Conversion of magnonic, electronic spin and charge currents in hybrid quantum dot

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We investigate thermal response of a hybrid system consisting of a quantum dot attached to magnetic insulators and magnetic metals. Both magnetic insulators and magnetic metals are assumed to be of ferromagnetic type. Magnetic insulators are sources of magnons, whereas magnetic metals are host for spin-polarized electrons. Generally, the considered system consists of two magnonic reservoirs and two metallic leads. However, the special cases with only two or three electrodes in different configurations are also studied. Here, we are interested in magnon current conversion to electric spin and charge currents, and *vice versa*. Magnon current is generated by temperature difference set to/in magnetic insulators and then converted to electronic spin and charge current by means of quantum dot. In turn, charge/spin current of electronic type induced by temperature gradient set between metallic leads can be transformed to magnon spin current. In the present work we model coupling between quantum dot and magnetic insulators by means of energy-dependent density of states which leads to energy-dependent coupling matrix element. The energy dependence is crucial for boson-like particles especially in low-energy limit where the lowest momentum states dominate the transport. As a consequence, one should consider explicit energy dependence of the density of states for magnonic reservoirs.
Moreover, taking into account many-body magnon interaction leads to temperature-dependent magnonic density of states, and thus, to asymmetry in couplings of magnetic insulators to quantum dot when temperature gradient is set between magnonic reservoirs.
This phenomenon can lead to asymmetric spin currents resulting in spin diode effect.

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