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A comparison of two $^{40}\text{Ca}^+$ single ion optical clocks at 5×10^{-17}

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A comparison of two optical clocks and a detailed study of the systematic frequency shifts of each $^{40}\text{Ca}^+$ single-ion optical clock were carried out in WIPM. A Ti:sapphire laser at 729 nm is frequency stabilized to an ultra-stable ultra-low thermal expansion coefficient (ULE) cavity by means of Pound-Drever-Hall method. 1 Hz linewidth and 2×10^{-15} frequency stability at 1-100 s is realized. Which is used for the probe of $^{40}\text{Ca}^+$ optical transition. After compensating for the micromotion, the two optical clocks both reach an uncertainty level of a few parts in 10^{-17} . The dominant source of uncertainty is the blackbody radiation (BBR) shift after minimizing the micromotion-induced shifts. The BBR shift is evaluated by controlling and measuring the temperature at the trap center. With a measurement over one month, the frequency difference between the two clocks is measured to be $3.2 (5.5) \times 10^{-17}$. Due to improvement of the clock laser and better control of the optical and electromagnetic field geometry and the laboratory conditions, a fractional stability of 7×10^{-17} in 20,000 s of averaging time is achieved. The absolute frequency of the $^{40}\text{Ca}^+$ $4s\ ^2S_{1/2} - 3d\ ^2D_{3/2}$ clock transition is measured to be 411 042 129 776 401.7 (1.1) Hz, with a fractional uncertainty of 2.7×10^{-15} using the GPS satellites as a link to the SI second.

Biography

Hua Guan has completed his PhD from Wuhan Institute of Physics and Mathematics (WIPM), The Chinese Academy of Sciences (CAS) and he visited NIST Boulder twice between 2008-2010. He is a Professor of WIPM. His major is Precision Measurement Physics. And his research interests are single-ion optical clocks and trapped ion precise spectroscopy. He has published more than 20 papers, including *Phys. Rev. Lett.*, *Phys. Rev. A*, *Appl. Phys. B*, *Rev. Sci. Instrum.* etc.

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