Abstract Submitted
for the DAMOP18 Meeting of
The American Physical Society

Beating the diffraction limit: an optical lattice of sub-wavelength barriers[1] YANG WANG, SARTHAK SUBHANKAR, PRZEMYSLAW BIENIAS, Joint Quantum Institute, MATEUSZ LKACKI, Jagiellonian University, Institute for Quantum Optics and Quantum Information of the Austrian Academy of Sciences, University of Innsbruck, TSZ-CHUN TSUI, Joint Quantum Institute, MIKHAIL BARANOV, Institute for Quantum Optics and Quantum Information of the Austrian Academy of Sciences, University of Innsbruck, ALEXEY GORSHKOV, Joint Quantum Institute, Joint Center for Quantum Information and Computer Science, PETER ZOLLER, Institute for Quantum Optics and Quantum Information of the Austrian Academy of Sciences, University of Innsbruck, JAMES PORTO, STEVEN ROLSTON, Joint Quantum Institute — We report on the creation of a conservative optical lattice for cold atoms with sub-wavelength features well below the diffraction limit of the light. To achieve this, we use the nonlinear optical response of three-level atoms in spatially dependent dark states. The geometric gauge potential of atoms in this spatially dependent dark state provides a conservative potential with ultra-narrow barriers, physically realizing a Kronig-Penney potential. We demonstrate optical lattices with barrier widths less than $\lambda/50$, study the band structure and dissipation mechanisms, and compare experimental findings with theory. The potential is generalizable to higher dimensions and different geometries, allowing, for example, nearly perfect box traps, narrow tunnel junctions for atomtronics applications, and dynamically generated lattices with subwavelength spacings.

[1]we acknowledge support by NSF PFC at JQI and ONR grant N000141712411

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Date submitted: 06 Feb 2018 Electronic form version 1.4