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Model-independent measurements of the excited state fraction in a sodium magneto-optical trap[1] JONATHAN KWOLEK, University of Connecticut, DOUGLAS GOODMAN, SAMUEL ENTNER, Wentworth Institute of Technology, JAMES WELLS, Claremont McKenna, Pitzer, and Scripps Colleges, FRANCESCO NARDUCCI, Naval Postgraduate School, WINTHROP SMITH, University of Connecticut — We perform a model-independent measurement of the excited-state population of a sodium (Na) magneto-optical trap (MOT) in a hybrid ion-neutral trap. By photoionizing the the excited Na atoms within our MOT, we separately measure the photoionization rate using MOT-fluorescence detection and by directly detecting the photoionized ions trapped in the LPT. A comparison of these two measurements yields a model-independent measurement of the excited state fraction. We found that below a critical trapping-laser intensity the excited-state fraction is accurately predicted by a two-level model with an experimentally determined effective saturation intensity. Under a wide range of trapping conditions, we measured the effective saturation intensity to be $I_{\rm se} = 22.9(3)$ mW/cm^2 for the type-I MOT and $I_{\rm se} = 48.9$ mW/cm^2 for the type-II MOT. These effective saturation intensities are both larger than the theoretically predicted value of $I_{\rm sat} = 13.4144(45)$ mW/cm^2 for isotropically-polarized light. Beyond the critical trapping-laser intensity, we find that the excited state fraction deviates from the two-level model as a function of repump-laser power and magnetic field gradient.

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