Spontaneous Decoherence in Superconducting Qubits

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A superconductor has a spontaneously broken phase symmetry. This implies the existence of a spectrum of states related to the symmetry breaking – the thin spectrum – which lies within the superconducting gap. Besides being essential for the breaking of the phase symmetry, these thin spectrum states also cause superconducting qubits to decohere. The decohering effect in superconducting qubits is precisely analogous to the case which we studied before in the context of antiferromagnetism [1, 2]. It gives rise to a universal limit to coherence $t_{spon} \simeq 2\pi N\hbar/(k_B T)$, given in terms of the number of microscopic degrees of freedom N (in this case the number of Cooper pairs), temperature T, and the constants of Planck ($\hbar$) and Boltzmann (k_B).

[1] J. van Wezel, J. van den Brink, and J. Zaanen, Phys. Rev. Lett. **94**, 230401 (2005).
[2] J. van Wezel, J. Zaanen, and J. van den Brink, Phys. Rev. B **74**, 094430 (2006).