacent to dopant layers, where unavoidable disorder obscures the intrinsic electronic states, particularly in the heavily underdoped regime, where electronic screening is weak. This limitation can be overcome by studying the inner CuO2 planes of multilayer cuprates, which are spatially separated from the dopant layers and therefore provide an almost ideal realization of a clean doped Mott system. In this talk, I will present our angle-resolved photoemission spectroscopy (ARPES) studies on multilayer cuprates. We directly observe the coexistence of a small Fermi pocket and a remarkably large superconducting gap in the clean inner CuO2 planes, resulting in an exceptionally large pairing strength (/F), together with pairing pseudogap behavior and Bogoliubov flat bands, which are hallmark signatures of the BCS-BEC crossover. Surprisingly, the crossover develops not with decreasing carrier density, as conventionally expected, but rather abruptly upon a slight increase in doping within a very narrow doping range. These findings establish clean CuO2 planes as an ideal platform for investigating the microscopic origin of superconductivity emerging from a doped antiferromagnetic Mott insulator. Finally, we demonstrate a unique electronic configuration realized in multilayer cuprates, where a clean inner CuO2 plane is sandwiched between highly overdoped metallic outer planes. The metallic outer planes electronically screen

the clean inner CuO2 plane, suppressing disorder and extending superconducting coherence beyond the antiferromagnetic zone boundary, where competing electronic orders emerge. These findings establish electronic screening as a fundamental control parameter of the doped Mott state and high-Tc superconductivity.

Wednesday, 28 October 2026, 16:15h, Room A348, Theresienstr. 37/III

Prof. Annabelle Bohrdt and Prof. Fabian Grusdt