

# References Reference

Abi Kaye

December 2, 2025

## 1 General Reads

This is a test document. Let's test if this compiles correctly:

This is a potential way of reducing light shift in compact clock systems [1]

This is the first use of vapour cells in atomic clocks / frequency references [2]

A recent review article of 2 photon Rb compact clocks [3]

Sean's thesis - good vapour cell and general reference [4]

French thesis - sean recommends - looks at LCVR and the noise it adds to system [5]

Rachel Cannon's thesis - good explanation of error signals / lock in detection [6]

New paper on short term stability of 87Rb 2 photon clock, nice diagrams [7]

Eilidh's journal club paper - 776nm fluorescence detection [8]

Paper by Aidan and Rachel O on how to characterise noise in an ECDL [9]

Aidan suggestion 2 - Doppler thermometry and how to fit spectra nicely [10]

Steck 87Rb [11]

More interest than anything - a new Python package atomSmltr for simulation laser cooling and MOTs [12]

The original 3 cornered hat maths - first paper but not useful reading [13]

A general review article on metrology - should read all through. The first mention of a three cornered hat and a good description including the maths [14]

Enrico Rubiola's phase noise / frequency noise chart - read! [15] [16]

## 2 Iodine Clocks

The main paper for optical iodine clocks (Vector Atomic, Roslund et al) [17] and their recent conference proceeding [18]

German group (Wust et al) who have made iodine frequency references for space [19]

A thesis on iodine frequency references that has some nice explanations in it [20]

Original (?) paper on use of unsaturated iodine cell for frequency stability. Short paper, easy to read. Takeaways: coating inside of cell walls with iodine then adding known amount (moles) of gas produces linear temp vs pressure relationship, when operating temperature is 10 degrees or more (good for frequency stability). Could consider higher vapour pressure / moles of gas for better SNR but need to operate at higher temps to get linear region. [21]

More recent paper on unsaturated iodine cells. Uses modulated transfer spectroscopy (MTS), where probe beam in SAS is modulated using an AOM to provide a locking signal [22]

A better explanation / example of MTS (see above iodine spectroscopy) [23]

## References

- [1] Claudio E. Calosso et al. “Laser-Frequency Stabilization Using Light Shift in Compact Atomic Clocks”. In: *Physical Review Applied* 22.3 (Sept. 12, 2024), p. 034033. DOI: [10.1103/PhysRevApplied.22.034033](https://doi.org/10.1103/PhysRevApplied.22.034033).
- [2] J. Kitching, S. Knappe, and L. Hollberg. “Miniature Vapor-Cell Atomic-Frequency References”. In: *Applied Physics Letters* 81.3 (July 15, 2002), pp. 553–555. ISSN: 0003-6951. DOI: [10.1063/1.1494115](https://doi.org/10.1063/1.1494115).
- [3] Asagwegbe C. Obaze-Adeleke, Bryan Semon, and Thejesh N. Bandi. “A Comprehensive Review of Rubidium Two-Photon Vapor Cell Optical Clock: Long-Term Performance Limitations and Potential Improvements”. In: *Photonics* 12.5 (May 2025), p. 513. ISSN: 2304-6732. DOI: [10.3390/photonics12050513](https://doi.org/10.3390/photonics12050513).
- [4] Sean Dyer. “Development of Micro-Fabricated Vapour Cell Technology for Compact Atomic Devices”. University of Strathclyde, 2024. DOI: [10.48730/VBWZ-7J94](https://doi.org/10.48730/VBWZ-7J94).
- [5] Moustafa Abdel Hafiz. “Development and Metrological Characterization of a High-Performance Cs Cell Atomic Clock Based on Coherent Population Trapping”. Theses. Université Bourgogne Franche-Comté, June 2017. URL: <https://theses.hal.science/tel-01809998> (visited on 11/24/2025).
- [6] Rachel Cannon. “Miniaturised, High-Reliability Lasers for Quantum Technologies”. 2024. DOI: [10.48730/hwv6-g295](https://doi.org/10.48730/hwv6-g295).
- [7] Martin Callejo et al. “Short-Term Stability of a Microcell Optical Reference Based on the Rb Atom Two-Photon Transition at 778 Nm”. In: *JOSA B* 42.1 (Jan. 1, 2025), pp. 151–159. ISSN: 1520-8540. DOI: [10.1364/JOSAB.533904](https://doi.org/10.1364/JOSAB.533904).
- [8] River Beard et al. “Two-Photon Rubidium Clock Detecting 776 Nm Fluorescence”. In: *Optics Express*, Vol. 32, Issue 5, pp. 7417-7425 (Feb. 26, 2024). DOI: [10.1364/OE.513974](https://doi.org/10.1364/OE.513974).

