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Three optical frequency ratios and a clock network below the 10^{-17} level

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Optical atomic clocks based on narrow-linewidth optical transitions have realized unprecedented levels of stability, precision, and accuracy. At this level, evaluation by microwave standards becomes unfeasible as the standards themselves are limited to an accuracy worse than their optical counterparts. Direct evaluation of optical frequency ratios circumvents this problem and is a precursor for the redefinition of the SI second based on optical standards, as well as searches for fundamental physics. Here, we will describe the results of a three-way interspecies atomic clock comparison performed at JILA and NIST, involving the 87Sr and 171Yb optical lattice clocks, and the $27Al^+$ ion clock. All clocks report fractional inaccuracies at the 10^{-18} level. Two of the atomic ratios are simultaneously measured with an underground 1.5km long telecom fiber and a free-space link based on optical two-way time transfer and agree at the 10^{-18} level. Together, these evaluations demonstrate a robust optical clock network with the most accurate set of optical frequency ratios measured[1].

[1]Measurements performed by the Boulder Area Clock Network collaboration