Steering magnetic skyrmions with currents: A nonequilibrium Green's functions approach

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We present a mixed quantum-classical scheme to describe how magnetic skyrmions can be manipulated with currents. Our approach is based on a microscopic treatment of the skyrmion-current interaction, where we treat the currents via nonequilibrium Green's functions (NEGF), the skyrmions in terms of classical localized spins, and describe the skyrmion motion within the Ehrenfest dynamics. This mixed quantum-classical scheme is then employed to gain insight into how time-dependent currents, and electron-electron and spin-orbit interactions in a current-carrying wire affect skyrmion dynamics. In the second part of the talk, we address scope and limitations of this approach, and speculate on possible ways forward. This is done using examples and concepts borrowed from NEGF treatments of molecular motors and density functional approaches for multi-component systems.