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Quantum phase transitions in the Kondo-necklace model[1] NADER GHASSEMI, SHAYAN HEMMATIYAN, Department of Physics, Texas A&M University, College Station, TX 77843-4242, MAHSA RAHIMI MOVASSAGH, Department of Physics, Mcmaster University, ON L8S 4L8, Canada, MAHDI KARGARIAN, Department of Physics, University of Texas at Austin, Austin, Texas 78712-1081, USA, ALI T. REZAKHANI, ABDOLLAH LANGARI, Department of Physics, Sharif University of Technology, Tehran 11155-9161, Iran — Kondo-necklace model can describe the magnetic low-energy limit of strongly correlated heavy fermion materials. There exist multiple energy scales in this model corresponding to each phase of the system. Here, we study quantum phase transitions between these different phases, and show the effect of anisotropies in terms of quantum information properties and vanishing energy gap. We employ the perturbative unitary transformations to calculate the energy gap and spin-spin correlations for the model one, two, and three spatial dimensions as well as for the spin ladders. In particular, we show that the method, although being perturbative, can predict the expected quantum critical point by imposing the spontaneous symmetry breaking, which is in good agreement with the results of numerical and Green's function analyses. We also use concurrence, a bipartite entanglement measure, to study the criticality of the model. Absence of singularities in the derivative of the concurrence in 2d and 3d in Kondo-necklace model shows this model has multipartite entanglement. We also discuss the crossover from the one-dimensional to the two-dimensional model via the ladder structure.

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