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Phase Transitions in a Two-dimensional Electron System at Oxide Interface with Dual Gate Tuning ZHUOYU CHEN, HISASHI INOUE, HYEOK YOON, DI LU, TYLER MERZ, SEUNG SAE HONG, ADRIAN SWARTZ, YANWU XIE, Stanford University, HONGTAO YUAN, YASUYUKI HIKITA, SLAC National Accelerator Laboratory, HAROLD HWANG, Stanford University and SLAC National Accelerator Laboratory — The ground state of a two-dimensional (2D) electron system can be controlled by parameters including disorder, carrier density, and magnetic field. Using the conducting channel formed at the $LaAlO_3/SrTiO_3$ (001) heterointerface, we performed magnetotransport measurements with simultaneous electric field effect gating from both the top epitaxial $LaAlO_3$ layer and the back $SrTiO_3$ (001) substrate. Besides conventional carrier density tuning, the structural asymmetry inherent to the dual-gate device also enables independent modulation of the disorder level in the conduction channel probed through carrier mobility. Under different top and back gate voltages and magnetic field combinations, the interface channel showed strikingly different conducting states including zero resistance (superconductor), saturating small finite resistance ("metal"), and increasing resistance (insulator), when approaching zero temperature. These results provide a unique opportunity for understanding the quantum phase transitions in 2D superconducting systems with continuously tunable parameters.

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