Stony Brook University
The Graduate School

Doctoral Defense Announcement

Abstract

Optical Forces from Periodic Adiabatic

Rapid Passage Sequences in Metastable Helium

By

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Over the past 30 years, optical manipulation of neutral atoms has been primarily performed with a monochromatic laser beam. The simplest tool for the control of atomic motion is the radiative force exerted by a monochromatic laser on a two-level atom. The radiative force arises from absorption followed by spontaneous emission, and its magnitude is limited by the atom's excited state lifetime. The coherent momentum exchanges between light fields and atoms can be exploited to produce long-range optical forces much greater than the radiative force through the use of absorption-stimulated emission processes.

Adiabatic Rapid Passage (ARP) is a long-existing method to invert the population of a two-level nuclear spin system. Its extension to the optical domain necessitates a frequency chirped light pulse to interact with a two-level atom via the dipole interaction. I will first present a numerical study of the properties of optical forces on moving atoms derived from purely stimulated processes produced by multiple ARP sequences. This will be followed by experimental observations of long-range ARP forces much larger than the radiative force in metastable helium. Sequences of properly timed laser pulses may be used for rapid deceleration of neutral atomic (or molecular) beams.

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