

Transverse Hall and Nernst effects in thin films from first principles

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The importance of transverse transport effects which are driven by spin-orbit interaction has been constantly rising in the past years owing to the key role these effects play for possible applications in future spintronics devices. Here, we will focus on the physics of the Hall and Nernst family of effects as accessed from first principles in thin films of transition metals. We will discuss the origins of the transverse currents in disordered media and the ways these currents can be manipulated by proper nano-structuring taking as an example the spin Nernst effect. Moreover, we will discuss the interplay of the topological Hall and anomalous Hall effect in thin films with non-collinear magnetic order and relation of the topological charge to the transverse thermoelectric properties in such systems. Finally, we will show how the topological concepts allow us to formulate the thermoelectric analog of the spin-orbit torque in ferromagnets, and we will discuss the magnitude of this thermal spin-orbit torque in thin transition-metal films.