On-line SPICE-SPIN+X Seminars

Wednesday, 22nd September 2021, 15:00 (German Time)

The seminar will be via Zoom (Meeting ID: 830 8965 1936) and live streamed in the SPICE YouTube Channel.

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Reconfigurable Training, Vortex Writing and Noise-Tolerant Reservoir Computation via Spin-Wave Fingerprinting in an Artificial Spin-Vortex Ice

Strongly-interacting artificial spin systems are moving beyond mimicking naturally-occurring materials to find roles as versatile functional platforms, from reconfigurable magnonics to designer magnetic metamaterials. Typically artificial spin systems comprise nanomagnets with a single magnetisation texture: collinear macrospins or chiral vortices.

By tuning array dimensions we achieve macrospin/vortex bistability and demonstrate a four-state metamaterial spin-system 'Artificial Spin-Vortex Ice' (ASVI). ASVI is capable of adopting Ising macrospins with strong ice-like vertex interactions, in addition to weakly-coupled vortices with low stray dipolar-field. The enhanced bi-texture microstate space gives rise to emergent physical memory phenomena, with ratchet-like vortex training and history-dependent nonlinear training dynamics.

We observe vortex-domain formation alongside MFM tip vortex-writing. Tip-written vortices dramatically alter local reversal and memory dynamics. Vortices and macrospins exhibit starkly-differing spin-wave spectra with analogue-style mode-amplitude control via vortex training and mode-frequency shifts of Δf = 3.8 GHz. We employ spin-wave 'spectral fingerprinting' for rapid, scaleable readout of dynamic vortex and macrospin populations over complex training-protocols. The history-dependent spectral fingerprint is leveraged for a noise-tolerant reservoir computation scheme predicting and classifying time-series datasets.