Unconventional Field-Effect on Conventional Metallic Superconductors

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Time: 14:00-15:00 pm, Dec 18th, 2019

Location: Lecture Hall C302, New Sci. BLD.

Abstract: Static electric fields are believed to have negligible influence on the electric and transport properties of metallic superconductors, because of the screening effect. Surprisingly, recent experiments have shown that the superconducting properties can be mastered by moderate electrostatic fields [1-7]. In this talk, I will review the experimental results obtained in the realization of field-effect metallic superconducting devices exploiting conventional solid gating. I will start by presenting the pioneering results on superconducting Bardeen-Cooper-Schrieffer (BCS) wires [1] and nano-constriction Josephson junctions [2-3] made of titanium. I will continue discussing quasiparticles overheating and the length scales involved in this effect [1-3]. Later, I will present the control of the interference pattern in a superconducting quantum interference device [5] and the switching current distribution in a Dayem brigde [6] indicating the coupling of the electric field with the superconducting phase. I will move on the discussion of the universality of the effect by showing results obtained on different metallic superconductors (aluminum, vanadium and niobium). Then, I will show the mastering of the Josephson supercurrent in superconductor-normal metal-superconductor proximity transistors suggesting that the presence of induced superconducting correlations is enough to see this unconventional field-effect [4]. I will conclude this talk discussing some devices that may represent a breakthrough in superconducting quantum and classical computation.

References:

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[2] **F. Paolucci**, G. De Simoni, E. Strambini, P. Solinas, and F. Giazotto, “Ultra-efficient superconducting Dayem bridge field-effect transistor”, Nano Lett. **18**, 4195-4199 (2018).

[3] **F. Paolucci**, G. De Simoni, P. Solinas, E. Strambini, N. Ligato, P. Virtanen, A. Braggio, and F. Giazotto, “Magnetotransport Experiments on Fully Metallic Superconducting Dayem Bridge Field-Effect Transistors”, Phys. Rev. Appl. **11**, 024061 (2019).

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[6] C. Puglia, G. De Simoni, and F. Giazotto, arXiv:1910.14000v1 (submitted, 2019)

[7] **F. Paolucci**, G. De Simoni, P. Solinas, E. Strambini, C. Puglia, N. Ligato, and F. Giazotto, “Field-Effect Control of Metallic Superconducting Systems”, arXiv:1909.12721 (2019). To appear in AVS Quantum Science