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Rashba spin-orbit coupling and orbital chirality in magnetic bilayers[1]

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The phenomenon of the Rashba spin-orbit coupling is examined theoretically for an ultrathin magnetic layer in contact with a non-magnetic heavy metal layer. From first-principles calculation, large Rashba parameter of order 1 eV·Å is obtained, which is strong enough to generate large spin transfer torque of spin-orbit coupling origin. Large Rashba parameter is attributed to the orbital mixing of $3d$ magnetic atoms and non-magnetic heavy elements with significant atomic spin-orbit coupling. Interestingly the magnitude and sign of the parameter vary from energy bands to bands, which we attribute to band-specific chiral ordering of orbital angular momentum. Through a simple tight-binding model analysis, we demonstrate that d-orbital hybridization allowed by the breaking of structural inversion symmetry generates band-specific chiral ordering of orbital angular momentum, which combines with atomic spin-orbit coupling to give rise to band-specific Rashba parameter. The band-dependence of the Rashba parameter is discussed in connection with recent experiments and we argue that the dependence may be utilized to enhance device application potentials.

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