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Group Invariant States as Quantum Many-Body Scars

When a Hamiltonian is invariant under a group G, the G-invariant states sometimes exhibit interesting simplifications. An example is the quantum mechanics of a Hermitian matrix which has SU(N) symmetry. The group invariant sector is described by wave functions of N eigenvalues that behave as free fermions. In recent years, there were studies of fermionic tensor models that have multiple O(N) symmetries (in the large N limit they have dynamics similar to the SYK model). The simplest invariant Hamiltonians are quartic in the fermions and finding the energies of group invariant states is an interesting problem.

An O(N) symmetric fermionic model may be deformed by quadratic hopping terms that break the symmetry, yet the group invariant states continue to be exact eigenstates. We show that these enhanced symmetry states have the expected properties of Quantum Many-Body Scars. This construction applies to fermionic lattice models with local interactions and hopping, such as generalized Hubbard models. An example of scar states is then provided by the well-known eta-pairing states. We show that these states are invariant under a large group whose rank is proportional to the number of lattice sites. Finally, we discuss generalizations of the group theoretic construction of lattice models with scars, including those with non-Hermitian Hamiltonians.