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Gapless quantum spin chains: multiple dynamics and conformal wavefunctions

We study gapless quantum spin chains with spin $1/2$ and 1: the Fredkin and Motzkin models. Their entangled groundstates are known exactly but not their excitation spectra. We first express the groundstates in the continuum which allows for the calculation of spin and entanglement properties in a unified fashion. Doing so, we uncover an emergent conformal-type symmetry, thus consolidating the connection to a widely studied family of quantum critical points in 2 spatial dimensions. We then obtain the low lying excited states via large-scale Density Matrix Renormalization Group simulations and find that the dynamical exponent is $z = 3.2$ in both cases. Other excited states show a different z, indicating that these models have multiple dynamics. Finally, we exploit an exact map from the quantum Hamiltonian to the non-equilibrium dynamics of a classical spin chain to shed light on the quantum dynamics.