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Robust Calibration of a Universal Single-Qubit Gate-Set via Robust Phase Estimation SHELBY KIMMEL, University of Maryland, QUICS, GUANG HAO LOW, THEODORE J. YODER, Massachusetts Institute of Technology — An important step in building a quantum computer is calibrating experimentally implemented quantum gates to produce operations that are close to ideal unitaries. The calibration step involves estimating the systematic errors in gates and then using controls to correct the implementation. Quantum process tomography is a standard technique for estimating these errors, but is both time consuming, (when one only wants to learn a few key parameters), and is usually inaccurate without resources like perfect state preparation and measurement, which might not be available. With the goal of efficiently and accurately estimating specific errors using minimal resources, we develop a parameter estimation technique, which can gauge key systematic parameters (specifically, amplitude and off-resonance errors) in a universal single-qubit gate-set with provable robustness and efficiency. In particular, our estimates achieve the optimal efficiency, Heisenberg scaling, and do so without entanglement and entirely within a single-qubit Hilbert space. Our main theorem making this possible is a robust version of the phase estimation procedure of Higgins et al. [B. L. Higgins et al., New J. Phys. 11 073023 (2009)].

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