Controllable spin switch in a single-molecule magnet tunneling junction

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Abstract

A new type of spin-current filter is proposed, which consists of a single-molecule magnet (SMM) coupled to two normal metal electrodes. It is shown that this tunneling junction can generate a highly spin-polarized current, whose spin polarization can be switched by the magnetic field and gate voltage applied to the SMM. Such a spin switching in the SMM tunnel junction arises from the spin-selected single electron resonant tunneling via the lowest unoccupied molecular orbit of the SMM. And the electron current spectrum in absences of external magnetic field is still spin-polarized, which can help us to judge if the molecule's spin state has reach to the ground-state doublet |±S⟩. This device can be realized with current technologies and may have practical use in spintronics and quantum information.

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Full Text

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Figures

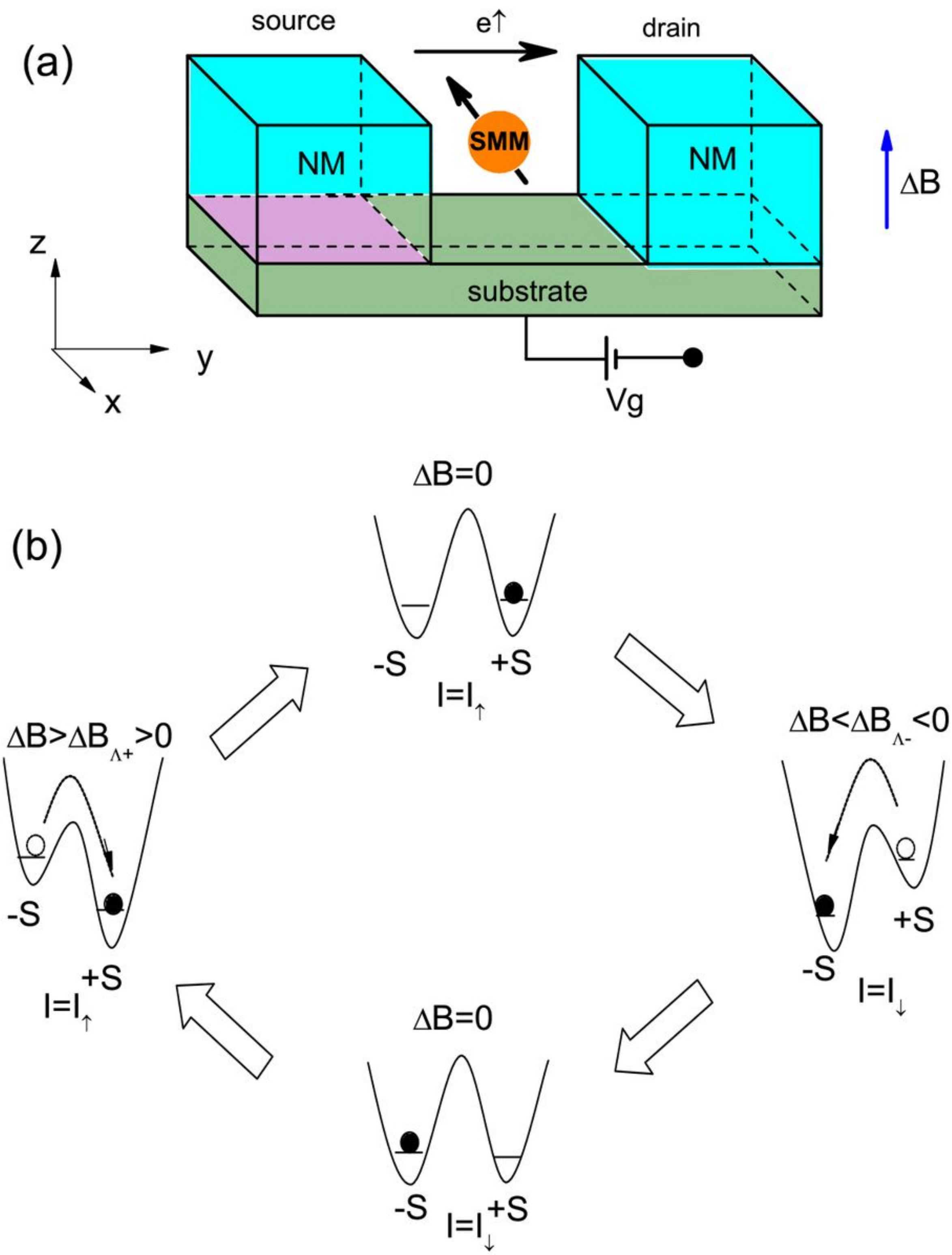

Figure 1

(Color online). (a)The schematic diagram for the spin filter and the spin-memory ,consists of a single-molecule magnet coupled to a couple of nonmagnetic electrodes.(b) schematically shows that the SMM's magnetization and tunneling current's spin-polarization can be switched by the external magnetic fields.

