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## **Quantum Cluster Variational Method and Message Passing Algorithms Revisited**

Abstract: We present a general framework to study quantum disordered systems in the context of the Kikuchi's Cluster Variational Method (CVM). The method relies in the solution of message passing-like equations for single instances or in the iterative solution of complex population dynamic algorithms for an average case scenario. We first show how a standard application of the Kikuchi's Cluster Variational Method can be easily translated to message passing equations for specific instances of the disordered system. We then present an "ad-hoc" extension of these equations to a population dynamic algorithm representing an average case scenario. At the Bethe level, these equations are equivalent to the dynamic population equations that can be derived from a proper Cavity Ansatz. However, at the plaquette approximation, the interpretation is more subtle and we discuss it taking also into account previous results in classical disordered models. Moreover, we develop a formalism to properly deal with the average case scenario using a Replica-Symmetric ansatz within this CVM for quantum disordered systems. Finally, we present and discuss numerical solutions of the different approximations for the Quantum Transverse Ising model and the Quantum Random Field Ising model in two dimensional lattices.