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Modelling Thermal Behaviour and Static Chirp of a Quantum Cascade Laser

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Quantum Cascade Lasers (QCL) become more and more popular in spectroscopic applications in the mid-infrared (MIR) region. Available devices can be operated in pulsed mode, but also continuous at room temperature. In pulsed mode, spectroscopic applications suffer from pulse-to-pulse intensity variations, as described in [1]. For these applications a continuous operation of the Laser is beneficial. A variation of the Laser current leads to a variation of the output frequency (static chirp). This can be used to scan over absorption lines of e.g. gases, but also to characterize optical resonances in the optical setup. Information on optical resonances can be considered in the subsequent signal processing and can increase spectroscopic sensitivity. Unfortunately the frequency shift due to the Laser current modulation is not proportional to the current but to the devices temperature shift (Fig. 1). Modelling the thermal behavior of the Laser device can help to linearize the frequency shift (Fig. 2). The linearization of the static chirp using a thermal model of a QCL of the type described in [2] is demonstrated. An example for a triangular current modulation is given and an optical resonance induced by a glass plate in the optical setup is characterized.

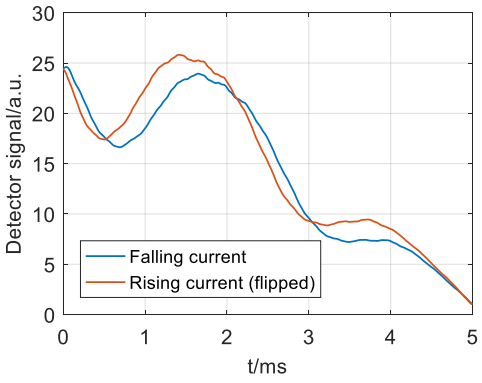

Figure 1: Increasing/decreasing Laser current lead to an increasing/decreasing Laser output power, which is in this case superimposed by an optical resonance. It can be seen, that the features of the optical resonance do not coincide for increasing/decreasing Laser current.

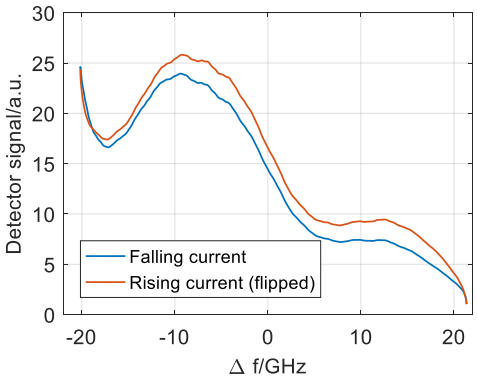

Figure 1: Modelling the thermal inertia of the Laser device, allows a correction of the frequency shift. It can be seen, that spectral features coincide for increasing and decreasing Laser current.

References:

[1] Schwaighofer, M. Brandstetter, B. Lendl, *Quantum cascade lasers (QCLs) in biomedical spectroscopy*, Chem. Soc. Rev., 2017, 46, 5903-5924, DOI 10.1039/C7CS00403F

[2] A. Bismuto, Y. Bidaux, C. Tardy, R. Terazzi, T. Gresch, J. Wolf, S. Blaser, A. Muller, J. Faist, *Extended tuning of mid-ir quantum cascade lasers using integrated resistive heaters*, Opt. Express 23, 29715-29722 (2015), DOI 10.1364/OE.23.029715