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Unitarity in periodic potentials and correlated s-wave Cooper pair insulators PREDRAG NIKOLIC, George Mason University, ZLATKO TESANOVIC, Johns Hopkins University — We explore the emergence of novel universal regimes and correlated states in strongly interacting band insulators. Lattice potentials introduce Cooper, exciton and inter-valley channels for scattering resonances, which can be studied in the BCS-BEC framework. This is revealed by characterizing a large number of renormalization group fixed points. The superfluid-insulator transition is found to be pair-breaking in the weak-coupling BCS limit, while it belongs to the bosonic mean-field or XY universality class in the strong-coupling BEC limit as fermionic excitations remain gapped. The latter leads to correlated bosonic Mott insulators of Cooper pairs, and is the only option in two dimensions. Such an insulator may break lattice symmetries, but even if it doesn't it can be sharply distinguished from the band insulator out of equilibrium. The models we study can be realized with ultra-cold gases of alkali atoms tuned to a broad Feshbach resonance in an optical lattice. We discuss possible consequences for cuprate superconductors, where antinodal pair dynamics has certain features in common with our simple s-wave picture.

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