

Quantum Scattering From Topological Spin Textures

Hareram Swain^{1,2}

¹*Condensed Matter Theory and Computational Lab,*

Department of Physics, IIT Madras, Chennai-600036, India

²*Center for Atomistic Modelling and Materials Design,*

IIT Madras, Chennai-600036, India

Electron scattering from the chiral spin textures such as skyrmion, bimeron, skyrmionium etc. is emerging as a vibrant research area due to the interplay between its topology, spin dynamics and quantum transport. We develop a novel numerical framework to investigate the real-time quantum dynamics of electron scattering from arbitrary non-collinear spin textures. Our technique goes beyond asymptotic scattering theory by capturing intermediate processes such as iterative spin flipping within the chiral textures and the formation of long-lived quasi-bound states at the scattering center. From the asymptotic states we study and compare the transport behaviors such as charge hall effect, anomalous hall effect, spin hall effect between skyrmion, bimeron, biskyrmion, and skyrmionium. Analysis of the asymptotic scattering states and systematic comparison of transport responses induced by different chiral spin textures unravel the distinct internal structures and topological properties of these spin textures. This qualitatively different transport signatures offers a pathway for texture-selective transport control. These findings have important implications for next generation spintronic devices and quantum information technologies.

References:

[1] H. Swain, A. Mandal, S.Satpathy, B.R.K. Nanda, Quantum dynamics of electron scattering from skyrmion (arxiv:2509.19437)