Next-generation frequency standards

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Optical frequency standards have reached systematic uncertainties of a few parts in 10^17, equivalent to an error of a few seconds accumulated over the lifetime of the universe, and are able to detect time dilation caused by a change in height of less than one metre in the Earth's gravitational potential. Next-generation microwave frequency standards are set to fly aboard the International Space Station, testing relativistic red-shift to a few parts per million and transferring time to ground stations with picosecond-level precision. How are these astonishing feats of ultra-precise measurement achieved? The presentation will cover a short history, some core techniques, and the two main approaches to realising an optical frequency standard: single trapped ions and neutral atoms in optical lattices. Space-borne microwave frequency standards and linear ion traps will also be briefly described, as well as the challenges in comparing standards across large distances. To conclude, we will speculate on a redefinition of the SI second, currently defined with reference to cesium, and on the frontier for the measurement of time and frequency.