Title: The quantum limit of interacting magnetic waves

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The dynamic response of magnetic materials lacks time-reversal symmetry and can often be described through the propagation and evolution of waves of magnetic orientation, or spin waves. These spin waves, or magnons when quantized, can move without electric charge motion, yet spin-orbit interactions allow the spin waves to couple, sometimes very strongly, both to voltages and to illumination. I will describe progress over the last several years in calculating and understanding, in collaboration with experimentalists, the coupling of magnons to microwave[1,2] and optical photons[3]. In analogy with optomechanics, two photons will interact, within a cavity containing a ferrite, with a magnon mode to coherently modify the spontaneous emission rate, to exhibit electromagnetically-induced transparency and even to reach the strongly-coupled quantum regime[3]. Microwave-mediated interactions between magnons lead to a new effect we call nonlocal magnon drag, whereby a flow of magnons in one sheet will drag magnons in a neighboring, disconnected sheet[4]. The presence of the magnetization in the two sheets introduces a twist in the drag, producing a transverse spin current. As a final example, we predict that quantum-coherent spin centers can sense the magnetic susceptibility of nearby materials, distinctly from the magnetization of the material itself, and so this provides a potential method of detecting superconductors or magnetic dead layers without applied magnetic fields[5].

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References

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