The evolution from BCS to Bose-Einstein Condensation: Superfluidity in Metals, Neutron Stars, Nuclei and Ultra-Cold Atoms."

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Abstract:

Superfluidity is a very interesting phenomenon that has been found in metals, neutron stars, nuclei and more recently in ultra-cold atoms. For a given metal, neutron star, or nuclei there is essentially zero tunability of the particle density or interaction strength, and thus superfluid properties can not be controlled at the turn of a knob. However, in ultra-cold Fermi atoms the interaction strength and the particle density can be tuned to change qualitatively and quantitatively superfluid properties. This tunability allows for the study of the evolution from BCS (weak coupling) superfluidity of large Cooper pairs to Bose-Einstein condensation (strong coupling) superfluidity of tightly bound molecules. I will discuss the BCS to BEC evolution in s-wave and p-wave angular momentum channels, and will conclude that this evolution is just a crossover phenomenon for s-wave, while a quantum phase transition takes place for p-wave systems.