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Spin pumping and spin-transfer torques in antiferromagnet

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Spin pumping and spin-transfer torques are key elements of coupled dynamics of magnetization and conduction electron spin, which have been widely studied in various ferromagnetic materials. Recent progress in spintronics suggests that a spin current can significantly affects the behavior of an antiferromagnetic material [1], and the electron motion become adiabatic when the staggered field varies sufficiently slowly [2]. However, pumping from antiferromagnets and its relation to current-induced torques is yet unclear. In a recent study [3], we have solved this puzzle analytically by calculating how electrons scatter off a normal metal-antiferromagnetic interface. The pumped spin and staggered spin currents are derived in terms of the staggered field, the magnetization, and their rates of change. We find that for both compensated and uncompensated interfaces, spin pumping is of a similar magnitude as in ferromagnets; the direction of spin pumping is controlled by the polarization of the driving microwave. Via the Onsager reciprocity relations, the current-induced torques are also derived, the salient feature of which is illustrated by a terahertz nano-oscillator.

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