Metallicity and ferroelectricity in SrTiO$_3$ and related compounds

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Strontium titanate avoids ferroelectric ordering thanks to quantum fluctuations. Since the low-temperature dielectric constant becomes extremely large, the effective Bohr radius is as long as a micron. Consequently, the insulator can be easily turned to a dilute metal subject to an intriguing superconducting instability. Substituting a tiny fraction of strontium atoms with calcium stabilizes ferroelectric order. Remarkably, dilute superconductivity and dilute ferroelectricity coexist in a narrow window of doping in Sr$_{1-x}$Ca$_x$TiO$_3$$^\delta$ [1]. The electrical transport in this dilute metal and the thermal transport in the parent insulator both present intriguing features [2-4].