University of Central Florida

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Stable, High-quality, and Tunable Frequency Combs

Photonic frequency comb technology can improve applications in the field of multi-heterodyne spectroscopy, including data harvesting and pattern recognition. Previous methods of stabilizing frequency combs are highly complex and inherently generate noise, but by applying the Hänsch-Couillaud (HC) method, formerly only applicable to single-mode systems, UCF researchers significantly reduced the complexity and thus eliminated the noise. The inventors' effective use of the HC method on an injection-locked, harmonically mode-locked system to generate and stabilize a high-finesse optical frequency comb eliminates the unwanted phase modulation sidebands of the conventionally used Pound-Drever-Hall (PDH) method.

Existing phase modulation techniques for generating 10 GHz frequency combs have been limited to less than 1nm. This technology extends the bandwidth range to more than 9nm, while providing tunable comb spacing, a benefit not offered by intracavity etalon-based alternatives. Additionally, the combs' narrow linewidth means low noise regardless of cavity resonance width.

Technical Details

This invention consists of a commercially available semiconductor optical amplifier in an external fiber ring cavity and a Mach-Zehnder intensity modulator driven at the desired pulse repetition rate and frequency comb spacing for the intended application, both acting as polarization discriminating devices. Further, the method involves the use of two couplers for laser output and injection input, with multiple polarization controllers and an optical isolator to ensure unidirectional operation. The inventors' prototype, for example, incorporates a continuous wave (CW) narrow linewidth (~1 kHz) laser at 1550 nm as the injection seed source, and a variable optical attenuator for injected power control. The injected tone experiences a phase shift while interacting with the cavity. Signals are then rotated via polarization controller(s) to interfere with both outputs of a fiberized polarization beam splitter. A balanced photodetector takes the difference between the two signals to produce an error signal.

UCF Inventors

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Inventors' Publication

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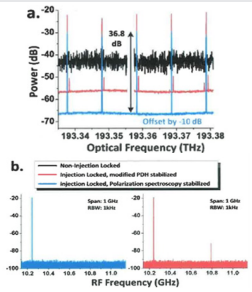

a. *High resolution optical spectra of harmonically mode-locked laser output showing frequency comb generation under optical injection with high OSNR. The latter curve was artificially offset by -10 dB to illustrate the absence of PM sidebands on each combline.* **b.** *Photodetected RF spectra of the injection locked laser stabilized via the two methods. Note the absence of an RF sideband 550 MHz offset from the 10.24 GHz carrier for the HC stabilization method.*

Benefits

- Tunable
- Low-noise
- Simpler stabilization method than conventional alternatives

Applications

- Multi-heterodyne spectroscopy
- Data harvesting
- Pattern recognition
- Optical arbitrary waveform generation
- Analog-to-digital conversion
- Optical time-domain multiplexing

Tech Fields

Optics and Lasers

Keywords

frequency comb generation, mode locking, data storage, optoelectronics, semiconductor lasers, laser stabilization, optical PM sidebands, polarization spectroscopy, multi-heterodyne spectroscopy

Patent Pending

If you or your company are interested in this opportunity, Contact:

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