High temperature superconductivity: an old story with a new twist.

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The main goal of Galilean science is to make measurable something that can´t be yet measured and this implies an improvement in the sensitivity in our experimental apparatus. How matter interacts with what we want to measure, however, is one of the puzzling aspects of quantum mechanics. Indeed, there is no ubiquitous way to exploit the properties of quantum physics for measuring devices; ultra-cold atoms, ion traps, photonics are just few examples of the possible ways to build applications in the quantum limit. However, one of the most promising platforms which is mostly used in the world of quantum devices is superconductivity since some of their technological applications include sensitive magnetometers (superconducting quantum interference device), fast digital circuits like rapid single flux quantum technology, qubits, high sensitivity particle detectors like kinetic inductance detector and superconducting nanowire single-photon detectors. Nevertheless, even if the achievements of the superconductive devices are impressive and their performances are surprising, it is also true that the materials employed are monoatomic, like Niobium or Germanium, or at most diatomic like AlO. In this talk, I demonstrate you that is possible to integrate in advanced circuits with nanometer sized high temperature superconducting complex materials: $Bi_2Sr_2CaCu_2O_{8+y}$ (T_c = 90 K). The results show that with a new artificial heterostructure where each layer is rotated by an angle respect to each other, the momentum space of the quantum condensate can be controlled, and a new superconducting phase with complex order parameter can be generated at the interface. Ultimately, I will show how these experimental results can lead to a new generation of quantum systems, theoretically leading to few orders of magnitude improvement in quantum sensitivity.

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