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Constraining the Quadrupole Shift in the Mercury Ion Optical Clock W.H. OSKAY, W.M. ITANO, J.C. BERGQUIST, Time and Frequency Division, National Institute of Standards and Technology — An optical-frequency atomic clock based upon the 282 nm $5d^{10}6s\ ^2S_{1/2}(F=0) \longrightarrow 5d^9 6s^2\ ^2D_{5/2}(F=2, m_F=0)$ transition in a single $^{199}\mathrm{Hg}^+$ ion has thus far been limited in accuracy by the shift due to the interaction of the electric quadrupole moment of the $^2D_{5/2}$ state with stray electric field gradients. We report an experimental measurement of the $^2D_{5/2}$ electric quadrupole moment and compare it with theory. We performed this measurement by observing the frequency shift of the clock transition with respect to the resonance of a stable optical cavity for various applied electric field gradients. By measuring the shift without an applied gradient, we can place an upper bound on the fractional frequency error caused by an ambient field gradient. With our existing setup, this uncertainty due to the quadrupole shift should be controllable to 10^{-17}. We discuss the error budget of the clock and implications for recent absolute measurements of the clock transition frequency.

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