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The 87Sr optical lattice clock at PTB

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We report on the implementation of a cryogenic optical lattice clock based on the $^1S_0 \leftrightarrow {}^3P_0$ transition of ^{87}Sr at PTB. While the atomic response to the blackbody radiation (BBR) field experienced by the atoms has been well characterized [1], our existing lattice clock is now limited to a total systematic uncertainty of 2×10^{-17} [2] by our knowledge of the effective BBR field itself. Several groups [3-5] have already demonstrated approaches to control the BBR-induced frequency shifts to the level of few parts in 1018 and below, near room temperature or at cryogenic temperatures.

The lattice clock at PTB is successively being upgraded to a fully cryogenic lattice clock. In a first step, we have implemented a cryogenic environment into which the atoms are transport-ed for interrogation. This has allowed us to achieve similar control of the BBR-induced fre-quency shifts and is expected to enable a total systematic uncertainty below 1×10^{-17}. A sub-sequent upgrade to a new physics package will remove the need for transporting the atoms and provide generally improved control of systematic effects to enable operation of the lattice clock at systematic uncertainties of few parts in 10^{-18} and better.

The instability of our optical lattice clock is $1.6\times10^{-16}/\sqrt{\tau/\mathrm{s}}$ [6], which is limited by Dick effect. We present a novel interrogation scheme to minimize the Dick effect by interrogating the atoms longer than the coherent time of the clock laser.

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