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Quantum Criticality for Extended Nodes on the Bethe Lattice[1]

JAMES MURRAY, Johns Hopkins University, ADRIAN DEL MAESTRO, University of Vermont, ZLATKO TESANOVIC, Johns Hopkins University — Theoretical description of anisotropic systems, such as layered superconductors and coupled spin chains, is often a challenge due to the different natures of interactions along different directions. As a model of such a system, we present an analytical study (1) of d-dimensional "nodes" arranged as the vertices of a Bethe lattice, where each node has nonzero spatial dimension and is described by an $O(N)$ quantum rotor model, and there is hopping between neighboring nodes. In the limit of large connectivity on the Bethe lattice, the hopping can be treated by constructing a self-consistent effective action for a single node. This procedure is akin to dynamical mean field theory, but generalized so that spatial as well as quantum fluctuations are taken into account on each node. The quantum phase transition is studied using this effective action for both infinite and finite N. The importance of the Perron-Frobenius uniform mode on the Bethe lattice is discussed, and its elimination via an "infinite range hopping" term shifts the transition, leading to nontrivial critical behavior. We calculate critical exponents and find that the internode hopping reduces the upper and lower critical dimensions each by one.

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