A study on dissipative models based on Γ-matrices

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We generalize the recent work of Shibata and Katsura (Phys. Rev. B 99, 174303 (2019)), who considered an S=1/2 chain with alternating XX and YY couplings in the presence of dephasing, as described by the GKLS master equation. Their model is equivalent to a non-Hermitian system which is described by the Kitaev formulation in terms of a single Majorana species hopping in the presence of a Z2 gauge field. Our generalization involves Dirac gamma matrix spin operators on the square lattice, and maps onto a non-Hermitian square lattice bilayer. In both cases, the nonequilibrium steady state is the infinite temperature state, but the various decay channels occur for nontrivial density matrices. We simplify the model using conserved quantities and study the Liouvillian spectrum and relaxation times. We observe a phase transition in the first decay modes (similar to that in Shibata and Katsura's result in Phys. Rev. B 99, 174303 (2019)) in the 2d model. We present a Monte Carlo approach to obtain the first decay modes in larger system sizes. We then present another dissipative model with a coordination number of 5 that can be solved using Gamma matrices and in which we again see a phase transition in the first decay modes.