Modulation Transfer and Double-Resonance Optical Pumping with optical transitions in ^{87}Rb

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We demonstrate modulation transfer from a pump to a probe beam via non-linear processes in ^{87}Rb using both the $5S_{1/2}$–$5P_{3/2}$ and $5S_{1/2}$–$5P_{3/2}$–$4D_{3/2,5/2}$ ladder transition schemes. This technique, when used in spectroscopy, produces Sub-Doppler spectroscopic lineshapes free of unwanted background offsets that typically shift the zero-crossing of the signal. Modulation transfer spectroscopy (MTS) on the $5S_{1/2}$–$5P_{3/2}$ transition displays characteristics observed in similar setups [1]; we demonstrate for the first time modulation transfer on the excited $5P_{3/2}$–4D transitions. These transitions are important since they correspond to an absolute standard reference for C-band telecom wavelengths (1529 to 1565 nm). We obtain suitable MTS error signals for the $5S_{1/2}$–$5P_{3/2}$ and $5P_{3/2}$–4D transitions, and confirm that the unique features of MTS are preserved even on the excited transitions. The narrow dispersion signals allow us to frequency stabilize narrow-linewidth fiber lasers at 1529 nm and 1560 nm (Fig. 1A).

Two-photon optical pumping on the ladder transition also allows us to measure the decay rate of the $5P_{3/2}$–4D transitions. As shown in Fig. 1B, instead of monitoring atoms excited (by laser L1) into the intermediate state $5P_{3/2}$ with laser L2 (expected to be low for a state with a large decay rate), the double-resonance optical pumping (DROP) mechanism provides a loss channel for atoms resonant with the two-photon cycling transition, returning them to a ground state not resonant with L1; an increase in transmission of L1 therefore coincides with the double resonance transition, providing an improved SNR on sub-Doppler spectrum for the $5P_{3/2}$–4D transitions. We report on our preliminary measurements and expected uncertainty budget of the decay rates.

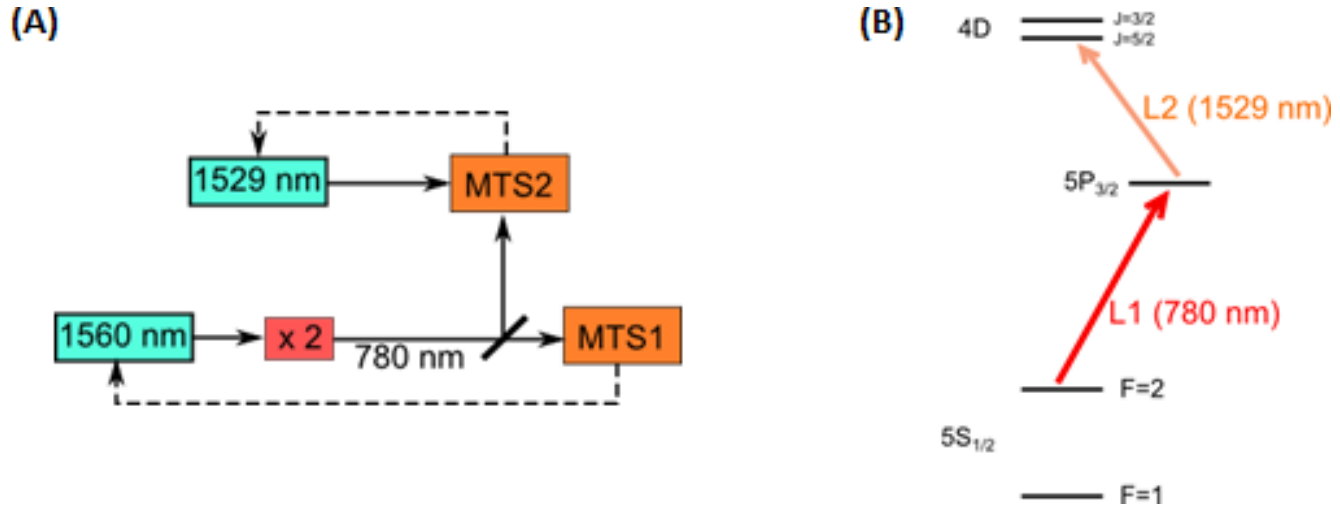

Figure 1: *(A) Schematic depicting the laser frequency stabilization approach in our experiment. (B) Atomic transitions involved in MTS and DROP spectroscopy (see text).*

References

[1] D. J. McCarron, S. A. King, S. L. Cornish Meas. Sci. Technol. **19**, 105601 (2008)