Optical atomic clocks - measurement at the 17th decimal place

Time is the most accurately measured quantity. Historically, advances in the accuracy of clocks have enabled advances in navigation, communication, astronomy, and fundamental physics. Since 1967, the definition of the SI second has been based on the frequency of a microwave transition in cesium, and present day cesium atomic clocks have a fractional uncertainty of 2×10^{-16}. Recently, a new type of atomic clock based on optical atomic transitions has been developed, with a present day fractional uncertainty of approximately one second divided by the age of the solar system (8×10^{-18}) that is rapidly improving.

This talk presents a summary of the development of optical atomic clocks based on single trapped ions and ensembles of neutral atoms, with a focus on the Al$^+$ quantum-logic clock developed at NIST. New applications including measurements of the time variation of fundamental constants and a demonstration of relativistic geodesy are described, and the ultimate performance of optical atomic clocks is considered.

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David's research interests focus on the development and applications of optical atomic clocks. He has contributed to the development of optical atomic clocks based on quantum-logic spectroscopy of single, trapped aluminum ions as well as laser frequency stabilization based on robust, portable optical cavities and spectral-hole burning. David has over 20 technical publications and received a Postdoctoral Research Fellowship from the National Research Council.