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Phases in the fundamental Kazakov-Migdal model on the graph

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We discuss the phase structure of the fundamental Kazakov-Migdal (FKM) model, which is defined on graphs and a generalization of the Kazakov-Migdal model by replacing the scalar fields in the adjoint representation with the fundamental representation. We first show that the partition function of the FKM model can be represented by the unitary matrix valued graph zeta functions, which systematically counts possible Wilson loops on the graph. The effective action of the FKM model reduces to the Wilson action and is expected to induced Yang-Mills theory thanks to lack of the extra local symmetry. We evaluate the partition function of the FKM model exactly in the large N limit. In the different regions of the coupling constant corresponding to the confinement/deconfinement phase, the partition function is evaluated by using the factorizing property and saddle point method. In some cases depending on the graph structure, the derivative of the specific heat is jumped at the critical coupling constant. So we can expect that there is third order phase transition in the FKM model as well as the Gross-Witten-Wadia phase transition. We also perform the numerical analysis by using the HMC and check the above phase structure of the FKM model on various graphs.

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