Quantum Control Tools for Probing Fundamental Physics with Long-Baseline Atom Interferometry

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Recent technological advances have paved the way for large-scale atom interferometers to contribute to multiple areas at the forefront of modern physics, including searches for wavelike dark matter, gravitational wave detection, and fundamental quantum science. In an atom interferometer, sequences of laser pulses spatially split, recombine, and interfere the atoms' quantum mechanical states. Typically, the sensitivity of the instrument increases as the number of applied pulses grows larger. However, in practice, experimental nonidealities and tradeoffs limit the fidelity with which each pulse can control the quantum states, severely limiting the number of pulses that can be applied. In this talk, I will first describe the MAGIS-100 100-meter-tall atom interferometer under construction at Fermilab. I will then discuss some of our recent experimental work to develop quantum control techniques that reduce limitations from pulse infidelities, opening a path for MAGIS-100 and related detectors to achieve dramatically improved sensitivity.