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**Polaronic behavior in a weak-coupling superconductor** ADRIAN SWARTZ, HISASHI INOUE, TYLER MERZ, Stanford University, YASUYUKI HIKITA, SLAC National Accelerator Laboratory, SRINIVAS RAGHU, Stanford University, TOM DEVEREAUX, SLAC National Accelerator Laboratory, STEVEN JOHNSTON, University of Tennessee, HAROLD HWANG, Stanford University
— Superconductivity in the dilute semiconductor $SrTiO_3$ has remained an open question for more than 50 years. The extremely low carrier densities at which superconductivity occurs suggests an unconventional origin of superconductivity beyond the adiabatic limit in which the Bardeen-Cooper-Schrieffer (BCS) and Migdal-Eliashberg theories are based. Using a newly developed method for engineering band alignments at oxide interfaces, we have measured the doping evolution of the dimensionless $e$-ph coupling strength ($\lambda$) and superconducting gap in Nb-doped $SrTiO_3$ by high resolution tunneling spectroscopy. In the normal state, we observe density of states replicas remarkably similar to observations from photoemission experiments. The observation of multi-phonon processes indicates strong polaronic coupling ($\lambda \approx 1$) to the highest energy longitudinal optical phonon mode. Surprisingly, when cooled below the superconducting transition temperature, we observe a single superconducting gap corresponding to weak-coupling BCS theory, indicating an order of magnitude smaller pairing strength ($\lambda_{BCS} \approx 0.1$). These results indicate that $SrTiO_3$ occupies a highly unusual regime of polaronic superconductivity, ideal for probing anti-adiabatic superconductivity.

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