Poster sessions IQCLSW2020

Room 1 Thursday 10 September/Mon/Wed

Poster n	Authors	Title
~~1.1~~	~~Hua Li, Xiaoyu Liao, Ziping Li, Kang Zhou, Yiran Zhao, Wen Guan, Wenjian Wan and J. C. Cao~~	~~Broadband terahertz laser dual-comb with off-resonant microwave injection~~
1.2	Alexander Dubinov, D. Ushakov, A. Afonenko, R. Khabibullin, D. Ponomarev, V. Aleshkin and S. Morozov	Modeling of HgCdTe-based quantum cascade lasers operating in the GaAs phonon Reststrahlen band
1.3	Kang Zhou, Junyi Nan, Jiabin Shen, Ziping Li, Boqu He, Heping Zeng, J. C. Cao, Min Zhu and Hua Li	Observation of phase change in Ge2Sb2Te5 illuminated by a terahertz quantum cascade laser
1.4	Tecla Gabbrielli, Francesco Cappelli, Nicola Corrias, Natalia Bruno, Simone Borri, Paolo De Natale and Alessandro Zavatta	Shot-Noise limited Mid-Infrared balanced detector
1.5	Kevin M. Oresick, Jeremy D. Kirch, Luke J. Mawst and Dan Botez	High-efficiency ~8 um-Emitting, Step-Taper-Active QCLs
1.6	Chao Song and Sukhdeep Dhillon	Mode control of high-power single plasmon terahertz quantum cascade lasers
1.7	Eleanor Nuttall, Yingjun Han, Michael Horbury, Li Xinyan, Nick Brewster, Matthew Oldfield, Lianhe Li, Giles Davies, Edmund Linfield, Brian Ellison, Paul Dean, Daniel Stone, Julia Lehman and Alex Valavanis	Analysis of gaseous species using self-mixing in a terahertz quantum-cascade laser
1.8	Chiara Ciano, Michele Montanari, Luca Persichetti, David Stark, Giacomo Scalari, Jèrome Faist, Luciana Di Gaspare, Giovanni Capellini, Cedric Corley, Thomas Grange, Stefan Birner, Michele Virgilio, Leonetta Baldassarre, Michele Ortolani and Monica De Seta	Perspectives on electrically pumped Ge/SiGe QW emitters at THz frequencies

4.3	Urban Senica, Paolo Micheletti, Mattias Beck, Jérôme Faist and Giacomo Scalari	Frequency comb operation of a coupled array of THz QCLs
4.4	Paris Blaisdell-Pijuan, Yiteng Zhang, Zhe Chen, Bruce Koel, Sankaran Sundaresan and Claire Gmachl	Mid-Infrared Scattering on γ-Al2O3 Catalytic Powders
4.5	Paolo Micheletti, Andreas Forrer, Mattias Beck, Giacomo Scalari and Jérôme Faist	Dispersion Compensation of Quantum Cascade Laser Frequency Combs Through Tunable Gires-Turnois Interferometer
4.6	Ming Lyu and Claire Gmachl	Correction to the Effective Refractive Index and the Confinement Factor in Waveguide Modeling for Quantum Cascade Lasers
4.7	Johannes Hillbrand, Nikola Opacak, Marco Piccardo, Harald Schneider, Gottfried Strasser, Federico Capasso and Benedikt Schwarz	Active mode-locking of mid-infrared quantum cascade lasers
4.8	Barbara Schneider, Filippos Kapsalidis, Matthew Singleton, Mathieu Bertrand, Mattias Beck and Jérôme Faist	RF-Enhanced Quantum Cascade Laser Frequency Combs

