Spin current manipulation through a Rashba dot by tunable nonequilibrium Fano-Kondo effect

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The Rashba-type spin-orbit interaction, which is generated by the potential asymmetry perpendicular to the semiconductor device plane, opens up a possibility of controlling electron's spin totally by electric field. It has been argued, however, that the mere existence of spin-orbit interaction is insufficient to realize such spin-dependent transport; it must be combined with ferromagnetic leads, magnetic field, or multilevel effect of the dot etc.
In the present work, we show that, even for a single-level dot without magnetic field (or apparent time-reversal breaking effect), spin dependent transport is possible in nonequilibrium. This is the outcome of an intertwining effect of spin-orbit interaction, Fano-Kondo Effect, and finite bias voltage. The phenomena may be regarded as a "nonequilibirum correlation effect" in every sense since this spin current vanishes either at zero bias or in a noninteracting dot. We analyze these results within the finite interaction (spin-invariant) slave-boson mean field theory, which gives consistent results with NRG in equilibrium cases and also has recently successfully described linear/nonlinear conductance profile through a carbon nanotube dot [1]. In addition, we examine the effect of explicitly time-breaking field such as longitudinal and transverse magnetic field to control this spin dependent transport.

[1]H. Oguchi and N. Taniguchi, J. Phys. Soc. Jpn. **78**, 083711 (2009); **79**, 056706 (2010).