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How Boson Dimers Reproduce Spin Projection Operators

The Bose-Hubbard Hamiltonian can be simplified to have only two lattice sites, in which case the system being described is referred to as a dimer. Due to its structure, the hopping term of the dimer Hamiltonian enjoys invariance in a family of subspaces indexed by a whole number k, each subspace corresponding to a system of only k particles. We have invented an inductive argument using the bosonic canonical commutation relations to find the eigenvalues and eigenvectors of the dimer hopping Hamiltonian in its k-particle subspaces. In particular, this Hamiltonian, when restricted to one of the k-particle subspaces, is exactly the spin projection operator along the x-axis, where the number of particles k in the dimer system yields the projection matrix for spin quantum number $s = k/2$. Thus, a new method for computing the eigenvalues and eigenvectors of the x-axis spin projector has been unearthed. In this talk, I will outline the mathematical framework used and discuss our argument and results. This talk represents work done in collaboration with Artur Sowa (University of Saskatchewan) and Jonas Fransson (Uppsala University).