루비듐원자에 대한 편광분광학의 실험 및 이론 연구

Numerical and experimental studies for polarization spectroscopy of Rubidium atoms.

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Polarization spectroscopy (PS), first demonstrated by Wieman and Hänsch in 1976, is an example of Doppler free technique with coumterpropagating pump and probe beams derived from the same laser[1]. The principle of polarization spectroscopy is to induce a birefringence in a medium with polarized pump beam and that birefringence is detected by a weak probe beam[2]. From the view point of the calculation, some models are introduced. Although these models provide rather reasonable results, they still fail to provide an accurate theoretical calculation of the PS spectra, specially in low hypefine transition[3,4,5].

In this paper, we develop a numerical calculation of polarization spectroscopy (PS) spectral based on the rate equation model. All the populations of the magnetic sublevels are calculated from the rate equations, and used in the calculation of the polarization spectra. Using this model, we generate theoretical line shape to make predictions about the general form of the polarization spectral of the D2 transitions in Rubidium.

By comparing the numerical calculation and the experimental traces, we easily see that our model reproduces accurately experimental features in hyperfine transitions spectra. Fine spectral details like ‘horns’ from the close spaced F=2->F’=2 and $X_{3,1}$ crossover peak in ^{87}Rb arise from calculated anisotropies. In the upper hyperfine transitions, the large diffrence in signal between the two arms shows the largest anisotropies in the close transitions and also the magnitudes of these peaks in experimental data agree well with theoretical calculation. In particular, the dispersion signal for the F=2 ->F’=3 transition has the large amplitude and steep slope is good for frequency stabilization in laser. The experimental results demonstrate that our model accurately reproduces spectra for all transitions in hyperfine structure.

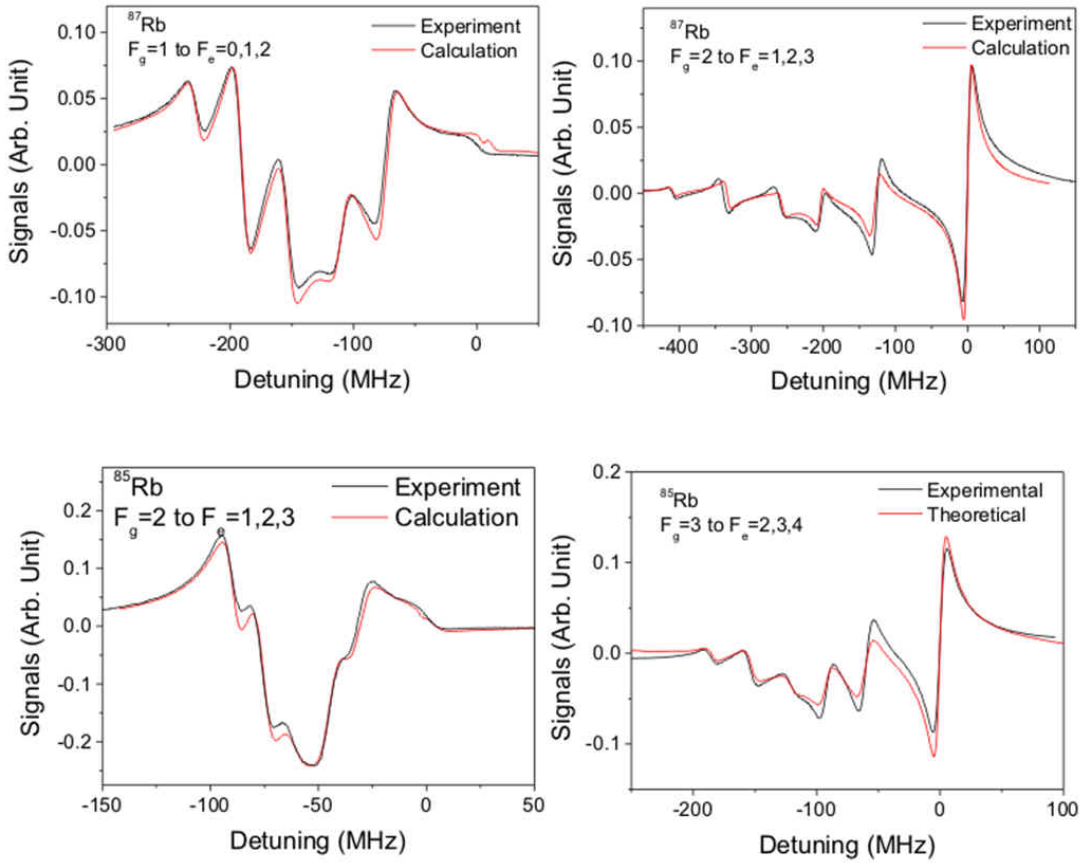

Fig1. Experimental (black line) and theoretical (red line) polarization spectra of D2 line transitions in (a) ^{87}Rb low (b) ^{87}Rb high (c) ^{85}Rb low (d) ^{85}Rb high.

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