

Re-entrant topology in Kitaev spin liquid

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We have studied the anti-ferromagnetic Kitaev model on honeycomb lattice under a magnetic field, using Majorana mean-field analysis. When the direction-dependent exchange couplings are equal, i.e., at the isotropic limit of the model, we show that the debated intermediate state under a conical field, has two phases. First, the system enters into a topologically non-trivial gapped quantum spin liquid phase. Then the system enters into a possible glassy phase. We have performed exact diagonalization calculations that qualitatively support our mean-field results. We extend our study to the anisotropic limit of the exchange couplings. The pure Kitaev model is known to host a gapped, topologically trivial spin liquid, when the couplings' strength are beyond the triangular inequality. We show that, in this parameter space, by application of a magnetic field, topology shows a re-entrant behavior, for some intermediate strength of the field. These results are in agreement (when comparable) with our earlier works where we investigated the Kitaev model in small clusters to study some static [1] and dynamical [2] properties. We comment on possible extension of this work to include the presence of Heisenberg interaction, to test the emergent many-body aspects of Kitaev-Heisenberg-Zeeman model that we find for small clusters, while investigating the potential application of Kitaev material as working medium for quantum Otto heat-engine [3].

References:

[1] [Sheikh Moonsun Pervez](#) and Saptarshi Mandal, 'Deciphering competing interactions of Kitaev-Heisenberg- Γ system in clusters: I. Static properties', [Journal of Physics: Condensed Matter](#) **37**, 025802 (2024).

[2] [Sheikh Moonsun Pervez](#) and Saptarshi Mandal, 'Deciphering competing interactions of Kitaev-Heisenberg- Γ system in clusters: II. Dynamics of Majorana fermions', [Journal of Physics: Condensed Matter](#) **37**, 025803 (2024).

[3] [Sheikh Moonsun Pervez](#) and Saptarshi Mandal, 'Quantum Otto heat-engine with Kitaev-Heisenberg cluster: Possible roles of frustration, magnons, and duality', [arXiv:2601.03826](#).