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Spin-Orbit Coupled Quantum Gases: New Physics and Challenges

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In this talk I will review recent progresses in studying spin-orbit coupling in ultracold quantum gases. I will discuss several examples of new states or phenomena when spin-orbit coupling is introduced to ultracold atomic gases. i) the single particle ground state degeneracy will lead to condensate with stripe order for bosons and interesting finite temperature phase diagram; ii) the new feature in two-body physics strongly modifies the scenario of fermion pairing; On the other hand, I will also discuss great challenges in this direction that is the heating problem. I will present several ways to overcome the difficult, for instance, by utilizing highly magnetic lanthanide atoms.