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Supersymmetry in strongly correlated fermion models DIMITRIS GALANAKIS, University of Illinois at Urbana - Champaign, STEFANOS PAPANICOLAOU, CHRIS HENLEY, Cornell University — We investigate the Fendley and Schoutens [1] model of hard core fermions on 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 $t = V$, they showed that 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 hardcore. 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 obtain insights on the nature of the zero-energy states and excitations, we perform exact diagonalization studies on finite clusters for various interaction strengths, fillings and lattice geometries. We note that for fillings beyond $n \approx 0.3$, we find coexisting domains of the inert crystal at $n = 1/2$, in contrast to a related non-supersymmetric model [2] Moreover, using both numerical and analytical tools, we investigate perturbative limits where $q(r)$ is changed so as to preserve supersymmetry but a particular class of ground-states becomes trivial.

[1]P. Fendley and K. Schoutens, Phys. Rev. Lett. 90, 120402 (2003).
[2]N.G. Zhang and C.L. Henley, Phys. Rev. B 68, 014506 (2003).

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