



**International Conference on Multi-Condensate Superconductivity and
Superfluidity in Solids and Ultra-Cold Gases
14 - 18 May 2018 (Trieste, Italy)**

**Critical Temperature Enhancement from Quantum Confinement in BCS
Superconductors**

Davide VALENTINIS

Ecole de Physique, DPMC, University of Geneva, Switzerland

Abstract:

Quantum confinement in a quasi-2D geometry changes the electronic properties of a material with respect to the bulk, due to the formation of subbands. In superconducting systems, such change of dimensionality alters the density of states and the pairing interaction, which leads to modifications of the critical properties.

In a quantum-confined superconductor, Cooper pairing is of a multi-band nature because all subbands are coupled. Furthermore, the pairing matrix elements depend on the shape of the confinement potential. We have developed numerical and analytical tools for solving the problem of a BCS superconductor in a square potential well at any electron density, including self-consistency in the chemical potential. The quasi-2D critical temperature shows oscillations as a function of density and confinement length, called shape resonances. Depending on the confinement strength, T_c can either increase with decreasing well thickness, before reaching a maximum and eventually dropping to zero, or it can be lower than the bulk for all thicknesses. We have applied our model to thin films of Nb-doped strontium titanate, a multiband low-density BCS superconductor. We consider a two-band model with pairing strength reproducing the bulk T_c of SrTiO₃. We apply our method to solve this model in a quasi-2D configuration for a finite rectangular-well confinement, thus obtaining T_c as a function of film thickness for a given doping. To experimentally test this picture, we have grown SrTiO₃/Nb:SrTiO₃/SrTiO₃ structures at 1% doping, with different thicknesses of the Nb:SrTiO₃ layer. Low-temperature transport measurements confirm the quantum-confined T_c enhancement predicted by theory.