**Probing 2D material's properties with superconducting quantum circuits coupled to 2D and 3D cavities**

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Integrating 2D materials (such as graphene) with superconducting quantum circuits is an emerging topic in searching of new types of quantum computing devices owing to its superb conductivity and 2D gateable nature. Several key observations, such as gate-tunable qubit energy, Rabi oscillation and qubit relaxation time T1 (dephasing time T2∗) at the scale of 36 ns (51 ns), have been reported [1]. Topological materials, for their topologically protected surface and edge states which can serve as a robust channel to carry supercurrent, are also promising candidates for use in 2D materials-based quantum computing devices [2-3]. In addition, the S-T-S junction (S is superconductor and T is topological material) naturally provides a platform to explore the physics associated with Majorana bound states (MBS). In the first part of this talk, I will review this field and introduce some of such quantum circuits integrated with 2D cavities in our lab [4]. On the other hand, 3D cavity-based superconducting qubits have the advantages of allowing DC transport measurements on their composing Josephson junctions. In the second part of this talk, I will introduce our recent works on characterizing flux-tunable graphene quantum circuits residing in a copper 3D cavity.

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