Spin and Orbital Hall Torques

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Over the past decade, extensive efforts have been directed towards discovering and understanding phenomena arising from the spin Hall effect and spin torques, leading to the rapid and exciting development of spintronics. The generation of spin currents by the spin Hall effect has been believed to be triggered by current-induced orbital dynamics, which governs the angular momentum transfer from the lattice to the electrons in solids. The fundamental role of the orbital response in the angular momentum dynamics suggests the importance of the orbital counterpart of spin currents: orbital currents. However, fundamental properties of orbital currents have been elusive. Here, we demonstrate the generation of orbital currents by the orbital Hall effect and uncover fundamental features of the orbital response [1]. We show that orbital currents propagate over longer distances than spin currents in a ferromagnet and nonmagnets. Our results also show that the orbital current enables electric manipulation of magnetization through orbital torques. These findings open the door to orbitronics that exploits orbital transport and spin-orbital coupled dynamics in solid-state devices.

[1] Hiroki Hayashi, Daegeun Jo, Dongwook Go, Yuriy Mokrousov, Hyun-Woo Lee, and Kazuya Ando, "Observation of long-range orbital transport and giant orbital torque," arXiv:2202.13896.

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