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Non-Degenerate Four-Wave Mixing through Rydberg States in a MOT[1] 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.

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