国家数学与交叉科学中心
综合报告会

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Venue: C110

Lecture1: Emergent phenomena in the Quantum Matter
Speaker: Prof. Yu Lu
Institute of Physics, Chinese Academy of Sciences
Time: 9:00am—9:50am

Abstract: The reductionism is a basic and successful tool in studying the material world. However, it is not the unique way to understand the complexity of the real world which is built up in a hierarchical manner. At each level of complexity there are new, 'emergent' properties, which cannot be reduced from the knowledge of its constituents. We will illustrate these properties on examples from the condensed matter, including elementary excitations, Landau Fermi liquid theory, phase transitions, symmetry breaking, renormalization group, etc. Recent progress in physics has revealed the limitation/failure of this standard paradigm, calling for new concepts like topological order, non-Fermi liquid behavior, etc. Some of these current challenges in studying the quantum matter will be briefly outlined.

Lecture2: Topology and States of Matter
Speaker : Prof. Wang Zhenghan
Microsoft Research, Station Q at UC Santa Barbarat
Time: 10:00am—10:50am

Abstract: Application of topology in physics predates topology when Gauss used his famous linking number formula for the tracking of asteroids and comets in 1833. Since then, knotting (and linking) has been a central theme in the interactions between mathematics and physics: in Lord Kelvin's model, knots are atoms, in string theory, knots are particles, and in condensed matter physics, knots are trajectories of quasi-particles, called anyons. We will explain the recent interaction of mathematics and physics in condensed matter physics: topological quantum field theories such as Witten-Chern-Simons theories are effective models of topological states of matter, where knots play a fundamental role. A profound consequence of this interaction is a promising route to the construction of a large scale quantum computer.

Lecture3: Topological order and Long range entanglements --tensor category in condensed matter physics
Speaker: Prof. Wen Xiao-Gang
Dept. of Physics, Massachusetts Institute of Technology
Time: 11:00am—11:50am

Abstract: Two gapped quantum ground states in the same phase are connected by an adiabatic evolution which gives rise to a local unitary transformation that maps between the states. On the other hand, gapped ground states remain within the same phase under local unitary transformations. Therefore, local unitary transformations define an equivalence relation and the equivalence classes are the universality classes that define the different phases for gapped quantum systems. Since local unitary transformations can remove local entanglement, the above equivalence/universality classes correspond to pattern of long range entanglement, which is the essence of topological order. The local unitary transformation also allows us to define a wave function renormalization scheme, under which a wave function can flow to a simpler one within the same equivalence/universality class. Using such a setup, we find conditions on the possible fixed-point wave functions where the local unitary transformations have finite dimensions. The solutions of the conditions allow us to classify this type of topological orders, which has a close relation to tensor category theory.