Abstract

We present a diode-based laser design with a linewidth of 2 kHz. This laser is locked to the ${}^1S_0 - {}^3P_1$ transition of strontium at 689 nm. Light from a semiconductor source is filtered by a temperature stabilized and vibration isolated high finesse cavity, then fed back to the diode for linewidth reduction. A Pound-Drever-Hall technique and a loop phase adjusting mirror are used to achieve a tighter and more stable locking. The theory of this optical feedback technique is discussed.

To lock the laser to the Sr ${}^1S_0 - {}^3P_1$ transition, we stabilize the cavity length via saturation spectroscopy on a heated strontium gas pipe. An offset of dispersive error signal caused by amplitude modulation of the light is canceled by a reference signal before the spectroscopy. Estimated from the close loop error signal, this laser achieves a linewidth less than 2 kHz and a long-term stability of about 10 kHz. This laser system is easy to setup and requires only low bandwidth electronics and a simple diode laser without grating stabilization.

Using this laser, our group cooled strontium atoms down to 2.5 μK and recently achieved the Bose-Einstein condensation of ^{84}Sr.