Spin-Orbital Entanglement and Violation of the Goodenough-Kanamori Rules

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In many cases mean field decoupling of spin and orbital operators in the superexchange model for a Mott insulator suffices to explain its magnetic and optical properties, as for instance in $LaMnO_3$ [1]. We point out that this is not always the case and large composite spin-orbital fluctuations in Mott insulators with t_{2g} orbital degrees of freedom are a manifestation of quantum entanglement of spin and orbital variables [2]. Both a one-dimensional SU(2)⊗SU(2) spin-orbital model and realistic models for d^1 and d^2 configurations are discussed. We also show that quantum transitions in spin-orbital models turn out to be continuous under certain circumstances, in constrast to the discontinuous transitions in spin models with SU(2) symmetry [3].

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