

Cavity Paper

General

- Making optical atomic clocks more stable with 10–16-level laser stabilization
, V. Jiang et al., Nature Photonics **5**, 158–161 (2011)
- High-precision laser stabilization via optical cavities
, M. Martin and J. Ye

Overview Cavities

Relevant effects influencing frequency stability

- **Fundamental limit: Thermal noise limit**
 - Thermal-Noise Limit in the Frequency Stabilization of Lasers with Rigid Cavities
, K. Numata et al., PRL **93**, 250602 (2004)
 - Thermal noise in optical cavities revisited
, T. Kessler et al., J. Opt. Soc. Am. B Vol. **29**, No. 1 (2012)
- **Reduction of thermal noise limit**
 - **Higher-order mode locking:**
 - Thermal noise limited higher-order mode locking of a reference cavity
, X. Y. Zeng et al., arXiv:1801.05026v1 (2018)
- **Laser Lock: Pound-Drever-Hall (PDH):**
 - Laser Phase and Frequency Stabilization Using an Optical Resonator
, R. W. P. Drever et al., Appl. Phys. B **31**, 97–105 (1983)
 - EOM-Temperature
- **Vibration:**
 - Simple vibration-insensitive cavity for laser stabilization at the 10^{-16} level
, J. Keller et al., Appl. Phys. B **116**, 203–210 (2014)
 - <https://journals.aps.org/pr/abstract/10.1103/PhysRevA.79.053829>
- **Residual amplitude modulation:**
 - Reduction of residual amplitude modulation to 1×10^{-6} for frequency modulation and laser stabilization
, W. Zhang et al., Optics Letters Vol. **39**, No. 7 (2014)
 - Investigation and cancellation of residual amplitude modulation in fiber electro-optic modulator based frequency modulation gas sensing technique
, Z. Li et al., Sensors and Actuators B **196**, 23–30 (2014)
 - Residual amplitude modulation in interferometric gravitational wave detector
, K. Kokeyama et al., J. Opt. Soc. Am. A Vol. **31**, No. 1 (2014)
 - Residual Amplitude Modulation in Interferometric Gravitational Wave Detectors

, K. Kokeyama et al., aXiv:1309.4522v1 [gr-qc] 18 Sep 2013

- **Temperature/CTE:**

- **ULE compensations rings:**

- Tuning the thermal expansion properties of optical reference cavities with fused silica mirrors

, T. Legero et al., J. Opt. Soc. Am. B Vol. **27**, No. 5 (2010)

- Mercury (Paris) cavity:

- Ultrastable lasers based on vibration insensitive cavities

, J. Millo et al., PR A **79**, 053829 (2009)

- Laser locking to the Hg199 $^101-^103$ clock transition with $5.4 \times 10^{-15}/\sqrt{\nu}$ fractional frequency instability

, J. J. McFerran et al., Optics Letters Vol. **37**, No. 17, 3477-3479 (2012)

Coating

- **Crystalline coatings:**

- Tenfold reduction of Brownian noise in high-reflectivity optical coatings

, Garrett D. Cole et al., Nature Photonics **7**, 644-650 (2013)

- Optical performance of large-area crystalline coatings

, M. Marchito et al., Opt. Exp. 6114, Vol. 26, No. 5 (2018)

Spacer geometries / Cavity types

- **Vertical geometry:**

- **Length: 2.5 cm:**

- Compact, thermal-noise-limited reference cavity for ultra-low-noise microwave generation

, J. Davila-Rodriguez et al., Opt. lett. Vol. 42, No. 7 (2017)

- **Length: 7 cm:**

- Compact, thermal-noise-limited optical cavity for diode laser stabilization at 1×10^{-15}

, A. D. Ludlow et al., Optics Letters Vol. **32**, Issue 6, pp. 641-643 (2007)

- **Length: 10 cm:**

- A compact, robust, and transportable ultra-stable laser with a fractional frequency instability of 1×10^{-15}

, Q. F. Chen et al., REVIEW OF SCIENTIFIC INSTRUMENTS 85, 113107 (2014)

- **Length: 48 cm:**

- 8×10^{-17} fractional laser frequency instability with a long room-temperature cavity

, S. Häfner et al., Optical Letters Vol. **40**, No. 9 (2015)

- A strontium lattice clock with 3×10^{-17} inaccuracy and its frequency:

a_strontium_lattice_clock_with_310_-17_inaccuracy_and_its_frequency.pdf

- **Cubic geometry:**

- Force-insensitive optical cavity
, S. Webster et al., Optics Letters Vol. **36**, Issue 18, pp. 3572-3574 (2011)
 - PTB took the NPL-design and updated it for a better longterm stability (see Häfner PHD-thesis, Chapter 4.2)

- **Cryogenic single-crystal optical cavities:**

- **Length: 6 cm:**
 - **Length: 21 cm:**
 - Ultrastable laser with average fractional frequency drift rate below $5 \times 10^{-19}/s$
, C. Hagemann et al., Optics Letters Vol. **39**, No. 17 (2014)
 - A sub-40-mHz-linewidth laser based on a silicon single-crystal optical cavity
, T. Kessler et al., Nature Photonics Vol. **6**, 687-692 (2012)
 - <https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.118.263202>

Measurement/characterization techniques

- Characterization of electrical noise limits in ultra-stable laser systems
, J. Zhang et al., Review of Scientific Instruments 87, 123105 (2016)
- Phase noise characterization of sub-hertz linewidth lasers via digital cross correlation
, X. Xie et al., Vol. 42, Issue 7, pp. 1217-1220 (2017)

Applications

- **Transfer of stability:**
 - Providing 10–16 Short-Term Stability of a 1.5-μm Laser to Optical Clocks
, C. Hagemann et. al., IEEE Transactions on instrumentation and measurement, VOL. 62, NO. 6 (2013)
- **Transportable cavities:**
 - Single-ion, transportable optical atomic clocks
, Marion Delehaye & Clément Lacroûte, Journal of Modern Optics, 65:5-6, 622-639 (2018)
- **Lorentz invariance for the electron:**

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