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Shortcuts to Adiabatic Passage in Particle Slowing[1] JARROD REILLY, JOHN BARTOLOTTA, MURRAY HOLLAND, University of Colorado, Boulder — We analyze theoretically a method for slowing particles by laser fields that potentially has the ability to generate large conservative forces, but without the associated momentum diffusion that typically results from the random direction of spontaneously scattered photons. We implement a shortcut to adiabaticity approach that is based on Lewis-Riesenfeld invariant theory. We apply a laser that addresses an ultranarrow electronic transition, and periodically modify its detuning so that it cycles through repeated stimulated Raman transitions between motional states. This affords our scheme the advantages of adiabatic transfer, where there can be an intrinsic insensitivity to the precise strength and detuning characteristics of the applied field, with the advantages of rapid transfer that is necessary for obtaining a short slowing distance. As an application of this scheme, we demonstrate how the adiabatic speedup protocol can be applied to reduce the typical slowing distance in a Zeeman slower by one to two orders of magnitude. This would result, for typical parameters, in slowing an atomic beam from a thermal oven source in only a few centimeters.

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