The Universal behavior of Superconducting Quantum Critical Points

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Quantum critical points (QCP) accompanied by superconductivity are common in condensed matter physics. In general, the transition temperature T^* of an ordered state, e.g. antiferromagnetic, goes to zero under the influence of an external parameter, e.g. pressure. Superconductivity appears before the disappearance of the ordered state, but reaches its maximum T_c when $T^* = 0$. Presently, the implications of the QCP's on superconductivity are a subject of debate, e.g. it is speculated that the superconducting state is a reaction of the system towards quantum fluctuations. It is shown here for nine systems with ordered states of different nature, under different external parameters, that both transition temperatures satisfy the relation $\tilde{T}^{*2}+\tilde{T}_c^2 = 1$, where the tilde indicates normalization to the maximum values. In order words, both states are related, as they are the consequence of the same interaction. Superconductivity is just another facet of the ordered state, and the dependence of its transition temperature with the external parameter can be retrieved from the dependence of transition temperature of the ordered phase. Although proposed here on intuitive grounds, this approach can be viewed as a phenomenological application of $SO(N)$ theories of superconductors, strongly supporting their relevance.