

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:**
- **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)
- **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., arXiv: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 $^1\text{S}_0 - ^3\text{P}_0$ 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)

Length

Coating

- **Crystalline coatings:**
 - Tenfold reduction of Brownian noise in high-reflectivity optical coatings
 , Garrett D. Cole et al., Nature Photonics **7**, 644-650 (2013)

Spacer geometries

- **Vertical geometry:**
 - **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:**
 - Ultrastable laser with average fractional frequency drift rate below $5 \times 10^{-19}/\text{s}$

- , 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>

Applications

- **Transfer of stability:**

- Providing 10–16 Short-Term Stability of a 1.5- μ m 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)

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