A theory of criticality for quantum ferroelectric metals

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According to standard lore, metallicity and ferroelectricity should be mutually exclusive phenomena, and if they were to coexist, they should be very weakly coupled. In sharp contrast with this view, experiments have identified dozens of compounds, typically doped semimetals or semiconductors, that can undergo a quantum phase transition to a ferroelectric state with broken inversion symmetry and signatures of strong correlations. I will discuss a theory of the quantum critical behavior of these systems, based on a model of soft transverse phonons interacting with electrons via spin-orbital or inter-orbital couplings. I will show that the model predicts a variety of interesting phenomena: marginal and non- Fermi liquids, quantum order-by-disorder, and, for Dirac materials, even synergetic superconductivity and ferroelectricity at the charge neutrality point. Finally, I will discuss how to control these systems via strain, and show recent experimental evidence for engineering of SrTiO3, via plastic strain, to enhance its superconductivity.