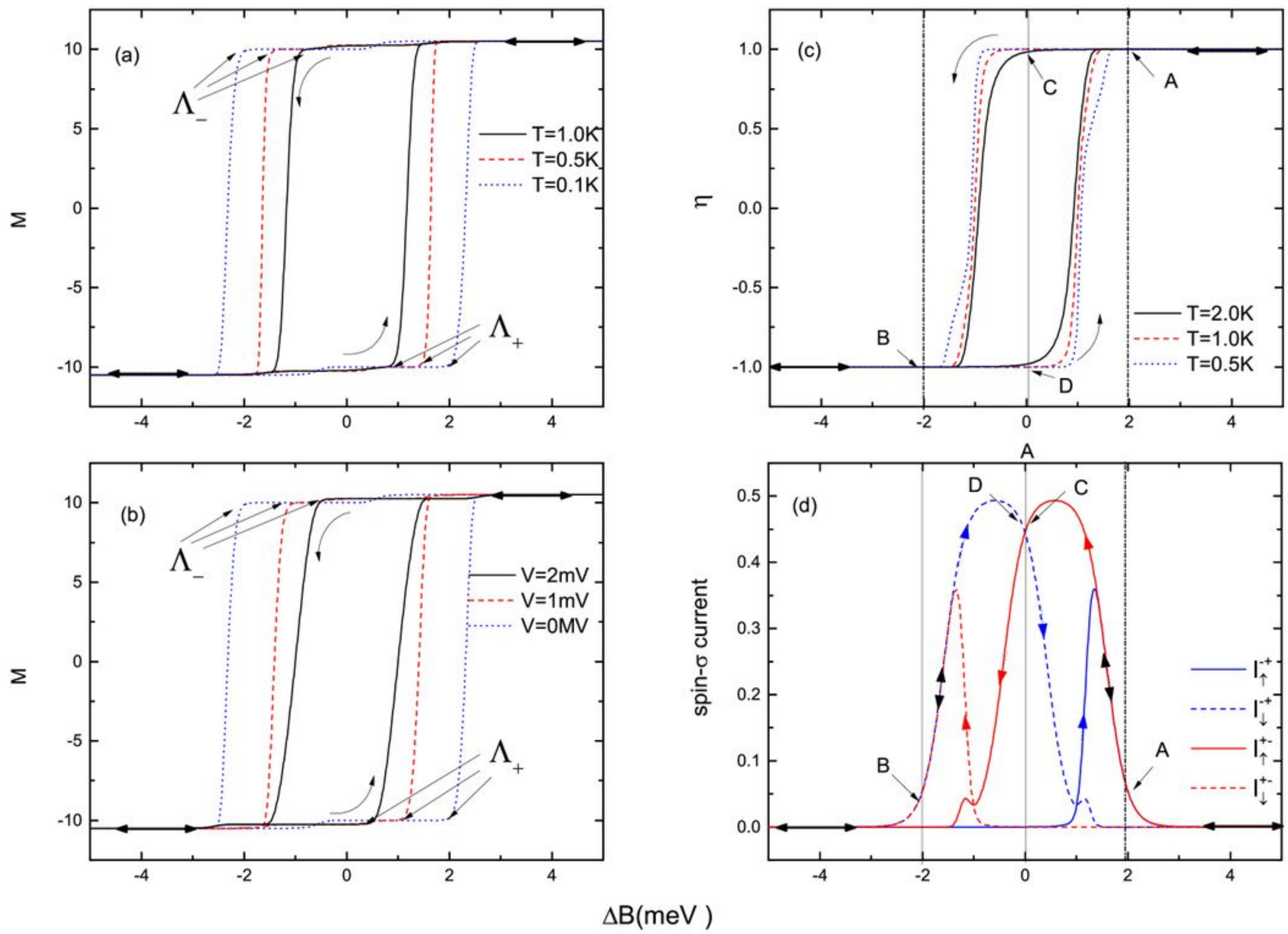

Figure 2

(Color online). Magnetic hysteresis loops of SMM for (a)different equilibrium temperatures and (b)different bias voltages , when scanning the external magnetic field ΔB back and forth. The spin polarization of tunneling current for (c)different equilibrium temperatures and (d)spin-σ currents(scaled by eΓ=~) at T = 0:5K,when scanning the external magnetic field ΔB back and forth at a fixed bias V=1mV.

