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Experiments with Sr lattice clocks at PTB

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I will report the ongoing activities and plans concerning our two strontium lattice clocks at PTB. In our stationary laboratory clock system we now can achieve clock instabilities of $1.6\times10^{-16}/(\tau/\mathrm{s})^{1/2}$. We deduce this from a noise model of our clock [1], which we compare with instabilities observed when measuring systematic frequency shifts in interleaved mode. Though we use a high quality interrogation laser [2], the instability is still limited by the Dick effect. Higher duty cycle achieved by e.g. longer interrogation would mitigate this effect. Along these lines I will discuss a demonstration of a compound clock that allows extending the interrogation time considerably beyond the coherence time of the laser. The scheme will actually provide better clock stability of the compound system compared to faster averaging of ratio measurements.

Our stationary clock was also involved in comparisons against optical clocks, in particular with a Sr clock from LNE-SYRTE. This comparison was enabled by a coherent fibre frequency link designed and built by the SYRTE, Laboratoire de Physique des Lasers, and PTB groups [3]. In this measurement we could confirm the agreement of both clocks on the level of 5×10^{-17}. With this performance of optical clocks, it is reasonable to think about an implementation of a timescale steered by an optical clock. We have demonstrated [4] that this is indeed feasible, and better performance than with the current primary standards could be achieved.

Our second Sr lattice clock is transportable. Its first evaluation yielded an uncertainty of 7×10^{-17}. The frequency difference between our two lattice clocks was found to be much smaller. The apparatus is now prepared for its first measurement campaign, a comparison with INRIM's clocks in Torino, Italy, via fibre link that involves a height difference of about 1000 m. This experiment will constitute a proof-of-principle experiment in relativistic geodesy.

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