Chirality-dependent spin polarization in metals: linear and quadratic responses

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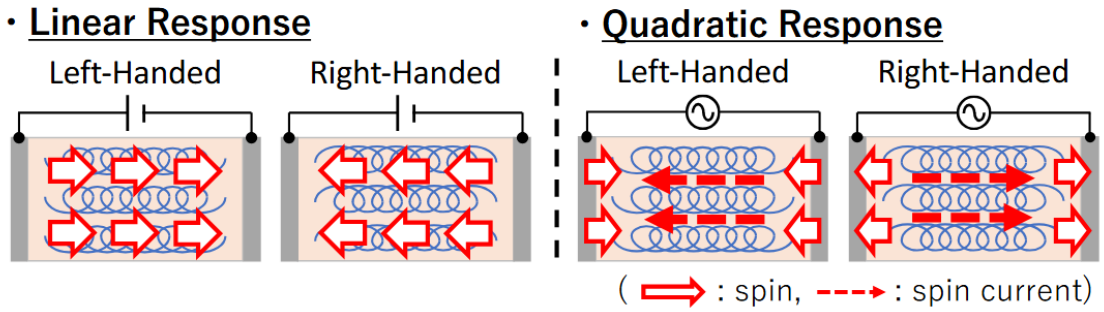
Chirality-induced spin selectivity (CISS) [1], first observed in photoelectron transmission through chiral molecules [2,3], has drawn significant attention due to large spin polarization at room temperature. Following the early studies, related phenomena have been reported in various systems, ranging from chiral molecules to inorganic metals and a superconductor. Accordingly, the term CISS now refers to the general correlation between electron spin polarization and the chirality of materials [4]. In this paper, we focus on the spin polarization in *chiral metals*, in the setup analogous to the experiments that demonstrated the CISS in solid state physics in the linear [5,6] and the quadratic [7] responses to a locally-injected electric current. We develop a microscopic theory that can consistently describe two features observed in these experiments[5-7]: (i) chirality-dependent spin polarization and (ii) antiparallel spin polarization near interfaces, as illustrated in Fig. 1. We also show (iii) that the sign of the spin polarization in the quadratic response is opposite to that expected from the bulk spin current. This sign discrepancy originates from spin polarization induced by dipole-like charge distribution appearing in the quadratic response.



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References

[1]R. Naaman and D. H. Waldeck, J. Phys. Chem. Lett. **3**, 2178 (2012).
[2]K. Ray, et al., Science **283**, 814 (1999).
[3]B. Göhler, et al. Science **331** 894 (2011)
[4] R. Naaman, Y. Paltiel, and D. H. Waldeck, J. Phys. Chem. Lett. **11**, 3660 (2020).
[5] A. Inui, et al., Phys. Rev. Lett. **124**, 166602 (2020).
[6] K. Shiota, et al. , Phys. Rev. Lett. **127**, 126602 (2021).
[7] R. Nakajima, et al. , Nature **613**, 479 (2023).
[8] K. Yoshimi, Y. Kato, et al., arXiv:2408.04450v2
[9] K. Yoshimi, et al., in preparation.