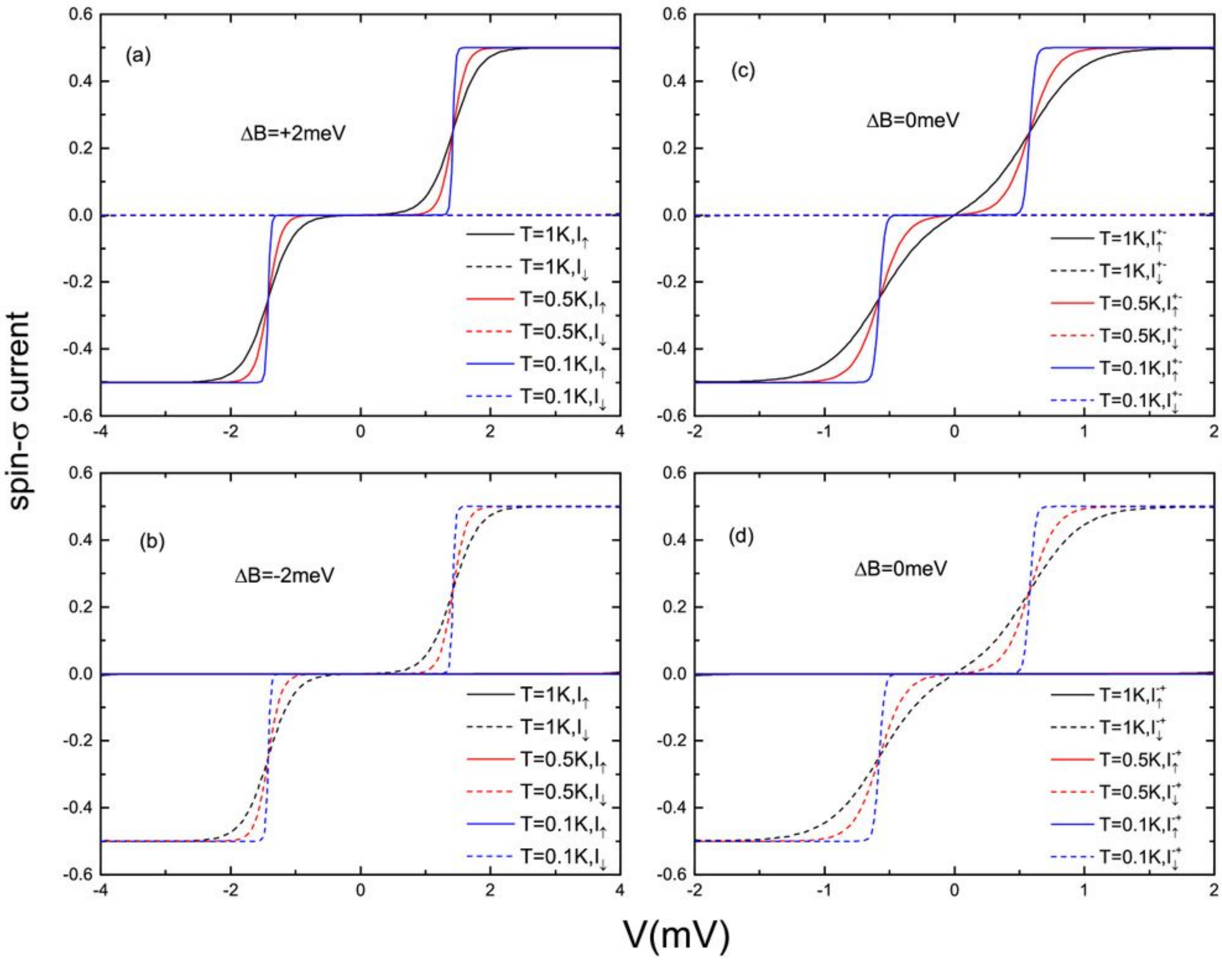

Figure 3

(Color online).Spin-� current I↑(↓) (scaled by eΓ=~) in the presence of external magnetic field (a)B = +2meV or (b)B = −2meV , and Spin-� current I↑(↓) (c)(d)in absence of magnetic field , as functions of bias voltage.

