"Electronic materials with nanoscale curved geometries"

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NATURE ELECTRONICS 5 (2022) 551

As the dimensions of a material shrink from an extended bulk solid to a nanoscale structure, size and quantum confinement effects become dominant, altering the properties of the material. Advances in nanostructuring techniques now allow electronic materials with 3D nanoscale architectures to be constructed from 2D and 1D materials, yielding three-dimensional shapes and configurations that would be impossible to achieve with bulk materials. The pursuit of these structures has largely been driven by the growing demand for next-generation electronics, based on electronic memory and logic devices with improved performance and reliability. Central to these customized appliances is the recognized possibility to modify and fine-tune the physical properties of essentially all electronic materials through a proper exploitation of geometric deformations and curvature effects at the nanoscale. Within this context, a key role turns out to be played by the characteristic radius of curvature associated to the curved geometric shape. In particular, in materials that exhibit long-range order, such as magnets and superconductors, the ground state and elementary excitations can be geometrically tuned when the radius of curvature is comparable to the magnetic length or the superconducting coherence length. Additionally, the interplay between nanoscale deformations and structure inversion asymmetry establishes a deep connection between electronic spin textures, spin transport properties, and the nanoscale shape of the system, making possible to induce novel topological states and modified Cooper pairs structures (Fig.1), thus leading to novel coherent effects for quantum technologies.

The exciting developments in the discovery and exploitation of these effects induced by curvature at the nanoscale allow ultimately to define a completely new field – *curved nanoelectronics*. This article examines in detail the origin of curvature effects at the nanoscale and illustrates their potential applications in innovative electronic, spintronic and superconducting devices. The paper also describes the methods needed to synthesize and characterize curvilinear nanostructures and highlights key areas for the future developments of curved nanoelectronics.

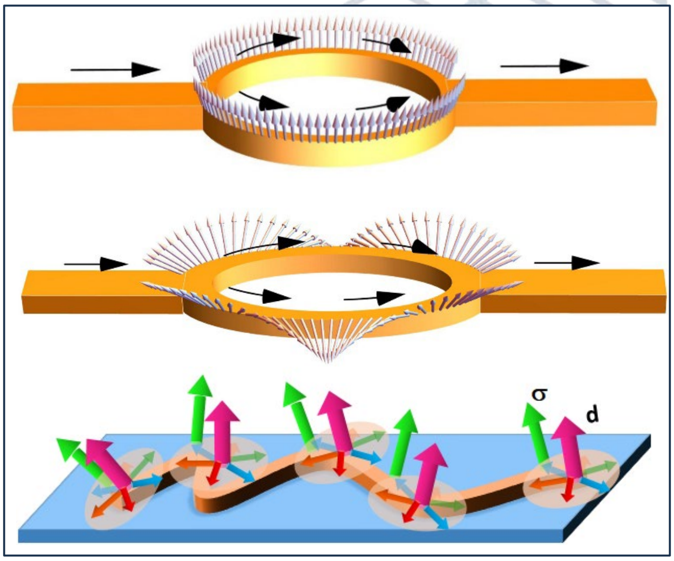

*Fig. 1: Schematics of the spin textures realized in circular (top) and shape-deformed (middle) interferometers, as well as of the spin and superconducting **d**-vector textures in superconducting nanostructures, due to the interplay between inversion asymmetry and geometric shaping.*