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Magnonic charge-pumping and spin-orbit torques in conducting ferromagnets

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In conducting ferromagnets, the spin-transfer torque and spin-motive force are known to exhibit a reciprocal relationship. Recent works on ferromagnets with strong spin-orbit coupling have revealed a rich complexity of the interaction between itinerant charge carriers and magnetization. As a result, currents can also induce magnetization excitations via spin-orbit torques, sometimes in more efficient ways than via spin-transfer torques. The reciprocal phenomenon of spin-orbit torques is magnonic charge-pumping. We will discuss how the material symmetry governs spin-orbit torques and magnonic charge-pumping. We will also relate magnonic charge pumping and spin-orbit torques via the Onsager reciprocal relations. Finally, we will give examples for important classes of systems including isotropic ferromagnets with nonuniform magnetization.