复旦大学物理系 Colloquium

Time: 14:00, Tuesday, 2024.10.29

Location: C108, Jiangwan Physics Building

Quantum Mechanics of Composite Fermions

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Abstract: In partially filled Landau levels or flat Chern bands, a fictitious world of composite fermions (CF) emerges. In this talk, I present the quantum mechanics governing CFs. Starting from a CF binding potential, I will show how the ground states wave functions of fractional quantum Hall (FQH) states can be derived by setting up and solving a wave equation for CFs, followed by a projection that eliminates redundant vortex degrees of freedom. While the approach reproduces the wave-functions prescribed by the standard CF theory for the lowest Landau level, it is also applicable to more general systems. I will discuss two applications of the approach: (1) The origin of the peculiar behaviors of FQH states in the first excited Landau level, which have long been puzzling and considered inconsistent with the CF theory; (2) A generalization for topological Bloch bands, revealing a possibility of hosting FQH states in non-flat Chern bands. Moreover, the approach suggests that the low-energy effective theory of a CF system differs from the one hypothesized in the Halperin-Lee-Read theory.

Biography: Junren Shi is a Professor of Physics at Peking University. He earned his B.S. from Fujian Normal University (1993), followed by graduate studies at Nanjing University (1993 – 1998) and a Ph.D. from Oklahoma State University (2002). He conducted postdoctoral research at Oak Ridge National Laboratory (2002 – 2004) and the University of Texas at Austin (2004 – 2005) before joining the Institute of Physics, Chinese Academy of Sciences, as a staff scientist (2005 – 2010). Since 2010, he has been at Peking University. His research is focused on the transport properties of condensed matter systems, including spin current, orbital magnetization, thermal and phonon Hall effects, superconductivity of liquids and anharmonic solids, and composite fermion theory.

Reference:

1. J. Shi, Phys. Rev. Research 6, 023306 (2024).
2. H. Jin and J. Shi, arXiv:2407.10647 (2024).