# Dynamics and Transport in Spin Orbit Coupled BECs

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I will describe experiments performed in my group studying dynamics and transport phenomena in spin-orbit coupled Bose-Einstein condensates (SOC-BEC). Our experimental setup[1, 2] creates optically trapped $^{87}$Rb BECs, with synthetic gauge fields and spin-orbit coupling induced by optical Raman transitions. In one experiment[1], we study BEC transport in the synthetic "dressed" bandstructure, and realize a fully tunable Landau-Zener (LZ) transition between the dressed bands. We also study the breakdown of the (adiabatic) spin-momentum locking characteristic of SOC-BEC in the (non-adiabatic) LZ regime. In the second experiment[3], we use spin-dependent synthetic electric field generated by dynamically varying the SOC Raman coupling to induce a spin-dipole mode (SDM, opposite oscillations between two spin components) and thus an AC spin current in the trap. We observe that SOC significantly enhance the damping of BEC momentum in SDM, and qualitatively changes the dominant mechanisms of spin current relaxation from collision-induced thermalization for bare BECs to momentum damping for dressed BECs. Our work reveals rich interplay between SOC and atom-atom interactions in a superfluidic BEC, and may enable quantum simulation of spin transport phenomena previously studied in solid state spintronics.

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[1] A. Olson *et al.*, Phys. Rev. A **87**, 053613 (2013)
[2] A. Olson *et al.*, Phys. Rev. A **90**, 013616 (2014)
[3] R. Niffenegger *et al.*, in preparation (2014)