复旦大学物理系 Colloquium

Time: 14:00, Friday, 2021.09.24

Location: Room C108, Jiangwan Physics Building

轨道活性六角蜂窝材料的统一理论
Unification of orbital-active honeycomb materials

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Abstract: Based on the symmetry principle, we provide a unified view on a class of orbital-active honeycomb materials. They possess a pair of degenerate orbitals on each site forming the 2D (E-) representation of the $\boldsymbol{D}_3$, or, $\boldsymbol{C}_{3v}$ point group symmetry. We found the same principle applies to a variety of solid state systems including the p_x and p_y orbitals of bismuthene, stanene, the exciton-polariton lattice, and the $\boldsymbol{d}_{x2\text{-}y2}$ and $\boldsymbol{d}_{r2\text{-}3z2}$-orbitals in transition-metal oxide layers, and also the ultra-cold atom optical lattices. I will explain that the recent focus of the twisted bilayer graphene is a particular example to manifest this symmetry. Such a unified view brings a variety of interesting properties, including the strong correlation physics of Wigner crystallization and ferromagnetism inside flat bands, interaction induced spontaneous quantum anomalous Hall states, and the orbital-assisted f-wave superconductivity. We also propose a new mechanism to boost the topological gap to the full scale of atomic spin-orbit coupling, which can reach the order of 1eV and has been recently realized in bismuthene on the substrate of SiC. In the Mott-insulating states, the orbital exchange is heavily frustrated as described by a novel quantum 120°-model -- a cousin of the Kitaev model, whose classic ground state problem maps to the fully packed loop model in the honeycomb lattice. The “order from disorder” study is performed to analyze its quantum ground state ordering.

Biography: Congjun Wu received his Ph.D. in physics from Stanford University in 2005, and did his postdoctoral research at the Kavli Institute for Theoretical Physics, University of California, Santa Barbara, from 2005 to 2007. He became an Assistant Professor in the Department of Physics at the University of California, San Diego (UCSD) in 2007, an Associate Professor of Physics at UCSD in 2011, and a Professor of Physics at UCSD in 2017. He was elected to be a Fellow of American Physical Society in 2018. His research interests are exploring new states of matter and reveling their organizing principles, including quantum magnetism, superconductivity, topological states, mathematical physics, and the numerical method of quantum Monte Carlo simulations.