Laser Frequency Offset Stabilization using Modulation Transfer Spectroscopy

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Summary—a method for stabilization of laser frequency with an offset from an atomic transition is presented. We use modulation transfer spectroscopy (MTS) with a wideband fiber electro-optic modulator (FEOM) and show that it is possible to generate an error signal suitable for laser locking with a frequency offset up to 10 GHz. The experimental setup and the optimization procedure are presented.

Keywords— offset frequency stabilization; high-resolution spectroscopy; modulation transfer spectroscopy;

I. INTRODUCTION

Laser frequency stabilization with an offset from atomic transition is essential for laser cooling. A wide range of frequency offset might be required. For example, in order to build an atomic gravimeter the Raman laser frequency must be shifted from atomic transition for a few GHz [1]. Different schemes have been suggested for offset frequency stabilization [2,3,4]. In our work we present a method that is based on combination of frequency modulation of laser radiation with a FEOM and MTS which has an advantage over other high-resolution spectroscopy schemes. The signal obtained with MTS has a dispersive lineshape with a flat background that is insensitive to fluctuations of cell temperature, laser intensity and polarization[5,6].

II. MTS OFFSET FREQUENCY STABILIZATION

In our work we modulate the radiation of frequency doubled telecom fiber laser with 780 nm wavelength which corresponds to $^{87}$Rb $D_2$ line with a FEOM that has a bandwidth of >10 GHz. One of the first order sidebands is used in MTS to generate an error signal with an offset from atomic transition (fig. 1). The tuning of the offset is done by varying the frequency of FEOM. The wide offset range up to 10 GHz is achieved. The optimization procedure of experimental setup will be presented.

The developed method can be used in number of applications where laser frequency stabilization with a tunable offset from atomic transition is needed such as atomic clocks and gravimeters[7].

REFERENCES