

Nanoskyrmions in spin–electron systems, with a preliminary outlook on photonic effects

Claudio Verdozzi

Magnetic skyrmions are topological spin textures of interest for applications in memory, spintronics, and quantum or neuromorphic computing. We study skyrmions formed by localized spins coupled to itinerant electrons, with electronic dynamics treated via NEGF-GKBA or exact diagonalization, and spins described classically or quantum mechanically. In the classical case, skyrmions evolve under the Landau–Lifshitz–Gilbert equation, allowing us to examine how spin currents and dilute disorder impact their transport. We find strong sensitivity to the local disorder profile due to the surrounding spin dynamics. For quantum skyrmions, spin–electron coupling is included at mean-field level, and tensor networks are used to capture quantum spin correlations. Benchmarks confirm the method's accuracy, and we show that itinerant electrons markedly influence entanglement and structure. We conclude with preliminary results from an extended model incorporating optical cavity photons, outlining progress achieved before the workshop.