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Intrinsic spin-orbit coupling effects on spin and charge pumping in magnetic tunnel junctions with microwave-driven precessing magnetization FARZAD MAHFOUZI, BRANISLAV NIKOLIC, Department of Physics and Astronomy, University of Delaware, Newark, DE 19711, USA, NAOTO NAGAOSA, Department of Applied Physics, University of Tokyo, Tokyo 113-8656, Japan — We develop a microscopic quantum transport approach to the problem of spin pumping by precessing magnetization in one of the ferromagnetic layers within FIF or FIN (F-ferromagnet; N-normal metal; I-insulating barrier) magnetic tunnel junctions (MTJs) in the presence of intrinsic spin-orbit couplings (SOC) at the FI interface. Our approach evaluates the nonequilibrium Green functions (NEGFs) by starting from the time-dependent Hamiltonian of these junctions. To express the time-averaged charge current, or the corresponding dc pumping voltage in open circuits that was measured in recent experiments on MTJs [T. Moriyama *et al.*, Phys. Rev. Lett. **100**, 067602 (2008)], we construct a novel solution for the double-time-Fourier-transformed NEGFs where their two energy arguments are connected by the Floquet theorem describing emission and absorption of finite number of photons. Within this fully quantum-mechanical treatment of the conduction electrons, we find that only in the presence of the interfacial Rashba SOC non-zero dc pumping voltage in F|I|N junctions emerges at the adiabatic level (i.e., proportional to microwave frequency).

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