Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Supersymmetry in strongly correlated fermion models DIMITRIOS GALANAKIS, Nanyang Technological University, STEFANOS PAPANIKOLAOU, Yale University, CHRIS HENLEY, Cornell University — We investigate the Fendley and Schoutens [1] model of hard core fermions on a lattice which have hopping elements t, and potential terms V which include a second-neighbor repulsion with some multi-particle terms. At the special point $t = V$, the Hamiltonian is $H = \{Q^\dagger(r), Q\}$ with $Q = \sum_r q(r) = \sum_r c(r)P(r)$, where $c(r)$ is an annihilation operator and $P(r)$ enforces the hard core. That means the system acquires an exact non-relativistic supersymmetry, and for a range of fillings has a large number of zero-energy ground states [1]. To better understand the nature of the zero-energy states and excitations, we perform exact diagonalizations on finite clusters for the square and triangular lattice, different fillings and center of mass momenta. In momentum sectors with unique zero energy ground states we find a menagerie of symmetry breaking patterns in the density-density correlation functions and we investigate them further by evaluating the entanglement spectrum. In momentum sectors with degenerate ground states we search for topological ground states using using the numerical Berry matrix method [2].

[1]P. Fendley and K. Schoutens, Phys. Rev. Lett. 90, 120402 (2003).
[2]E. Kapit, P. Ginsparg, and E. Mueller, arXiv:1109.4561

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Date submitted: 11 Nov 2011 Electronic form version 1.4