Tunable topological protection in Rydberg lattices via a novel quantum Monte Carlo approach

Rydberg atom arrays have recently been conjectured to host Z2 quantum spin liquids in certain parameter regimes. Due to the strong interactions between these atoms, it is not possible to analytically study these systems, and one must resort to Monte Carlo sampling of the path integral to reach definite conclusions. The complex landscape of path integral configurations prevents efficient sampling, and leads to a severe lack in ergodicity for the Monte Carlo simulation. Here we use the resonances expected between different configurations of a Z2 spin liquid to design a sampling protocol which is especially suited to the expected path integral landscape. This allows us to reliably simulate Rydberg atoms on a triangular lattice in this regime, and identify a correlated paramagnetic phase at low temperatures which hosts topological protection similar to a Z2 spin liquid upto a lengthscale tuned by Hamiltonian parameters.

[1] Pranay Patil, Owen Benton, arXiv:2503.12949 (2025).

Pranay PATIL, Indian Institute of Technology Madras, India