SPIE Photonics West 2018 – LASE Conference

Vertical External Cavity Surface Emitting Lasers (VECSELs) VIII

Single Frequency/Intracavity Conversion

Title: "Towards compact and portable sub-kHz AlGaInP semiconductor disk lasers for cold atom experiments"

Authors: Paulo H. Moriya, Jennifer E. Hastie

1. Abstract text for online and/or printed programs

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Stable lasers are crucial for experiments that target narrow atomic transitions (kHz down to Hz linewidth). Such transitions are used, for example, to cool and trap atoms in magneto-optical traps down to the µK regime, in particular for optical clock systems. In this context, semiconductor disk lasers (SDLs) have demonstrated great potential due to their spectral flexibility, high brightness, and low intensity and frequency noise. Here we report our recent progress in frequency stabilisation of an AlGaInP SDL designed for ultra-narrow linewidth at 689 nm for a strontium clock, achieving sub-kHz RMS frequency noise, relative to a reference Fabry-Perot resonator.

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Stable lasers are crucial for experiments that target narrow atomic transitions (from kHz down to Hz linewidth). Such transitions are used, for example, to cool and trap atoms in magneto-optical traps down to the µK regime, in particular for optical clock systems. In this context, semiconductor disk lasers (SDLs) have demonstrated great potential due to their spectral flexibility, high brightness, and low intensity and frequency noise. Here we report our recent progress in frequency stabilisation of an AlGaInP SDL designed for ultra-narrow linewidth at 689 nm for a strontium clock, achieving sub-kHz RMS frequency noise, relative to a reference Fabry-Perot (F-P) resonator. The laser cavity consists of 2 mirrors: the distributed Bragg reflector of the gain structure and a high reflectivity output coupler mounted on a piezo electric transducer for frequency locking. Single mode operation is achieved by insertion of an intra-cavity filter and optimisation of the cavity length. To achieve ultra-narrow linewidth operation, the Pound-Drever-Hall stabilisation technique was implemented by modulating the light and coupling it to a F-P resonator (finesse = 1000 and free spectral range = 30 MHz). The generated error signal is used to compensate any frequency fluctuation by optimising the laser cavity length. From this setup, a sub-kHz relative RMS frequency noise is obtained (over sampling time 4s) with output power >150 mW (0.6% stability).