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Harvesting spin-orbit coupling at interfaces

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The ever-increasing demand of information technology for power-efficient components has led to the search for alternative solutions to mainstream microelectronics. In this context, spintronics devices stand out as competitive candidates, especially for memory and logic applications. A promising route harvests unconventional transport properties arising from spin-orbit coupling in magnetic heterostructures lacking inversion symmetry.
In these systems, typically multilayers of transition-metal ferromagnets and heavy materials (e.g., W, Pt, Ta, Bi2Se3, WTe2), interfacial spin-orbit coupling promotes a wealth of remarkable physical phenomena: the generation of spin-orbit torques, the interconversion between spin and charge currents, and the stabilization of topological magnetic skyrmions. The recent synthesis of novel classes of materials has profoundly enriched this vivid field of research by unlocking unforeseen forms of torques and magnetic interactions, thereby enhancing the functionalities of spin-orbitronic devices.

In this presentation, I will provide a general perspective of the advancement of the fascinating field of spin-orbitronics, focusing on two emblematic mechanisms: the spin-orbit torque and the Dzyaloshinskii-Moriya interaction. I will present standard phenomenological descriptions of these two effects and give a broad overview of the current state-of-the-art of the field in various systems of interest including transition metal multilayers, topological insulators and antiferromagnets. I will then explore how spin-orbitronics takes a completely new form in materials possessing low crystalline symmetries, such as Fe3GeTe2 and CuPt/CoPt(111) bilayers. Finally, I will show how interfacial spin-orbit coupling can be exploited to generate high-harmonic charge currents induced by spin pumping opening entirely novel perspectives in the field.

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