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Spin-Orbit Coupled Quantum Gases

HUI ZHAI, Institute for Advanced Study, Tsinghua University

In this talk I will discuss both spin-orbit coupled Bose condensate and degenerate Fermi gases. In the first part of this talk, I will discuss bosons with Rashba type spin-orbit coupling. We find the ground state exhibits two distinct non-trivial phases: the plane wave phase and the stripe superfluid phase. And the finite temperature thermal fluctuations can lead to an even more interesting boson paired superfluid state with half vortices. I will further discuss collective mode of spin-orbit coupled condensate. We find the dipole modes of a BEC is no longer harmonic due to the non-abelian nature of the gauge potential, and there will be a magnetization oscillation synchronized to the dipole motion due to the absence of Galilean invariance. Macroscopic quantum tunneling will also take place during the dipole oscillation. In the second part of this talk, I will discuss degenerate Fermi gases and the BEC-BCS crossover with spin-orbit coupling. I will talk about spin dephasing and interaction effects in the Raman induced spin dynamics, and the topological change of Fermi surfaces. I will emphasize that Rashba spin-orbit coupling can significantly enhance the pairing strength and the superfluid transition temperature.