

Joint Mathematics and Physics Summer School

Topological Phases, Conformal Field Theory and Tensor Category

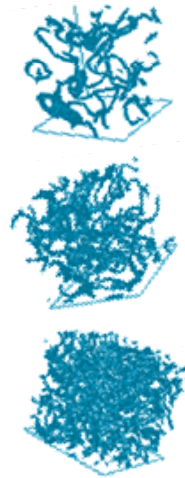
June 28 - July 2, 2010

Institute for Advanced Study, Tsinghua University

In recent years, there has been considerable interest in quantum systems which show novel behaviors emerging from the collective motion and interaction of the constituent local degrees of freedom. The novel phenomena include fractional quantum number, fractional statistics, topologically protected gapless bulk/edge excitations, etc. The goal of this summer school is to introduce the physical background and the mathematical framework for those novel behaviors. The intended audiences are the graduate students in mathematics and physics.

Prof. Yi-Zhi Huang (4 lectures)

- Vertex operator algebras (Heisenberg, Virasoro and affine Lie algebras).
- Modules for vertex operator algebras. Operator product expansions. Fusing and braiding matrices. Intertwining operator algebras.
- Tensor products of modules for vertex operator algebras. Intertwining operator algebras and braided tensor categories. Modular invariance. Modular tensor category structures.

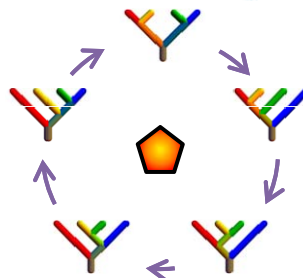


Prof. Yong-Shi Wu (2 lectures)

- Fractional statistics: Abelian and non-Abelian anyons, braid groups and Chern-Simons gauge theory, realization in the quantum Hall systems.
- Ground state degeneracy (GSD) of topological phases: FQHE, theoretical proofs (Chern-Simons theory, braid group), methods for determining GSD (gauge theory, topological algebra, the Levin-Wen model).

Prof. Zhenghan Wang (4 lectures)

- Topological quantum field theories: Levin-Wen model and $6j$ symbols.
- Algebraic theory of anyons: Tensor category theory.
- Interacting anyons: Anyon chains and some ladder theories.
- Anyon condensation.



Prof. Xiao-Gang Wen (5 lectures)

- An introduction of topological order.
- Mathematical data that describe topological orders: the pattern of zeros and tensor product state.
- Physical properties that characterize the topological orders.
- How to calculate those physical properties from the mathematical data.

