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Microscopic theory of non-equilibrium spin transport at metal-insulator interfaces

We theoretically describe non-equilibrium spin transport in metal-insulator interfaces. From the interface exchange interaction between the conduction electrons and the insulator spins, we derive semi-classical stochastic equations of motion for the spins. The non-equilibrium driving here originates from spin accumulation of the electrons at the interface. From the resulting equations of motion, microscopic contributions are identified for damping-like spin transfer torque, interfacial Gilbert damping, and noise magnetic fields. We discuss the relevant elastic and inelastic scattering processes responsible for each contribution. Within the same framework, we also derive an expression for the interface spin current. This is written only in terms of the stochastic insulator spin variables, providing a convenient basis for numerical simulations of insulator spin transport.

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