Course on Symmetry, Topology and Entanglement

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I. CONTENTS

1. Overview of the course and mains goals
2. Introduction to algebraic topology (manifolds and homotopy groups)
3. Topological defects and Berezinskii-Kosterlitz-Thouless phase transition
4. Topology and topological terms in quantum mechanics
5. Landau levels and integer quantum Hall physics
6. 2D topological Insulators
7. 1D and 2D topological superconductors (Kitaev's 1D model, p+ip state, ...)
8. Bloch bundles and obstructions
9. Fractional quantum Hall physics, Laughlin wavefuctions and beyond
10. Exact diagonalization of toy models for the FQH states
11. Edge states of FQH states (free boson theory, correlation functions, ...)
12. A formal introduction to topological order
13. A overview of quantum entanglement (entanglement spectrum and entropy of non-interacting systems, Laughlin states, etc)
14. Topological entanglement entropy
15. Spin liquids, RVB states and $\mathbb{Z}_2$ gauge theory

II. REFERENCES

- B. Andrei Bernevig and Taylor L. Hughes, *Topological Insulators and Topological Superconductors*, Princeton University Press 2013.
- Mikio Nakahara , *Geometry, Topology and Physics*, CRC Press 2003.
- Xiao-Gang Wen, *Quantum Field Theory of Many-body Systems: From the Origin of Sound to an Origin of Light and Electrons*, Oxford University Press (2007).

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