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Quantum fluctuations and gapped Goldstone modes in spinor Bose-Einstein condensates ARON BEEKMAN, RIKEN Center for Emergent Matter Science — The classical Heisenberg ferromagnet is an exact eigenstate of the quantum Hamiltonian and therefore has no quantum fluctuations. Furthermore it has a reduced number of Goldstone modes, an order parameter that is itself a symmetry generator, is a highest-weight state for the spin algebra, and has no tower of states of vanishing energy. We derive the connection between all these properties and provide general criteria for their presence in other spontaneously-broken symmetry states. The phletora of groundstates in spinor Bose-Einstein condensates is an ideal testing ground for these predictions. In particular the phases with non-maximal polarization (e.g. the F-phase in spin-3 condensates) have an additional gapped mode that is a partner to the quadratically dispersing Goldstone mode, as compared to the maximally polarized, ferromagnetic phase. Furthermore there is a fundamental limit to the coherence time of superpositions in the non-maximally polarized state, which should manifest itself for small-size systems.

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