Exponential quantum randomness expansion with trapped ions based on contextuality\(^1\) MARK UM, QI ZHAO, JUNHUA ZHANG, PENGFEI WANG, YE WANG, MU QIAO, HONGYI ZHOU, IIS, Tsinghua University, KAI-MIN CHUNG, IIS, Taiwan, XIONGFENG MA, KIHWAN KIM, IIS, Tsinghua University — We report a self-testing quantum random number generator (QRNG) achieving an exponential gain of randomness expansion. Similar to Bell’s theorem \([1]\), violation of Kochen and Specker theory, which also presents the intrinsic randomness of quantum mechanics and excludes noncontextual hidden variable models, is also used to certify generated randomness \([2]\). Here, we employ an extended Klyachko-Can-Binicoglu-Shumovsky (KCBS) inequality \([4,5]\) on a qutrit system of a trapped 138Ba+ ion system. Furthermore, by applying a spot-checking protocol of \([3]\), our self-testing QRNG realizes exponential randomness expansion without independent and identically distributed assumption considering the most general quantum adversary scenario. The system demonstrates 1.2410\(^8\) trials and results in randomness extraction of 2.310^5 bits realizing a 6.610^4 bits exponential randomness expansion with the speed of 270 bits/s. \([1]\) S. Pironio, et al., Nature 464, 1021 (2010). \([2]\) Mark Um, et al., Sci. Rep. 3, 1627 (2013). \([3]\) Carl Miller and Yaoyun Shi, Siam J. Comput. 46, 1304 (2017). \([4]\) O. Guhne, et al., Phys. Rev. A 81, 022121 (2010). \([5]\) J. Szangolies, et al., Phys. Rev. A. 87, 050101 (2013).

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