Functional renormalization group - a new approach to frustrated quantum magnetism

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The experimental and theoretical investigation of quantum spin systems has become one of the central disciplines of contemporary condensed matter physics. From an experimental viewpoint, the field has been significantly fueled by the recent synthesis of novel strongly correlated materials with exotic magnetic or quantum paramagnetic ground states. From a theoretical perspective, however, the numerical treatment of realistic models for quantum magnetism in two and three spatial dimensions still constitutes a serious challenge. This particularly applies to frustrated systems, which complicate the employment of established methods. This talk gives an introduction into the pseudofermion functional renormalization group (PFFRG) as a novel approach to determine large size ground state correlations of a wide class of spin Hamiltonians. Using a diagrammatic pseudofermion representation for quantum spin models, the PFFRG performs systematic summations in all two-particle fermionic interaction channels, capturing the correct balance between classical magnetic ordering and quantum fluctuations. Numerical results for various frustrated spin models on different 2D and 3D lattices are presented and benchmarked against other methods if available. Furthermore, recent applications to novel magnetic materials in the context of the search for quantum spin liquids are discussed.