Non-Degenerate Four-Wave Mixing through Rydberg States in a MOT

JASON DAY, ERIK BREKKE, THAD WALKER, University of Wisconsin-Madison — In this work, we use a three-photon near-resonant process in a laser-cooled Rb vapor to achieve phase-matched four-wave mixing using an intermediate Rydberg state. Rydberg atoms in the 36D5/2 state are efficiently produced using a 780 nm/480 nm two-photon excitation detuned 500 MHz above the 5P3/2 intermediate state. When a 1019 nm laser stimulates emission down to the 6P3/2 state, the Rydberg atom populations are significantly depleted and 422 nm 6P3/2-5S photons are observed by photon-counting photomultiplier tubes. With the 780 nm, 480 nm, and 1019 nm lasers configured in a non-collinear phase-matched geometry, we observe a coherent 422 nm phase-matched signal that is up to 10 times larger than the non-phase-matched radiation. Under these phase-matched conditions, the incoherent radiation is partially depleted. These experiments demonstrate the ability to coherently manipulate ultracold atoms at optical frequencies using Rydberg states.

This work is supported by the NSF