Discrete diffraction and discrete solitons in an optically induced lattice

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We present an experimental study of the propagation of light through an optically induced lattice in a far-detuned Λ system in Doppler-broadened ^{87}Rb atomic vapor. Discrete diffraction patterns are observed when a probe beam propagates through an optically induced lattice created by the interference of two coupling laser fields intersecting at a small angle. We investigate the influence of various experimental parameters, such as probe beam size, probe and coupling laser detunings and intensities, and the concentration of atoms on the observed diffraction patterns and the patterns' contrasts. Finally, we show that by increasing the power of the probe been we enter a nonlinear regime, where, for suitable detunings we observe the formation of a discrete soliton.

These periodic structures in atomic systems are analogous to weakly coupled waveguides, yet they have tunable optical properties. As such, they provide a powerful experimental platform that can enable the exploration of complex quantum and optical physics phenomena, such as non-Hermitian physics, Aubry–André localization, PT-symmetric potentials [1], and photonic Floquet topological insulators [2].

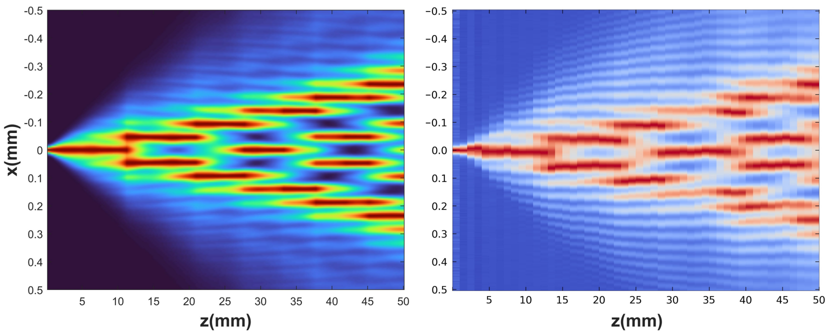

Figure 1. Simulated (left) and measured (right) propagation of light through an optically induced lattice in rubidium vapor in the linear regime.

[1] Z. Zhang, Y. Zhang, J. Sheng, et al., Phys. Rev. Lett. 117, 123601 (2016).
[2] M. C. Rechtsman, J. M. Zeuner, Y. Plotnik, et al., Nature 496, 196 (2013).