Strain and ferroelectric soft-mode induced superconductivity in strontium titanate

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Strontium titanate (STO) is a quantum paraelectric that can be made superconducting at low temperatures (~0.4K) and carrier densities. It has been proposed that the superconducting pairing is mediated by ferroelectric phonons that are almost soft due to the quantum paraelectric nature of STO [1].

Here we investigate the effect of strain on superconducting STO by assuming that a ferroelectric mode that softens under tensile strain is responsible for the coupling. This leads to an increase in the critical temperature and range of carrier densities for superconductivity, with the peak of the superconducting dome shifting towards lower carrier densities. Using a Ginzburg-Landau approach in 2D, we find a linear dependence of the critical temperature on strain: if the couplings between the order parameter and strains in different directions differ while their sum is fixed, different behaviours under uniaxial and biaxial strain can be understood. [2]

References:
[1] J. Edge, Y. Kedem, U. Aschauer, N. A. Spaldin, and A. V. Balatsky, PhysRevLett.115.247002 (2015)
[2] K. Dunnett, Awadhesh Narayan, N. A. Spaldin, A. V. Balatsky, PhysRevB.97.144506 (2018)