Metal-Graphene hybrids as a model system for 2D Superconductivity

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Graphene provides a ideal 2D gas of Dirac Fermions which is directly exposed to the environment. Therefore it provides an ideal platform on which to tune, via application of an electrostatic gate, the coupling between electronically ordered adsorbates deposited on its surface. This situation is particularly interesting when the network of adsorbates can induce some electronic order within the underlying graphene substrate, such as magnetic or superconducting correlations [1]. To demonstrate this concept, we have measured arrays of superconducting clusters physisorbed on Graphene capable to induce via the proximity effect a gate-tunable superconducting transition. We have experimentally studied the case of macroscopic graphene decorated with an array of superconducting tin clusters [2], which induce via percolation of proximity effect a global but tunable 2D superconducting state. By adjusting the graphene disorder and its charge carrier density on one side , the geometrical order, cluster size and density of the superconducting dot network on the other side, the superconducting state can exhibit very different behaviors, allowing to test different regimes and quantum phase transition from a granular superconductor to either metallic or insulating states, leading to a bosonic-type gate-controlled quantum phase transition [3]. I will show recent experimental results involving three sets of triangular arrays sparsely distributed on graphene, in which superconductivity is destroyed for a critical gate value that we attribute to the effect of quantum fluctuations of the phase giving rise to an intermediate metallic state [4].

References

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