**Minicolloque n°MMPS17** ■ **Oral** □ **Poster**

# One to two-band superconductivity transition driven by gate voltage at an oxide interface

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The two dimension electron gases (2DEG) at the two band-insulator oxide interface LaAlO3/SrTiO3, first discovered in 2004 [1] have raise interest as it can host multiple electronic states including metallic, insulating or superconducting, and its properties are tuneable with a gate voltage [2][3].

In this context, we've probed the superfluid stiffness of the condensate at the LaAlO3/SrTiO3 interface, where SrTiO3 is oriented in the (110) direction, using resonant micro-wave measurement at mK temperature. Our work provides evidence of a transition from single to two-condensate superconductivity, driven by continuous and reversible electrostatic doping. We find that the superconductivity gap is suppressed as the second band is populated. Such behaviour is not expected in the Bardeen-Cooper-Schrieffer theory and can be explained using repulsive coupling between the condensate, characterized by an opposite sign in the order parameter. [4]

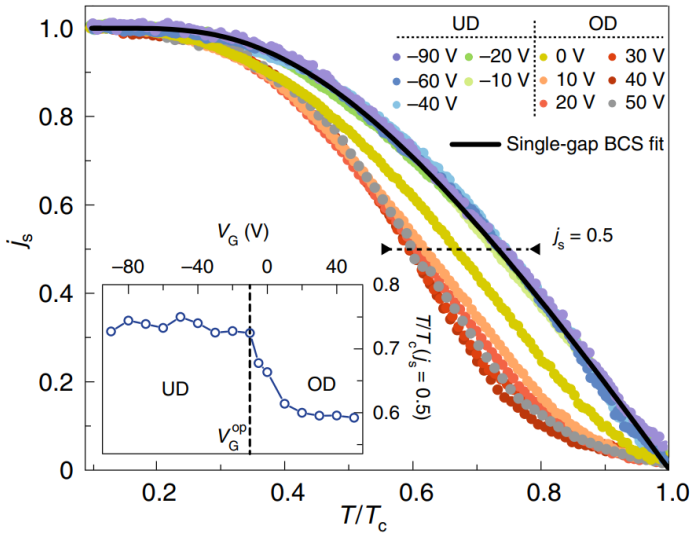


**Figure 1 :** Normalized superfluid stiffness js as a function of the reduced temperature T/Tc for different gate voltages. In the under-doped (UD) regime, all the curves are superimposed and follow a single-gap BCS behavior (dashed line). In the over-doped (OD) regime, the temperature dependence of the js curves is strongly modified. Inset, reduced temperature T/Tc corresponding to js = 0.5 as a function of gate voltage. Whereas the values are constant in the UD regime, an abrupt decrease takes place at the Liftshitz transition

[1] A. Ohtomo & H. Y. Hwang., Nature 427, 423-426 (2004)
[2] N. Reyren et al., Science 317, 1196-1199 (2007)
[3] A. D. Caviglia et al., Nature 546, 624-627 (2008)
[4] G. Singh et al., Nature Materials, 10.1038/s41563-019-0354-z (2019)