Accuracy and precision of the JILA 1D strontium clock

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We have recently achieved an optical lattice clock with record low systematic uncertainty of 8.1×10^{-19} [1]. We perform recoil free spectroscopy of the least magnetically sensitive $^1S_0$ to $^3P_0$ transition in neutral fermionic strontium-87 atoms. A dilute sample of 10^5 atoms is confined within a lattice formed using an in-vacuum buildup cavity ensuring repeatable control of the lattice light shift [2]. In-situ imaging allows us to resolve and correct for local frequency gradients [3,4]. Although the clock is at room temperature, careful management of a thermally equilibrated environment and additional measurement of the dynamic term of the black body radiation shift allows us to further reduce systematic uncertainty. Additionally, we have been able to demonstrate record-long atomic coherence and characterize density dependent dephasing, potentially opening the door to lifetime limited spectroscopy of the clock transition.

References

[1] Aeppli et al., Phys. Rev. Lett. 133, 023401, 2024.
[2] Kim et al., Physical Review Letters 113203, 2023.
[3] Bothwell et al., Nature 602, 2022.
[4] Aeppli et al., Science Advances 8 (41), eadc9242, 2022.