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Atom Counting by Hyperfine Raman Optical Pumping in Cold Rubidium 87[1] JOSHUA CARTER, BRENT JONES, STETSON J. ROOF, KASIE J. KEMP, M. D. HAVEY, Old Dominion University, I. M. SOKOLOV, D. V. KUPRIYANOV, State Polytechnic University, St. Petersburg, Russia — We report studies of interaction of a weak probe beam and a small, cold cloud of ^{87}Rb atoms. For this configuration, a range of complex phenomena, such as super and subradiance, have been observed. These occur typically at greater optical depths, where atoms interact cooperatively with both the incident light and the fields from all the other scatterers in the system. A recent paper has reported that cooperative interactions can also lead to suppression of hypefine Raman transitions in a cold and dense lattice of ^{87}Rb atoms [1]. The same hyperfine transitions may also be used to count the number of atoms in the sample, via optical pumping [2]. Our measurements show that this method is effective for weak probing of a magneto optical trap, and holds over a range of detuning, atom density, and probe intensity. However, random walk simulations suggest that at higher optical depths, multiple scattering can cause an overcounting effect of the sample, modifying the optical decay rates, see also [3]. We present low density benchmark measurements of atom number and optical decay rates, along with simulation data at higher optical depth.

[1] S. Machluf, et al., arXiv:1804.09759.
[2] Y.-C. Chen, et al., Phys. Rev. A 64, 1 (2001).
[3] R. R. Mhaskar, et al., EPJ D 41, 221 (2006).

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