北京大学量子材料科学中心

International Center for Quantum Materials, PKU

Weekly Seminar

One-Dimensional Luttinger Liquids in a Two-Dimensional Moiré Lattice

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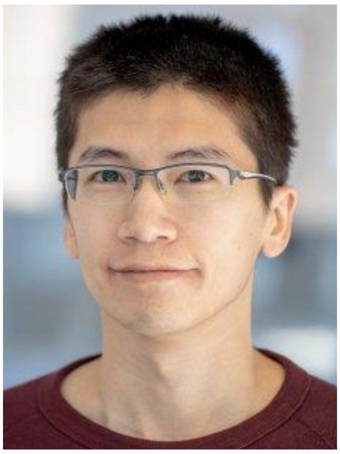

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Abstract

The Luttinger liquid (LL) model of one-dimensional (1D) electronic systems provides a powerful tool for understanding strongly correlated physics including the quasi-particle excitations, e.g., spin-charge separation. Substantial theoretical efforts have attempted to extend the LL phenomenology to two dimensions (2D), especially in models of closely packed perfect arrays of 1D quantum wires, each being described as a LL. For instance, such coupled-wire models have been successfully used to construct 2D anisotropic non-Fermi liquids, various quantum Hall states, topological phases, and quantum spin liquids. Despite these exciting theoretical developments, an experimental demonstration of high-quality arrays of 1D LLs suitable for realizing these models remains absent. In this talk, I will mainly present our recent experimental realization of 2D arrays of 1D LLs in a moiré superlattice made of twisted bilayer tungsten ditelluride ($tWTe_2$). Originating from the anisotropic lattice of the monolayer, the moiré pattern of $tWTe_2$ hosts identical, parallel 1D electronic channels, separated by a fixed nanoscale distance, which is tunable by the twist angle between layers. At a twist angle of ~ 5 degrees, we find that hole-doped $tWTe_2$ exhibits exceptionally large transport anisotropy with a resistance ratio of ~ 1000. The conductance measurement reveals a power-law scaling behavior, consistent with the formation of a 2D anisotropic phase that resembles an array of LLs. Our results open the door for realizing a variety of 2D correlated and topological quantum phases based on coupled-wire models and LL physics.

About the speaker

Pengjie Wang is a postdoctoral researcher working with Prof. Sanfeng Wu, in the Department of Physics, Princeton University. He earned his PhD under the supervision of Prof. Xi Lin in 2018, in the International Center for Quantum Materials, Peking University. His current research interests focus on the interplay of strong correlations and topology in 2D crystals and twisted stacks.