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Thermal pure matrix product state in two dimensions: tracking thermal equilibrium from paramagnet down to the Kitaev spin liquid state

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We show that the matrix product state provides a thermal quantum pure state representation in equilibrium in two spatial dimensions over the entire temperature range. We use the Kitaev honeycomb model as a prominent, non-trivial example hosting a quantum spin liquid ground state. Our method is able to qualitatively capture the double-peak in the specific heat, which was previously obtained nearly exactly using a method tailored to the Kitaev honeycomb model. In contrast, our method can be applied to general systems including those with competing interactions. We also demonstrate, that the truncation process efficiently discards the high-energy states, eventually reaching the long-range entangled topological state with very low statistical errors.

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