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Closed loop feedback control of an external cavity diode laser for laser cooling application

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Laser cooling of neutral atoms is currently receiving a lot of attention worldwide due to the fact that cold atoms are promising candidates for implementation of quantum information processing elements. To cool neutral atoms, such as Rubidium and Caesium, external cavity diode lasers (ECDL) are commonly used. The laser frequency is finely tuned by adjusting the cavity length as well as the diode current. The ECDL is locked to the appropriate transition, of Rubidium in our case, using a saturated absorption setup in the feedback path together with a proportional-integral-derivative (PID) controller, to control the cavity length and diode current. In this presentation we report on the analysis and performance of the closed loop control system using theoretical and numerical analysis, together with validation using experimental data. We present numerical and experimental results of the system's response to various input stimuli and provide regions of safe operation.

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