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Optimal control for high-precision atom interferometry MICHAEL GOERZ, U.S. Army Research Laboratory, Adelphi, MD 20783, MARK KASEVICH, Physics Department, Stanford University, Stanford, CA 94305, VLADIMIR MALINOVSKY, U.S. Army Research Laboratory, Adelphi, MD 20783 — Recent advances in atomic interferometry open up new pathways to high precision measurements, as well as tests of general relativity, and new gravitational wave detectors. The fundamental limitation in an atomic fountain interferometer is the realization of high-fidelity, robust atom beamsplitters and mirrors. These must be realized through carefully tuned laser pulses manipulating the atomic momentum states. We present avenues for the use of numerical optimal control theory (OCT) to design suitable pulse sequences. OCT has been shown to be a powerful tool in a wide range of design tasks, allowing to steer a quantum system towards a desired goal in the shortest possible amount of time. It also allows to maximize the robustness against dominant sources of noise, and can be targeted to the specific parameters of an experimental setup. Our scheme for the realization of an atomic mirror relies on using frequency-chirped standing waves and rapid adiabatic passage. Using a combination of control techniques, we show how an analytical pulse scheme can be compressed by more than an order of magnitude, while also bringing non-adiabatic errors arbitrarily close to zero. We will discuss how the resulting scheme may also be made robust with respect to both quantum and classical noise sources.

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