Advances in the twistronics of high temperature superconductors

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Van der Waals heterostructures formed by mechanically stacking layers of 2-Dimensional (2D) materials possess unique properties and new functionalities, not seen in standard materials, that make them an irreplaceable platform for emergent electronics. One of the stumbling stone that hinders the progress in utilizing van der Waals' attractive features in technology, is the fact that many of them, especially the novel topological quantum states and related phenomena are restricted to low temperatures. This poses the challenge of creating van der Waals heterostructures harboring novel topological quantum matter physics at elevated temperatures. This challenge is met by employing high temperature superconductors-based 2D crystals which offer the most advantageous route to increase the temperature range in which the topological states and phenomena associated with van der Waals devices can be used. Realizing this daunting task requires understanding the microscopic mechanisms underlying their properties as well as the developing technologies for their engineering and manipulation. This talk addresses the use of Bi-2212 optimally doped crystals (Tc = 90 K), their chemical complexity is analyzed by studying the role of the oxygen dopants and incommensurate lattice modulation which is a key element for understanding the electrical properties of cuprates. Utilizing solvent- and polymer-free nanofabrication at cryogenic temperatures makes it possible to create Josephson junctions based on high temperature superconductors. This seminar describes the fundamental properties of such twisted junctions and discusses the possibility of introducing twisted high temperature superconductors in electrodynamical quantum circuits.

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