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Two-Photon Excitation of Launched Cold Atoms in Flight[1] ANNE GOODSELL, RENE GONZALEZ, EDUARDO ALEJANDRO, EMMA ERWIN, Middlebury College — We demonstrate two-photon bi-chromatic excitation of cold rubidium atoms in flight, using the pathway $5S_{1/2} \rightarrow 5P_{3/2} \rightarrow 5D_{5/2}$ with two resonant photons. In our experiment, atoms are laser-cooled in a magneto-optical trap and launched upward in discrete clouds with a controllable vertical speed of 7.1±0.6 m/s and a velocity spread that is less than 10% of the launch speed. Outside the cooling beams, as high as 14 mm above the original center of the trap, the launched cold atoms are illuminated simultaneously by spatially-localized horizontal excitation beams at 780 nm ($5S_{1/2} \rightarrow 5P_{3/2}$) and 776 nm ($5P_{3/2} \rightarrow 5D_{5/2}$). We monitor transmission of the 780-nm beam over a range of intensities of 780-nm and 776-nm light. As the center of the moving cloud passes the excitation beams, we observe as much as 97.9±1.2% transmission when the rate of two-photon absorption is high and the $5S_{1/2}$ and $5P_{3/2}$ states are depopulated, compared to 87.6±0.9% transmission if only the 780-nm beam is present. This demonstrates two-photon excitation of a launched cold-atom source with controllable launch velocity and narrow velocity spread, as a foundation for three-photon excitation to Rydberg states.

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