Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Quantum critical origin of the superconducting dome and the isotope effect in $SrTiO_3$[1] YARON KEDEM, JONATHAN EDGE, NORDITA, ULRICH ASCHAUER, NICOLA SPALDIN, ETH Zurich, ALEXANDER BALATSKY, NORDITA, Los Alamos National Laboratory — We expand the notion that quantum criticality can induce superconductivity, by proposing a concrete mechanism for superconductivity due to quantum ferroelectric fluctuations. To this end, we investigate the origin of superconductivity in doped $SrTiO_3$ (STO) using a combination of density functional and strong coupling theories within the framework of quantum criticality. Our density functional calculations of the ferroelectric soft mode frequency as a function of doping reveal a crossover related to quantum paraelectricity at a doping level coincident with the experimentally observed top of the superconducting dome. Thus, we suggest a model in which the soft mode fluctuations provide the pairing interaction for superconductivity carriers. Within our model, the low doping limit of the superconducting dome is explained by the emergence of the Fermi surface, and the high doping limit by departure from the quantum critical regime. This results in a prediction that the highest critical temperature will increase and shift to lower carrier doping with increasing ^{18}O isotope substitution, a scenario that is experimentally verifiable. In addition we show a connection between the isotope exponent of superconductivity and the critical exponent pertaining to quantum phase transition.

[1]This work was supported by US DOE BES E304, by the ETH Zürich (NAS and UA) and by the ERC Advanced Grant Program, No. 291151 (NAS and UA), No321031, KAW and LDRD (YK).

Yaron Kedem
NORDITA

Date submitted: 05 Nov 2015 Electronic form version 1.4