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State-independent experimental test of quantum contextuality with a single trapped ion XIANG ZHANG, MARK UM, JUNHUA ZHANG, SHUOMING AN, YE WANG, KIHWAN KIM, Center for Quantum Information, Institute for Interdisciplinary Information Sciences, Tsinghua University, Beijing 100084, P. R. China, DONG-LING DENG, CHAO SHEN, LU-MING DUAN, Michigan Center for Theoretical Physics and Department of Physics, University of Michigan, Ann Arbor, MI 48109, USA — We experimentally demonstrate state-independent quantum contextuality in a three-level system (qutrit) with a single trapped ion [1] by observing the violation of the Kochen-Specker (KS) inequality proposed in Ref. [2]. Our results are clearly conflicted with the predictions of non-contextual classical theories, where a measurement outcome is predetermined and is unaffected by other measurements of compatible observables. Qutrit is the most fundamental system that reveals quantum contextuality, which is not based on entanglement or particular quantum states but rooted in the structure of quantum mechanics. We realize the qutrit system by using three levels in the hyperfine ground states of $^{171}Yb^{+}$ ion. The qutrit system is manipulated by microwaves with near-perfect fidelity and is measured without the detection loophole by a standard two-step quantum jump technique. [1] Zhang Xiang, et al., accepted in Phys. Rev. Lett. [2] S. Yu and C. H. Oh, Phys. Rev. Lett. 108, 030402 (2012). This work was supported by the National Basic Research Program of China Grant 2011CBA00300, 2011CBA00301, 2011CBA00302, the National Natural Science Foundation of China Grant 61073174, 61033001, 61061130540. KK acknowledges the support from the Thousand Young Talents plan.

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