Room 5 Monday 7th September/Wed/Thu

Poster n	Presenter's name	Title
5.1	Miriam Giparakis, Hedwig Knötig, Maximilian Beiser, Johannes Hillbrand, Hermann Detz, Werner Schrenk, Benedikt Schwarz, Gottfried Strasser and Aaron Andrews	2.7 µm short-wavelength InAs/AlAsSb quantum cascade detector
5.2	Tudor Olariu, Mattias Beck, Giacomo Scalari and Jerome Faist	Post-processing GHz-level frequency tuning of THz Quantum Cascade Lasers
5.3	Maximilian Beiser, Johannes Hillbrand and Aaron Maxwell Andrews	Picosecond pulses in Interband Cascade Lasers
5.4	Andres Forrer, Mattias Beck, Jérôme Faist and Giacomo Scalari	Self-Started Harmonic Frequency Combs in THz Quantum Cascade Lasers
5.5	Seonggil Kang and Sukhdeep Dhillon	Reflection spectra of metasurface gain medium using finite element analysis
5.6	Jacques Hawecker, Pierre Baptiste Vigneron, Jean-Michel Manceau, Juliette Mangeney, Jerome Tignon, Lianhe Li, Edmund Linfield, Alexander Giles Davies, Raffaele Colombelli and Sukhdeep Dhillon	Time resolved spectroscopy of THz intersubband polaritons at small k vector
5.7	Carlo Silvestri, Lorenzo Columbo, Massimo Brambilla and Mariangela Gioannini	Numerical Study of Optical Frequency Combs in Fabry-Perot Quantum Cascade Lasers

IQCLSW

Quantum cascade lasers (QCLs) are unipolar optoelectronic devices that exploit optical transitions between electronic subbands in semiconductor quantum wells. Now over 25 years from their first experimental realization, QCLs have proven to provide outstanding performance across the mid-infrared and terahertz (THz) spectral ranges. The QCL has already been commercialized by a number of companies, and is a core photonic component in a variety of applications such as: environmental and security sensing; telecommunications; and metrology. The QCL is also an exciting vehicle for the pursuit of fundamental blue sky research, including coherent control in condensed matter systems and developing quantum technologies.

IQCLSW 2020 will be the ninth conference in this successful series. It will bring together leading international researchers in the field of QCLs, both established and early career, and the program will consist of a series of presentations spanning all aspects of QCLs, from fundamental physics to the exploitation and applications of this technology.

The workshop will cover device design, modeling, characterization and testing, as well as the basics of laser/detector transport and optical confinement. Applications, such as high-resolution spectroscopy, chemical sensing for a variety of diagnostic uses, coherent detection, and imaging will also be discussed. Key features of the workshop will be international participation, connection to applications, as well as an educational tilt for PhD students.

The conference will also invovle with new subjects related to:

– Interband cascade lasers (ICLs)
– New microcavity and ultrafast detector technology
– Topological photonics
– Optical frequency comb generation and spectroscopy
– New photonic crystal concepts
– Ultra-low dissipation device and design
– New materials including but not limited to Ge, SiGe, ZnO, 2D materials
– Microcavity devices
– Mid-infrared integrated photonic systems

Previous meetings, listed below, have been successfully attended with typically 150 participants. IQCLSW 2020 will continue this important event, presenting the recent advances in the domain of QCLs and related phenomena.

2020 – IQCLSW 2018 – Monte Verita, Switzerland

2018 – Cassis, France
2016 – Cambridge, UK
2014 – Policoro, Italy

Active mode-locking of mid-infrared quantum cascade lasers

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Introduction

Ultrashort light pulses have enabled numerous breakthroughs in science and technology. Nowadays, optical pulses generated by mode-locked lasers have reached a high degree of maturity in the visible or near-infrared range [1,2]. In contrast, methods for the generation of pulses in the mid-infrared region and particularly in the molecular fingerprint region beyond 5 µm wavelength generally rely on non-linear downconversion of near-infrared pulses [3]. Such techniques require tabletop-sized setups and are often limited to sub-mW power levels.

