Abstract Submitted
for the DAMOP20 Meeting of
The American Physical Society

Creating solitonic excitations with controllable velocity in Bose-Einstein condensates AMILSON R FRITSCH, MINGWU LU, GRAHAM H REID, ALINA M PIÑEIRO, IAN B SPIELMAN, Joint Quantum Institute, National Institute of Standards and Technology, and University of Maryland, Gaithersburg, Maryland, 20899, USA — Established techniques for deterministically creating dark solitons in repulsively interacting atomic Bose-Einstein condensates (BECs) can only access a narrow range of soliton velocities. Because velocity affects the stability of individual solitons and the properties of soliton-soliton interactions, this technical limitation has stymied experimental progress. Here we create dark solitons in highly anisotropic cigar-shaped BECs with arbitrary position and velocity by simultaneously engineering the amplitude and phase of the condensate wavefunction, improving upon previous techniques which only manipulated the condensate phase. We readily create dark solitons with speeds from zero to half the sound speed. The observed soliton oscillation frequency suggests that we imprinted solitonic vortices, which for our cigar-shaped system are the only stable solitons expected for these velocities. Our numerical simulations of 1D BECs show this technique to be equally effective for creating kink solitons when they are stable. We demonstrate the utility of this technique by deterministically colliding dark solitons with domain walls in two-component spinor BECs.

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Date submitted: 03 Feb 2020 Electronic form version 1.4