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Domain Wall Trajectory Determined by its Fractional Topological Edge Defects

AAKASH PUSHP, IBM Almaden Research Center, San Jose, CA 95120

The theory of topological defects has had a significant influence on the understanding of various physical phenomena ranging from superfluid Helium-3 to liquid crystals. Topological defects are general features in systems with broken symmetries such as head-to-head (HH) and tail-to-tail (TT) domain walls (DWs) in soft ferromagnetic nanowires (NWs). Such DWs are further composed of elementary topological bulk and edge defects with integer and fractional winding numbers, respectively; whose relative spatial arrangement determines the chirality of the DW. Understanding the influence of the DW structure on its motion is critical for both fundamental and technological reasons. In this talk, I will show how one can understand and control the trajectory of DWs in magnetic branched networks, composed of connected NWs, by a consideration of their fractional elementary topological defects and how they interact with those innate to the network. I will describe a simple and yet a highly reliable mechanism that we have developed for the injection of a DW of a given chirality into a NW and exploit it to show that it is the DW's chirality that determines which branch the DW follows at a symmetric Y-shaped magnetic junction, the fundamental building block of the network. Using these concepts, I'll unravel the microscopic origin of the one-dimensional (1D) nature of magnetization reversal of artificial spin ice systems that have been observed in the form of Dirac strings. This understanding will allow for the formation of more complex chiral magnetic orders by controllably generating and propagating several domain walls of specific chiralities into artificial spin ice structures to form defined lattices of Dirac strings.

Reference:

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