Local Injection of Pure Spin Current Generates Electric Current Vortices

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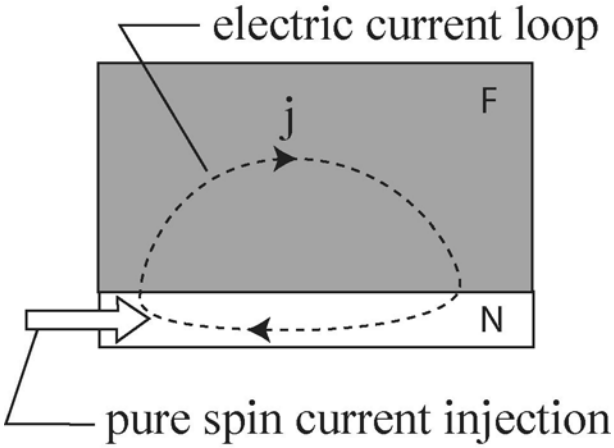
We show that local injection of pure spin current can produce electric currents running inside an electrically disconnected device with ferromagnetic and normal metal parts.[1] These currents are circular, run along closed loops inside the device, and are powered by the outside source responsible for spin injection.

Pure spin current injection is always assumed to be special because electric and spin currents are dissociated in such an experiment. Generation of circular currents violates this assumption, and may lead to important consequences. For example, in the non-local voltage measurements of Johnson-Silsbee type circular currents change measured voltages by an amount that has the same order of magnitude as voltages in zero-current situation.

Another surprising consequence of the loop current generation is the enhancement of spin diffusion length along the normal metal - ferromagnet interface. For an infinitely thick ferromagnetic overlayer spin diffusion length becomes infinite, and spin decay follows a power law.

More generally, electric current vortices at the interface between two conducting materials shall be expected whenever electric current is coupled to another driven diffusive current by linear relationships with material-dependent Onsager cross-coefficients.



Pure spin current injected into the normal part of the F/N bilayer

[1] Ya. B. Bazaliy and R. R. Ramazashvili, *Applied Physics Letters* **110**, 092405 (2017).