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Excited state population of a 3D transmon in thermal equilibrium X.Y. JIN, S. GUSTAVSSON, A. KAMAL, Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, A.P. SEARS, T. GUDMUNDSEN, D. HOVER, A.J. KERMAN, MIT Lincoln Laboratory, 244 Wood Street, Lexington, Massachusetts 02420, F. YAN, Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, J. YODER, MIT Lincoln Laboratory, 244 Wood Street, Lexington, Massachusetts 02420, T.P. ORLANDO, Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, W.D. OLIVER, Research Laboratory of Electronics, Massachusetts Institute of Technology, MIT Lincoln Laboratory, 244 Wood Street, Lexington, Massachusetts 02420 — We present a systematic study of the excited state population of a 3D transmon qubit at various temperatures. We experimentally demonstrate that the population of the first excited state follows the Maxwell-Boltzmann distribution in the temperature range of 35-150 mK. For bath temperatures below 35 mK, the excited-state population saturates, with an upper-bound estimate of 0.1%. The saturation suggests a qubit effective temperature of approximately 35 mK. The Lincoln Laboratory portion of this work was sponsored by the Assistant Secretary of Defense for Research & Engineering under Air Force Contract number FA8721-05-C-0002. Opinions, interpretations, conclusions and recommendations are those of the author and are not necessarily endorsed by the United States Government.

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