复旦大学物理系 Colloquium

Time: 10:00, Wednesday, 2023.11.8

Location: C108, Jiangwan Physics Building

Quantum Metamaterials

Prof. Allan H. MacDonald

Physics Department, University of Texas at Austin

Abstract: According to Wikipedia a metamaterial is any material engineered to have properties that are not readily realized in naturally ocurring crystals. In practice the metamaterial notion has been employed mainly to design exotic properties for light wave in matter by patterning it on sub-optical wavelengths. The advent of two-dimensional materials in recent years has opened up an emerging opportunity to realize quantum metamaterials, in which many-particle matter waves that exhibit strongly-correlated and topologically non-trivial properties rare in naturally occuring crystals appear at will. For example, two-dimensional van der Waals crystals that are overlaid with a difference in lattice constant or a relative twist form a moir é pattern. In semiconductors and semimetals, the low-energy electronic properties of these systems are accurately described by Hamiltonians that have the periodicity of the moir é pattern – artificial crystals with lattice constants on the 10 nm scale. Over the past several years substantial progress has been made in the fabrication of these moire metamaterials, especially ones based on graphene, hexagonal boron nitride, and transitional metal dichalocogenides (TMDs). Since the miniband widths in both graphene and TMD moir é materials can be made small comparted to interaction energy scales, for different reasons [1,2] in the two cases, the birth of moir é materials has opened up a new platform to study strongly correlated electrons and excitions, a platform that can be used both for simulation and for design and has been surprisingly rich. An important property of moir é materials is that their band filling factors can be tuned over large ranges without introducing chemical dopants, simply by using electrical gates. In addition to realizing Mott insulators, density waves, a vareity of different types of magnets, and superconductors – states of matter that are familiar.

Biography: Allan H. MacDonald is now Sid W. Richardson Foundation Regents Chair professor in Department of Physics, the University of Texas at Austin. He received his Ph. D. degree in University of Toronto in 1978. He was appointed co-recipient of the Buckly Prize in 2007, Fellow of the National Academy of Sciences of the United States in 2010, was awarded Ernst Mach Honorary Medal Academy of Sciences of the Czech Republic in 2012, and the 2020 Wolf Prize in Physics for his groundbreaking work in a field known as twistronics. His research interests are centered on the electronic properties of electrons in metals and semiconductors. He has contributed principally to research on the quantum Hall effect, electronic structure theory, magnetism and spintronics, electronic transport theory, superconductivity, mesoscopic physics and other topics. He is motivated primarily by the goal of predicting unanticipated new properties of condensed matter. He has over 600 ISI publications and over 40,000 ISI citations, with an h-index = 90. He is among 119 physicists identified as highly-cited researchers.