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Quantum Control with Spinor Bose-Einstein Condensates[1] HILARY M. HURST, National Institute of Standards and Technology, SHANGJIE GUO, University of Maryland, I. B. SPIELMAN, National Institute of Standards and Technology — Understanding and controlling many-body quantum systems in noisy environments is paramount to developing robust quantum technologies. An external environment can be thought of as a "measurement reservoir" which extracts information about the quantum system. Cold atoms are well suited to examine system-environment interaction via weak (i.e. minimally destructive) measurement techniques, wherein the measurement probe acts as the environment and provides a record of system dynamics. The measurement record can then be used in a feedback scheme, leading to real time control of quantum gases. I will discuss our proposal to use weak measurement and feedback to engineer new phases in spin-1/2 Bose-Einstein condensates. We show that measurement and feedback alters the effective Hamiltonian of the system, thereby driving phase transitions reminiscent of a quantum quench for the closed system. We also develop a feedback cooling protocol which prevents runaway heating of the condensate due to measurement backaction. Our results provide a new route toward Hamiltonian engineering in many-body systems.

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