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Electrical Detection of Dynamically Generated DC and AC Spin Currents

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Developing new methods for generating and detecting spin currents has been the central task of spintronics. In the pioneering work of Johnson and Silsbee, the generation and detection of spin-polarized currents were both achieved through the use of ferromagnetic metals (FM). Recent breakthroughs reveal ferromagnetic insulators (FI) to be promising spin current sources, in which spin currents can be generated without the presence of any charge current. So far, electrical detection of the spin current generated in FI was achieved by utilizing the spin-orbit coupling in heavy normal metal (NM) platinum (Pt). Given the fact that FM are broadly used as spin detectors in both semiconductor and metallic spintronics devices, it is of particular interest to develop new methods for detecting spin currents generated from an insulator using FM electrodes, which will make insulator spintronics devices compatible with both semiconductor and metallic spintronics devices.

In this talk, we report dual spin pumping in magnetic bilayers made of a ferromagnetic insulator yttrium iron garnet (YIG) and a ferromagnetic metal Permalloy (Py). At the YIG ferromagnetic resonance (FMR), we detect a charge voltage in Py caused by YIG spin pumping. At the Py FMR, we measure the charge voltage generated by Py spin rectification. A striking simultaneous enhancement of both voltages is found at the equal resonance condition of both FMRs, which we attribute to dynamic coupling of the dual spin pumping. Our results demonstrate that Py enables electrical detection of both dc and ac spin currents in the spin pumping from YIG, which reveals a new path for developing insulator spintronics.

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