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The Hg/Al single-atom, optical clocks: on the path to inaccuracies below 10^{-17}[1]

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For the past fifty years, atomic standards based on the frequency of the cesium ground-state hyperfine transition have been the most accurate timepieces in the world. Recently, we reported a comparison between the cesium fountain standard NIST-F1, which has been evaluated with an inaccuracy of about 4×10^{-16}, and an optical frequency standard based on an ultraviolet transition in a single, laser-cooled mercury ion for which the fractional systematic frequency uncertainty was below 7.2×10^{-17} [1]. We have also compared the frequency of the mercury ion optical clock to that of an optical standard based on the $^1S_0 \leftrightarrow {}^3P_0$ transition of $^{27}Al^+$ at 267 nm, which offers several attractive features as a single-ion optical clock. Its sharp natural linewidth, small electric quadrupole moment, and low quadratic Zeeman coefficient (0.7 Hz/B^2) allow for high stability and accuracy, but until recently, precision spectroscopy of Al^+ had not been possible, because it lacked an accessible, laser-cooling transition. However, with the development of quantum logic based spectroscopy [2, 3] a single aluminum ion can be efficiently probed. In our realization of this scheme, a single $^9Be^+$ ion is trapped together with the single Al ion in a linear Paul trap and is used to sympathetically cool the Al ion and to detect its internal state after the clock radiation is applied. We will report the latest results of the frequency comparison of the two optical standards and the implication these comparisons might have toward improved tests of the stability of Fundamental Constants. [1] W. H. Oskay *et al.*, submitted for publication. [2] D. J. Wineland *et al.*, Proc. 6th Symp. on Freq. Standards and Metrology, 361 (2002). [3] P. O. Schmidt *et al.*, Science 309, 749 (2005).

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