Ferroelectricity and superconductivity in ^{18}O-substituted $SrTiO_{3-\delta}$

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$SrTiO_3$ (STO) is an insulator and quantum paraelectric with a remarkably high dielectric constant. A long-range ferroelectric order can be induced by ^{18}O-isotope substitution above a quantum critical point (QCP) located at 0.33 at. % ^{18}O. On the other hand, $SrTiO_3$ becomes a metal with a superconducting ground state after the removal of an extremely small number of oxygen atoms making it one of the most dilute superconductors known today. Although superconductivity in this material has been discovered already half a century ago, the pairing mechanism leading to the superconducting dome is still under debate. The superconducting and ferroelectric orders may be accidental neighbors or intimately connected, as in a recently proposed quantum critical scenario where pairing is mediated by the ferroelectric soft mode [1, 2].

We developed a ^{18}O substitution process to control substitution levels beyond the quantum critical point in bulk STO. In these samples, dielectric and Raman measurements evidence a ferroelectric order below the Curie temperature. Upon electron-doping by oxygen removal, we find that a polar order coexists with the induced metallicity up to a critical doping threshold. In oxygen deficient samples with ^{18}O-substitution levels close and beyond the QCP, the superconducting critical temperature is strongly enhanced. This supports the role played by the ferroelectric vicinity in the precocious emergence of superconductivity, restricting possible theoretical scenarios for pairing.

[1] J.M. Edge et al., Phys. Rev. Lett. 115, 247002 (2015).

[2] D. van der Marel, F. Barantani and C.W. Rischau, Phys. Rev. Research 1, 013003 (2019).