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Spin pumping in electrodynamically coupled magnon-photon systems[1]

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The electronics industry is quickly approaching the limitation of Moore's Law due to Joule heating in high density-integrated devices. To achieve new higher-speed devices and reduce energy consumption, researchers are turning to spintronics where the intrinsic spin, rather than the charge of electrons, is used to carry information in devices. Advances in spintronics have led to the discovery of giant magnetoresistance (GMR), spin transfer torque etc. Another subject, cavity electrodynamics, promises a completely new quantum algorithm by studying the properties of a single electron interacting with photons inside of a cavity. By merging both spintronics and cavity electrodynamics, a new cutting edge field called Cavity Spintronics is forming, which draws on the advantages of both subjects to develop new spintronics devices utilizing light-matter interaction. In this work, we use electrical detection, in combination with microwave transmission, to investigate both resonant and nonresonant magnon-photon coupling in a microwave cavity at room temperature. Spin pumping in a dynamically coupled magnon-photon system is found to be distinctly different from previous experiments. Characteristic coupling features such as modes anticrossing, linewidth evolution, peculiar line shape, and resonance broadening are systematically measured and consistently analyzed by a theoretical model set on the foundation of classical electrodynamic coupling. Our experimental and theoretical approach paves the way for pursuing microwave coherent manipulation of pure spin current via the combination of spin pumping and magnon-photon coupling.

[1]Co-authored with M. Harder, C.-M. Hu from University of Manitoba, Y. P. Chen, J. Q. Xiao from University of Delaware, and X. Fan from Univeristy of Denver