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Using magnons to probe spintronic materials properties[1]

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For many spin-based electronic devices, from the read sensors in modern hard disk drives to future spintronic logic concepts, the device physics originates in spin polarized currents in ferromagnetic metals. In this talk, I will describe a novel "Spin Wave Doppler" method that uses the interaction of spin waves with spin-polarized currents to determine the spin drift velocity and the spin current polarization [1]. Owing to differences between the band structures of majority-spin and minority-spin electrons, the electrical current also carries an angular momentum current and magnetic moment current. Passing these coupled currents though a magnetic wire changes the linear excitations of the magnetization, i.e spin waves. Interestingly, the excitations can be described as drifting "downstream" with the electron flow. We measure this drift velocity by monitoring the spin-wave-mediated transmission between pairs of periodically patterned antennas on magnetic wires as a function of current density in the wire. The transmission frequency resonance shifts by $2\pi\Delta \mathrm{f} = \mathbf{v}\bullet\mathbf{k}$ where the drift velocity v is proportional to both the current density and the current polarization P. I will discuss measurements of the spin polarization of the current in $Ni_{80}Fe_{20}$ [2], and novel alloys $(CoFe)_{1-x}Ga_x$ [3] and $(Ni_{80}Fe_{20})_{1-x}Gd_x$ [4].

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