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Title: Quantum Monte Carlo methods: many-body nodal structures and treating the spins

Name: Mitas, Lubos

Affiliation: North Carolina State University

For Hamiltonians without explicit spin operators the real space quantum Monte Carlo (QMC) methods such as variational and fixed-node diffusion Monte Carlo are well established. For these types of systems the particle spins and their components commute with the Hamiltonian and, consequently, are conserved quantities. Indeed, this is a common framework of most electronic structure QMC and also of most basis set correlated calculations. However, many systems require treating spins as true quantum variables. We will review options for treating the spins in the diffusion Monte Carlo for heavy atoms with spin-orbit operators and present results for systems which show competition of spin-orbit and correlations. We will discuss the spin degrees of freedom in a broader framework of nodal structures of many-body wave functions and their forms such as pfaffians, and the implications of the fixed-node/fixed-phase approximations in this context. We show that the nodal domain structures are directly related to the nodal domains/hypersurfaces averages which are different from usual expectation values and provide new and unexpected insights into the spectral and topological properties of wave functions and corresponding many-body effects.