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Inducing and probing dynamics in a spin-orbit coupled BEC[1]

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Spin-orbit coupling (SOC) provides a very flexible tool for modifying the dispersion relation, and thus the dynamical properties of a BEC. The plane-wave phase of an SOC BEC features a double-well structure including a region of negative curvature. Effects of the associated negative mass have been revealed in our previous expansion experiments, where one edge of an expanding SOC BEC decelerated upon entering the negative mass regime. Based off of these studies, we have developed a range of experimental tools to excite and probe dynamics from the linear to the nonlinear regime, and even in extreme regimes such as shock waves or quantum turbulence. For example, by releasing an initially trapped BEC in the presence of a BEC background density, we can study the transition from sound to shock and show how the anisotropy of the spin-orbit coupling affects the shock structure. As a second example, static or moving barriers can be used to excite dynamics and even turbulence in a spin-orbit coupled BEC. Our experiments are corroborated by accompanying numerical simulations. The current status and future directions of this line of research will be discussed.

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