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Topological Quantum Order from Symmetry and the Role of Temperature[1]

GERARDO ORTIZ, Indiana University

What does a fractional quantum Hall liquid and Kitaev's proposals for topological quantum computation have in common? It turns out that they are physical systems that exhibit degenerate ground states with properties seemingly different than ordinary (Landau-type) phases of matter, such as ferromagnets. For example, those (topologically quantum ordered) states cannot be characterized by (local) order parameters such as magnetization. How does one characterize this new order? I will present a unifying framework which will allow us to engineer physical systems displaying topological quantum order. What are the physical properties of these new orders? How robust are they to temperature effects? What are they useful for? Topologically quantum ordered states of matter seem to be ideal physical systems to store and manipulate quantum information since they are believed to be robust against decoherence with an environment, and thus appropriate for building a quantum computer and quantum memories. I will discuss the role of temperature in the protection of quantum information. Have we finally found a new technological application for quantum Hall liquids?

[1]Work done in collaboration with Zohar Nussinov