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Critical fluctuations near excitation threshold of a quantum parametric oscillator M. I. DYKMAN, Michigan State University, Y. NAKAMURA, The University of Tokyo and CEMS RIKEN, Z. R. LIN, CEMS RIKEN — A weakly damped parametrically driven oscillator has several vibrational states already for weak driving. These are stable and unstable states with twice the modulation period and also the steady state. At the critical point all states merge. We show that this leads to anomalously strong quantum fluctuations. These fluctuations are similar whether the friction, in the classical picture, is linear or nonlinear. The critical region is $\propto [\hbar(2\bar{n}+1)]^{1/3}$ along the field frequency axis and $\propto [\hbar(2\bar{n}+1)]^{2/3}$ along the field amplitude axis, where $\bar{n}$ is the Planck number. The correlation time scales as $[\hbar(2\bar{n}+1)]^{-2/3}$. The number of photons for $\bar{n}=0$ scales as $\hbar^{-2/3}$. It is determined by the oscillator nonlinearity and decay rate. Above the threshold, quantum fluctuations induce transitions between the period-two states over the quasienergy barrier. We find the effective quantum activation energies for such transitions and their scaling with the difference of the driving amplitude from its critical value. We also present the results of relevant experimental observations obtained with a circuit QED system.

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