Spin Hall and Edelstein effects in metallic films: from 2D to 3D

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A normal metallic film sandwiched between two insulators may have strong spin-orbit coupling near the metal-insulator interfaces, even if spin-orbit coupling is negligible in the bulk of the film. In this paper we study two deeply interconnected effects that arise from interfacial spin-orbit coupling in metallic films. The first is the spin Hall effect, and the second is the Edelstein effect. At variance with strictly two-dimensional Rashba systems, we find that the spin Hall conductivity has a finite value even if spin-orbit interaction with impurities is neglected and "vertex corrections" are properly taken into account. Even more remarkably, such finite value becomes "universal" in a certain configuration. This is a direct consequence of the spatial dependence of spin-orbit coupling on the third dimension, perpendicular to the film plane. The non-vanishing spin Hall conductivity has a profound influence on the Edelstein effect. Our results, although derived in a specific model, should be valid rather generally, whenever a spatially dependent Rashba spin-orbit coupling is present.

References:

[1] J.Borge, C. Gorini, G. Vignale and R. Raimondi, (2014), arXiv:1403.4195.