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Moiré Physics in Ultracold Atoms

Tuesday, 24 September 2024 16:30 (30 minutes)

Moiré physics has flourished since the realization of twisted bilayer graphene at magic angles. Thanks to the high controllability and clean environment, ultracold atoms are ideal platforms for studying moiré physics. In this talk, I will present our recent progress in this direction. Using spin-dependent optical lattices for Rb87, Jing Zhang's group at Shanxi University first realized the moiré lattice in 2023. Our theoretical analysis contributed to explaining the new phases found in the experiment. Recently, we have further investigated the single-particle energy spectrum as a function of the twisting angle. We found beautiful fractal patterns and explained such behaviors by mapping the twisted bilayer optical lattice into an extended Hofstadter model. We have also extended the moiré physics to three dimensions. We emphasize a key distinction of three-dimensional moiré physics: in three dimensions, the twist operation generically does not commute with the rotational symmetry of the original lattice, unlike in two dimensions, where these two always commute. Therefore, the moiré crystal can possess a different crystal structure compared with the original lattice. We show that various crystal structures can be generated by twisting a simple cubic lattice. This capability of changing crystal structure by twist offers a broad range of tunability of band dispersion, including topological or flat bands, which can lead to richer few-body and many-body effects after adding interactions. I will also discuss possible scenarios in the two-body sector.

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