

Spin swapping of band-structure origin in centrosymmetric ferromagnets

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We theoretically demonstrate the spin swapping effect of band-structure origin, which is mediated by orbital degree of freedom. The proposed mechanism does not require inversion asymmetry or impurity spin-orbit scattering, so is relevant for centrosymmetric ferromagnets. Analytic and tight-binding models reveal that its main contributions originate from \mathbf{k} points where bands with different spins and different orbitals are close and thus it has no counterpart in normal metals. The spin swapping conductivities calculated from first-principles calculations for Fe, Co, and Ni are comparable in magnitude to the intrinsic spin Hall conductivity of Pt. Our theory generalizes transverse spin currents generated by ferromagnets and implies the importance of orbital degree of freedom in spin-orbit-coupled transport. In the presentation, we will show detailed analytical and computational results about spin swapping effect of band-structure origin.