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Spin-orbit coupled Bose-Einstein condensates[1]

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Ultracold atoms are quantum systems under precise experimental control, ideal for realizing and characterizing novel artificial gauge fields [1-4]. Our latest experiments [5- 7] with ^{87}Rb Bose-Einstein condensates (BECs) have demonstrated and explored Abelian, both scalar and matrix valued, light-induced gauge potentials. We optically dressed our BECs with a pair of far detuned Raman lasers. The resulting dressed states are spin and momentum superpositions, and we adiabatically load the atoms into the lowest energy of these dressed states. The nature of the dressed states is experimentally tunable via the strength of the laser coupling and the detuning from Raman resonance, thereby introducing gauge fields into the Hamiltonian. I will discuss Spin-Orbit (SO) coupling [6], the interaction between a quantum particle's spin and its momentum. We experimentally realized SO coupling with equal contributions of Rashba and Dresselhaus coupling, which modified the interaction between the *dressed spin states* and resulted in a phase transition from a spatially *spin-* mixed state to a phase-separated state as a function of laser power. The location of this transition is in agreement with our calculations. Finally I conclude by focusing on our most recent progress on artificial gauge fields. This work was performed in collaboration with Y.-J. Lin, R. A. Williams, L. J. LeBlanc, M. Beeler, W. D. Phillips, J. V. Porto and I. B. Spielman.

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