Quantum cascade laser frequency combs: physics and applications

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The quantum cascade laser[1] has demonstrated the ability to provide gain over a very broad wavelength range, and has found may applications for sensing based on arrays of single frequency lasers or as external cavity lasers. Recently, we have shown that such broadband devices, when operated in continuous wave, emit as a coherent optical comb[2] in which the phase relation between the comb modes corresponds approximately to a FM modulated laser[3]. The important role of controlling the dispersion in the mid-infrared devices was shown also theoretically by using a Maxwell-Bloch formalism[4]. In effect, by measuring the group delay dispersion (GDD) of the device and correcting for it using dedicated coatings, record power levels (120mW) with bandwidth approaching 100cm^{-1}, together with excellent comb stabilities have been achieved. It has also recently shown that these combs can also be produced in the THz region of the spectrum[5], with the gain bandwidth covering a full octave[6]. These new comb lasers enables the fabrication of a dual comb spectrometer based on a quantum cascade laser that offers a broadband, all solid-state spectrometer with no moving parts and a ultrafast acquisition time[7]. We demonstrate a spectrometer and its first proof-of-principle applications, as well as new integrated dual-comb devices.

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Bio

Jérôme Faist obtained his Diploma and Ph.D. in Physics (1989) from EPFL (Switzerland). After working at IBM Rueschlikon in Zürich (89-91) and Bell Laboratories, Murray Hill (91-97), he was nominated full professor in the physics institute of the University of Neuchâtel (1997) and then ordinary professor in the ETH Zurich (2007). His key contribution to the development of the quantum cascade laser was recognized by a number of awards that include the IEEE/LEOAS William Streifer award(1998) the National Swiss Latsis Prize 2002. His present interests cover Quantum cascade laser frequency combs and the physics of the ultrastrong coupling regime.