Effects of particle-hole channel and BCS-BEC crossover on an optical lattice[†]

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BCS-BEC crossover is effected by increasing pairing strength between fermions from weak to strong. Such pairing is associated primarily with the particle-particle channel. Effects of the particle-hole channel is often dropped. On the other hand, Gor'kov et al argued that the particle-hole channel can cause a substantial reduction in both Tc and the pairing gap. However, this result has largely been neglected until recent years when BCS-BEC crossover has been realized experimentally in ultracold Fermi gases. On the other hand, a periodic lattice potential has also dramatic effects on the behavior of BCS-BEC crossover, In this talk, we study both types of effects on BCS-BEC crossover in a G_0G scheme. While in the BCS limit, the particle-hole channel effects may be approximated by a shift in the pairing strength, the situation becomes more complex as the interaction becomes stronger where the gap is no longer small. At low densities, lattice effects make the transition temperature decrease with increasing pairing strength due to virtual ionization. In particular, at high density, the superfluid phase may disappear on an optical lattice when the pairing strength is high enough. References: Q.J. Chen, I. Kosztin, B. Jankó, and K. Levin, Phys. Rev. Lett. 81, 4708 (1998); Phys. Rev. B 59, 7083 (1999); Q.J. Chen, J. Stajic, S.N. Tan, and K. Levin, Physics Reports 412, 1 (2005); C.-C. Chien, Q.J. Chen, and K. Levin, Phys. Rev. A 78, 043612 (2008); Q.J. Chen, arXiv:1101.2836. [†]Supported by NSF of China and Ministry of Education of China.