

Abstract Submitted
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Rapid Manipulation of Bose-Einstein Condensates using Shortcuts to Adiabaticity¹ E. CARLO SAMSON, CHANGHYUN RYU, MALCOLM BOSHIER, Physics Division, Los Alamos National Laboratory, Los Alamos, NM 87545, ADOLFO DEL CAMPO, Department of Physics, University of Massachusetts Boston, Boston MA 02125 — We are investigating practical methods based on shortcuts to adiabaticity (STA) for rapid manipulation of BECs. STA is an emergent field in quantum science that develops nonadiabatic protocols to drive a system into a target state much faster than the conventional slow adiabatic process. The first STA method that we are developing involves the ultrafast expansion (or compression) of a trapped BEC, as initially proposed by Del Campo and Boshier [Sci. Rep. 2, 648 (2012)]. We discuss our experimental implementation of this protocol, and our studies of the BEC dynamics and the fidelity of the final state. The other STA method is a launching protocol, in which we accelerate a trapped BEC to a target speed. We show through numerical GPE simulations that the target speed can be achieved in short durations and short launching distances with minimal excitations to the BEC, despite the nonadiabatic nature of the method. We also present initial results from the experimental implementation of this launching protocol. These STA-based experimental techniques would prove beneficial in systems that require fast initial state preparation and cycle time, without loss of coherence nor emergence of perturbations, such as in matter wave circuits, atom interferometry, and quantum heat engines.

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