

TOPOLOGICAL PHASES IN CONDENSED MATTER PHYSICS

organized by

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Workshop Summary

Topology can cause the entrapment of defects and dislocations in a physical medium. This phenomenon has both a classical and a quantum mechanical aspect and the two are linked by symmetry breaking within a gauge theory. We heard a variety of microscopic mechanisms which could be relevant for producing the quantum form of this phenomenon, i.e. quasiparticles or anyons. Anyons may be thought of as defects which fluctuate too strongly to be characterized as singularities of an order parameter. The microscopic description of theories which support anyons is a nexus between the mathematical ideal and the physical; between model and material. Much energy was devoted during the workshop to finding the simplest possible and hence the most realistic microscopies which could account for computationally universal anyons.

Mike Levin a third year student at MIT brought forward a well thought out understanding of the Yang-Lee category, a structure well known in other languages to certain topologists e.g. Greg Kuperberg. This looks like a promising candidate for a microscopic formulation. It is gratifying to see such a young person participate so fully with such a distinguished group.

The problem of estimating the spectral gap of a candidate model was thoroughly discussed. In the simplest case the defining terms in the Hamiltonian commute with each other and the analysis is straight forward. We would like to achieve a detailed understanding of how to at least perturb away from this simple case. This will be the subject of future work. Progress on this problem will have applications outside the context on which the workshop was focused, and perhaps be useful in the construction of anyonic materials.

The meeting proved to be an efficient mechanism for arriving, as a group, at a shared understanding of the issues. Researchers from mathematics, physics and chemistry were essentially brought to the same page to consider a problem with both mathematical beauty and technological importance.

Because the participants were so diverse in background we ended up using about half our time in lecture, to bring the group toward a common “fact set”. This is an unusually large fraction of the workshop time by ARC standards but in the present instance was essential.