Strong-weak dualities for spin systems

Gustavo E. Scuseria

Department of Chemistry
Department of Physics & Astronomy
Department of Materials Science & Nano Engineering
Rice University, Houston, Texas, USA

The Jordan–Wigner transformation establishes a duality between su(2) and fermionic algebras. We present qualitative arguments and numerical evidence that when mapping spins to fermions, the transformation makes strong correlation weaker, as demonstrated by the Hartree–Fock approximation to the transformed Hamiltonian. The presence of string operators poses challenges to the implementation of quantum chemistry methods on classical computers, but these can be dealt with using established techniques of low computational cost. Our proof of principle results for XXZ and J1-J2 Heisenberg (in 1D and 2D) indicates that the JW transformed fermionic Hamiltonian has reduced complexity and provides a better starting point for addressing challenging spin problems. This work was recently published in T. M. Henderson, G. P. Chen, and G. E. Scuseria, *J. Chem. Phys.* **157**, 194114 (2022).