Cluster Gutzwiller Monte Carlo approach for a driven-dissipative spin model

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Variational principles are fundamental in our theoretical understanding of closed quantum systems at thermal equilibrium. For open, driven-dissipative systems, variational techniques are much less established. For the theoretical simulation of driven-dissipative quantum systems, two equivalent approaches exist: a master equation for the density matrix and a quantum trajectory equation for wave functions. We will give a basic introduction to this quantum trajectory approach and apply it to a crticical dissipative spin model.

Recently, the dissipative XYZ Hamiltonian has been subject of different approaches attempting to describe the behaviour of this system. Among these are the cluster mean-field approach for the density matrix and a Gutzwiller Monte Carlo approach for the wave function. We will make a cluster Gutzwiller ansatz and use the quantum trajectory method for the wave function to make a comparative study. Considering lattices of finite size we show the emergence of a ferromagnetic phase, two paramagnetic phases and the possible existence of a phase transition which is entirely quantum in nature. The inclusion of short-range quantum correlations has a drastic effect on the phase diagram but our results show the inclusion of long-range quantum correlations or the use of more sophisticated methods are needed to quantitatively match the exact results. A study of the susceptibility tensor shows that reciprocity is broken, a feature not observed in closed quantum systems. Furthermore, increasing the magnetic field suppresses the magnetization, also in contrast with closed quantum systems.