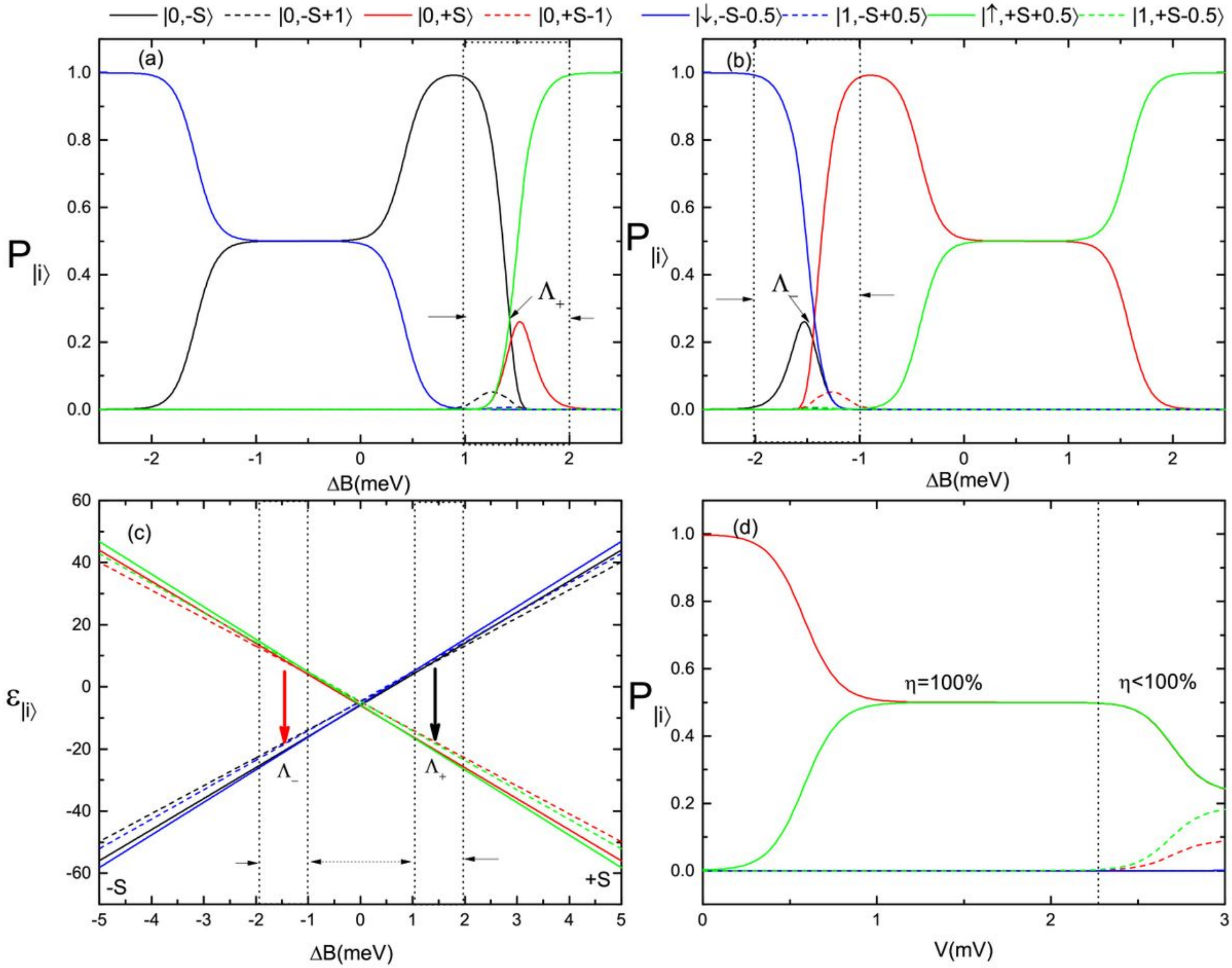

Figure 4

(Color online). The probabilities of molecular states changes when (a)ΔB scans from −5meV to +5meV and (b)ΔB scans from +5meV to −5meV . (c) Zeeman diagram for these spin-states for the ΔB changes -5meV to +5meV.(d)The probabilities of molecular states changes as function of bias voltages ,where the initial preparation of molecule's spin states is P|0;+S⟩=1 and Pi=0.

