Interfacing Spin Centers and Magnons in Twisted Moiré 2D Magnets

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Poster: Complete Result

Magnonic hybrid quantum systems (HQSs) composed of solid-state spin centers and magnon modes within a magnet offer a practical platform for on-chip quantum information processing and for long-distance entanglement of spin qubits[1] [2] [3]. Although there have been substantial advances for Magnonic HQSs with three-dimensional materials, proposals focusing solely on two-dimensional (2D) materials remain scarce. This research endeavors to confront this issue.

In recent years, there has been a growing interest in the physics of moiré 2D materials[4]. This is mainly due to the tunability of its electronic and magnetic properties via the twisting angle between adjacent stacked layers. In this work, we study the tunability of the magnon band structure and density of states via the twisting angle between two 2D ferromagnetic honeycomb lattices[5]. This is obtained by considering both ferromagnetic intra-layer and inter-layer exchange interactions, as well as Zeeman interaction. Our magnonic HQS is then defined by including a 2D layer of hexagonal boron nitride (hBN) hosting spin vacancy centers, which is placed on top or in between the 2D magnet layers. We then calculate the coupling between spin centers and magnons via both exchange and dipole interaction, along with their dependence on the twisting angle. Ultimately, we show that the entanglement and coupling of two spin centers can be switched on and off via the twisting angle.

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