- [9] Andrew Daffurn, Rachel F. Offer, and Aidan S. Arnold. “A Simple, Powerful Diode Laser System for Atomic Physics”. In: *Applied Optics*, Vol. 60, Issue 20, pp. 5832-5836 (July 10, 2021). DOI: [10.1364/AO.426844](https://doi.org/10.1364/AO.426844).
- [10] Nicola Agnew et al. *Practical Primary Thermometry via Alkali-Metal-Vapour Doppler Broadening*. July 24, 2025. DOI: [10.48550/arXiv.2505.24854](https://doi.org/10.48550/arXiv.2505.24854). arXiv: [2505.24854](https://arxiv.org/abs/2505.24854) [physics]. Pre-published.
- [11] *Alkali D Line Data*. URL: <https://steck.us/alkalidata/> (visited on 11/24/2025).
- [12] Mateo Weill, Andrea Bertoldi, and Alexandre Dureau. *atomSmltr: A Modular Python Package to Simulate Laser Cooling Setups*. Nov. 25, 2025. DOI: [10.48550/arXiv.2511.20596](https://doi.org/10.48550/arXiv.2511.20596). arXiv: [2511.20596](https://arxiv.org/abs/2511.20596) [physics]. Pre-published.
- [13] Frank E. Grubbs. “On Estimating Precision of Measuring Instruments and Product Variability”. In: *Journal of the American Statistical Association* 43.242 (June 1, 1948), pp. 243–264. ISSN: 0162-1459. DOI: [10.1080/01621459.1948.10483261](https://doi.org/10.1080/01621459.1948.10483261).
- [14] Judah Levine. “Introduction to Time and Frequency Metrology”. In: *Review of Scientific Instruments* 70.6 (June 1, 1999), pp. 2567–2596. ISSN: 0034-6748. DOI: [10.1063/1.1149844](https://doi.org/10.1063/1.1149844).
- [15] Enrico Rubiola. “The Enrico’s Chart for Phase Noise and Two-Sample Variances”. In: (Mar. 2, 2023). DOI: [10.5281/zenodo.7691686](https://doi.org/10.5281/zenodo.7691686).
- [16] Enrico Rubiola and François Vernotte. “The Companion of Enrico’s Chart for Phase Noise and Two-Sample Variances”. In: *IEEE Transactions on Microwave Theory and Techniques* 71.7 (July 2023), pp. 2996–3025. ISSN: 1557-9670. DOI: [10.1109/TMTT.2023.3238267](https://doi.org/10.1109/TMTT.2023.3238267).
- [17] Jonathan D. Roslund et al. “Optical Clocks at Sea”. In: *Nature* 628.8009 (Apr. 2024), pp. 736–740. ISSN: 1476-4687. DOI: [10.1038/s41586-024-07225-2](https://doi.org/10.1038/s41586-024-07225-2).
- [18] J. Roslund et al. “Molecular Iodine Optical Atomic Clocks”. In: *2024 Conference on Lasers and Electro-Optics (CLEO)*. 2024 Conference on Lasers and Electro-Optics (CLEO). May 2024, pp. 1–2. URL: <https://ieeexplore.ieee.org/document/10728808> (visited on 12/01/2025).
- [19] Jan Wust, Markus Oswald, and Martin Gohlke. “Optical Iodine Clocks for Future GNSS”. In: *9th International Colloquium on Scientific and Fundamental Aspects of GNSS*. 9th International Colloquium on Scientific and Fundamental Aspects of GNSS. Wrocław, Polen, Sept. 25, 2024. URL: [https://elib.dlr.de/212670/1/74wuest\\_update-74-44-W%C3%BCst-Jan.pdf](https://elib.dlr.de/212670/1/74wuest_update-74-44-W%C3%BCst-Jan.pdf).

- [20] Sigrid Skovbo Adersen. “An Iodine Based Thermal Optical Frequency Reference Using NICE-OHMS Detection”. MA thesis. Niels Bohr Institute, University of Copenhagen, June 30, 2016. URL: [https://nbi.ku.dk/english/theses/masters-theses/sigrid-skovbo-adsersen/SigridAdersen\\_Speciale2016.pdf](https://nbi.ku.dk/english/theses/masters-theses/sigrid-skovbo-adsersen/SigridAdersen_Speciale2016.pdf) (visited on 11/28/2025).
- [21] T.J. Quinn and J.-M. Chartier. “A New Type of Iodine Cell for Stabilized Lasers”. In: *IEEE Transactions on Instrumentation and Measurement* 42.2 (Apr. 1993), pp. 405–406. ISSN: 1557-9662. DOI: [10.1109/19.278591](https://doi.org/10.1109/19.278591).
- [22] Zhenqi Zhang et al. “High Performance Molecular Iodine Optical Reference Using an Unsaturated Vapor Cell”. In: *Review of Scientific Instruments* 95.6 (June 13, 2024), p. 063003. ISSN: 0034-6748. DOI: [10.1063/5.0210784](https://doi.org/10.1063/5.0210784).
- [23] Álvaro M. G. de Melo et al. “Laser Frequency Stabilization by Modulation Transfer Spectroscopy and Balanced Detection of Molecular Iodine for Laser Cooling of  $^{174}\text{Yb}$ ”. In: *Optics Express* 32.4 (Feb. 12, 2024), pp. 6204–6214. ISSN: 1094-4087. DOI: [10.1364/OE.512281](https://doi.org/10.1364/OE.512281).