1. Actively mode-locked mid-infrared quantum cascade lasers

Quantum cascade lasers (QCL) have matured to the dominant mid-infrared laser source [4]. However, the short gain recovery time and sub-picosecond upper-state lifetime in QCLs have proven to be major obstacles for the formation of short pulses [5,6,7].

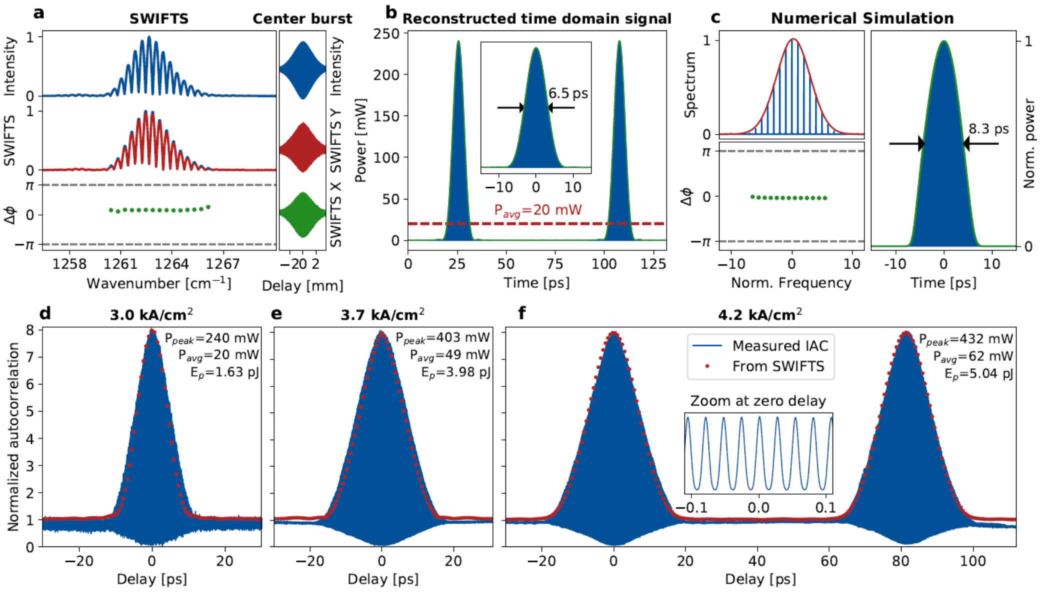

Fig. 1: Active mode-locking of 8 µm wavelength QCLs. **a**: SWIFTS characterization. **b**: reconstructed waveform using SWIFTS. **c**: numerical simulation using the Maxwell-Bloch equations. **d**: interferometric autocorrelation (IAC) recorded close to threshold using a two-photon QWIP. The peak to beackground ratio is 8:1, which is generally regarded as the smoking gun of mode-locked pulses **e**: IAC at higher driving current. **f**: IAC at rollover.

Here, we demonstrate the generation of mode-locked pulses in high-performance mid-infrared QCLs via active modulation of the intracavity loss [8,9]. To this end, the contacts (Fig. 1a) and bandstructure of the QCL were designed to achieve maximal modulation depth. Both an interferometric radio-frequency technique [10] (Fig. 1a,b) and numerical simulations (Fig. 1c) confirm that the QCL emits a train of 6.5 ps short and transformation-limited pulses. Furthermore, a well-established technique called interferometric autocorrelation (IAC) (Fig. 1d,e,f) is employed to corroborate both the proof for mode-locking and the pulse width. Mode-locked operation of the QCL is observed over its entire lasing range from threshold to rollover, with peak power in excess of 400 mW and pulse energies up to 5.5 pJ. Further experiments unveil striking similarities of mode-locking in QCLs to synchronization of coupled oscillators [11] and confirm the existence of multiple synchronization states. Both states can be excited by modulating at their synchronization frequency.

Finally, we show that the emission spectrum of QCL frequency combs can be broadened considerably by strong RF modulation.

References

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