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Spin transport at interfaces with spin-orbit coupling

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Spintronic devices typically contain multiple layers and utilize spin-orbit coupling through a variety of effects, such as anisotropy, damping, or novel transport processes like the spin Hall effect. These devices are most simply analyzed when spin-orbit coupling plays a dominant role in the bulk layers rather than at the interfaces. However, recent observations of novel phenomena suggest the importance of strong spin-orbit coupling at interfaces. These phenomena can be desirable (e.g. perpendicular magnetic anisotropy, spin-to-charge conversion, topologically-protected magnetization textures) or parasitic (e.g. spin memory loss). While the precise role of interfacial spin-orbit coupling on transport remains unclear, substantial evidence indicates that it can no longer be ignored. We discuss the theory of spin transport at interfaces with spin-orbit coupling, focusing on phenomenological models and highlighting new effects. In particular, we show that interfaces with spin-orbit coupling can generate spin currents with spin polarizations in unconventional directions (i.e not orthogonal to both the charge current and spin flow). These spin currents are a direct consequence of interfacial spin-orbit coupling and could assist in switching magnetic layers with perpendicular magnetic anisotropy. We present the boundary conditions needed for drift-diffusion models to capture interfacial spin-orbit effects, and discuss the interpretation of experiments in which interfacial spin-orbit coupling might play a significant role.