# NEW PERSPECTIVES FOR THZ WATER LASER USING QCL OPTICAL PUMPING

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Laboratory astrophysics and molecular spectroscopy are among the most demanding applications for coherent, intense, and tunable continuous wave (CW) THz radiation (0.3 – 10 THz). Such THz source is still lacking despite the continuous efforts of specialized teams and the various approaches developed in the last decades (see e.g Ref[1] for a review on the subject). The recent demonstration of efficient optical pumping using highly tunable quantum cascade lasers (QCL) renewed the interest for THz molecular lasers [2,3,4]. Moreover, some of us recently demonstrated the recording of several absorption lines of methanol, at sub-MHz resolution in the 1–3.3 THz, range by heterodyne mixing of the THz continuum extracted by the AILES beamline of SOLEIL synchrotron with the laser lines produced by a QCL-based optically pumped molecular laser[5,6] acting as the THz local oscillator. To extend such heterodyne mixing experiments to various molecular systems, it is mandatory to generate new lists of THz laser frequencies using the great opportunities offered by QCL optical pumping. In this work, we investigate the use of the water molecule ($H_2O$ and its isotopologue of same symmetry, $D_2O$) as a gain medium for a THz molecular laser pumped by a mid-IR QCL. Indeed, within its firsts vibrational states, water presents dense and intense pure rotational spectra covering the 0.5–10 THz spectral range, making this molecule an interesting candidate for the heterodyne set-up for high resolution spectroscopy. This spectroscopic method as well as results obtained with THz water laser as a local oscillator will also be presented.

[1] J. C. Pearson and al, IEEE *Journal of Microwaves* **1** 43 (2021)
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[3] M. Wienold and al, *Optics Express* **28** (2020)
[4] P. Chevalier and al, *Applied Physics Letters* **120** (2022)
[5] J. F. Lampin and al, *Optics Letters* **44** (2019)
[6] T. S. Hearne and al, *Optics Express* **30** (2022)