Frequency stabilization of a laser diode using Rb saturated absorption lines

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1. Introduction

While the advantages of LDs over competing technologies are great, in both number and scale; overall compactness, light weight, proven durability and energy-efficiency; one issue continues to disturb all efforts at their application in generating controlled THz waves; oscillation-frequency stabilization.

We have succeeded, thus far, in stabilizing LDs' frequencies to Rb absorption lines, by means of negative electrical feedback. While the absorption lines were stable over the long term, the Doppler Effect's influence was evident, in broadened spectrum linewidth. To avoid the problem in subsequent tests, we used Rb-saturated absorption signals (SAS).

The estimation of the stability is relative and obtained from the beat frequency, which is the frequency difference between two LD's oscillation frequencies. More immediate tasks involve the use of LD's beat notes, to generate microwaves, due to the LD's tunability.

2. Experiment

Figure1 describes experimental setup to stabilize LD-frequency using SAS. The beam transmitted through half-mirror 1 (HM1) is then further divided into saturating- and probe-beams at a polarizing beam splitter (PBS), and both of these beams are introduced to the Rb cell, such that they pass along overlapped, but, from opposite directions. The probe beam is then detected by an avalanche photo diode (APD1). An independent system with the same optical setup is prepared using LD2, in order to observe the beat note between two LDs and evaluate frequency stability. A frequency counter measures the detected beat frequency and a temperature controller controls the LD temperature within ±0.001K. We observed around 1GHz beat-note between the stabilized LD1 and the tunable LD2 (Fig.2) and calculated the 1GHz beat-note's square root of the Allan variance as the measure of its controllability.

3. Experimental result

Figure 3 contrasts the laser-frequency's overall stability. The symbol ● and ○ show stabilities of the beat-note observed around 1.2GHz region. The result of the symbol ○ (Both LDs are stabilized) has the better stability than ● (LD2 is in a free running condition).

4. Conclusion

We succeed in observing the beat-note of 1 GHz or more. Thus it shows possibility of applying our system to a microwave generator. We would like to use both D1 (794.76 nm) and D2 (780.02 nm) absorption lines of the Rb atom as frequency references, and observe the beat-note.

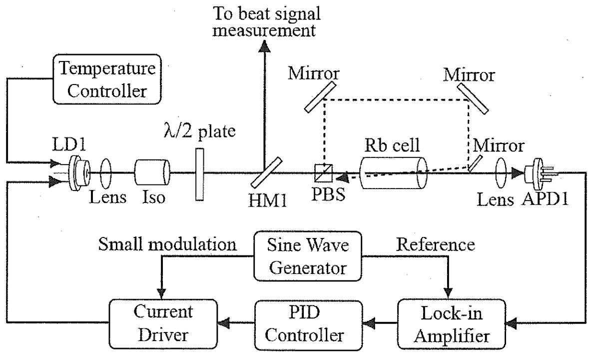

Fig.1 Experimental setup

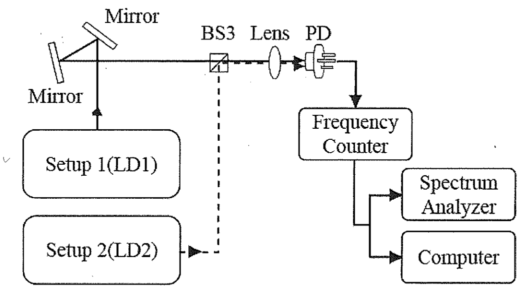

Fig.2 Estimation system of beat frequency

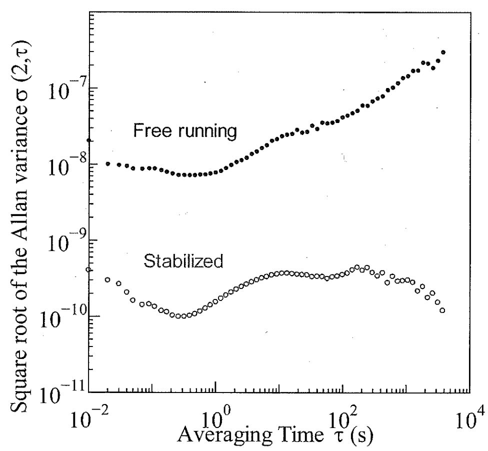

Fig.3 Result