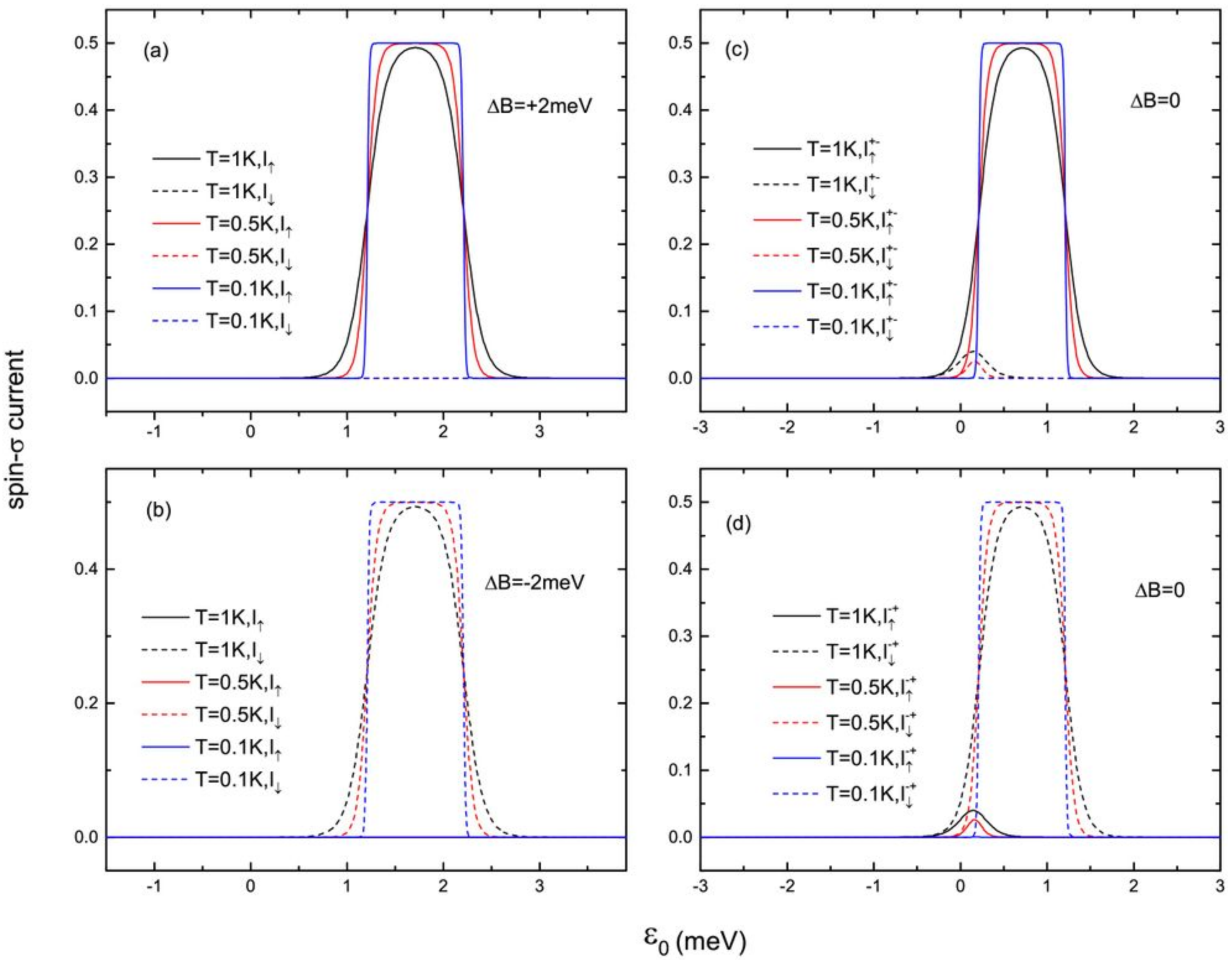

Figure 5

(Color online). Spin-� current I↑(↓) in the presence of external magnetic field (a)B = +2meV or (b)B = −2meV , and Spin-� current I↑(↓) (c)(d)in absence of magnetic field , as functions of molecular level "0.