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Feshbach resonances and BCS-BEC crossover in optical lattices ZHAOCHUAN SHEN, LEO RADZIHOVSKY, VICTOR GURARIE, Department of Physics, University of Colorado — In this talk we study Feshbach resonances of fermionic atoms placed in a periodic potential. We investigate the criteria when such a system can be described by a Hubbard model with variable interaction strength in case of broad resonance, or by a tight binding model of atoms and molecules with can convert into each other on sites of the lattice in case of narrow resonances. Assuming the applicability of these models, we first study the BCS-BEC crossover for broad resonance. We find that while below half filling the system undergoes the conventional crossover from a BCS superconductor to a Bose condensate of molecules, above half filling the nature of the BEC phase changes to that of a condensate of molecules made of holes. Switching our attention to the case of narrow resonance, we find that the crossover takes the system from a BCS to hole-BEC regime, than back to BCS, and finally to a conventional BEC of atomic molecules. In the latter crossover, we find that the size of Cooper pairs/molecules changes non-monotonously, being larger in the BCS and smaller in the BEC regimes. Finally, at a unity filling we find a quantum phase transition from a band insulator to a BCS-BEC superfluid replacing the crossover.

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