

PhD Project : «Spin 1 systems: quantum spin liquids and simulated melting»

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Project description:

In this project we will study effective spin Hamiltonians related to the physics of spin $S=1$ systems in both the quantum and classical regimes. The work is of experimental relevance for quantum materials research, to artificial nano-magnetic arrays and more broadly to the long standing problem of melting in two-dimensional molecular systems.

Spin $S=1$ and related emergent models have been extensively studied as prototypes for quadrupolar (spin-nematic) order in magnetic insulators, and Fe-based superconductors. They are of fundamental interest for their rich phase diagram, including quadrupole and nematic phases and challenging critical phenomena [1,2]. Understanding both the ground state and thermal phase diagram in different lattice geometry offers a challenging numerical project which will be addressed during the project. Numerical simulations using semiclassical approaches, allowing classical simulations within the tensor phase space of the spin $S=1$ object will be supplemented by exact diagonalisation calculations.

In a related project we will study the passage from Kosterlitz-Thouless to first order phase transition in model two dimensional systems [3,4]. The motivation here is the non-universal nature of the two stage melting scenario for fluids predicted more than 40 years ago [5]. Recent technical developments have exposed that a large range of scenarios exist requiring such an evolution of the KT transition [6]. We plan to study simpler spin systems which possess many attributes of 2D melting while remaining on lattice.

The combined project is ideal for a motivated Ph.D. or PLR student. There is also the possibility of a visit of six months to the Kalvi Institute for Theoretical Physics, University of California Santa Barbara during the lifetime of the project.

Starting date: 01/09/2024 – stage M2 possible preceding this date

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