Highlights

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Tuning Pairing Amplitude and Spin-Triplet Texture by Curving Superconducting Nanostructures

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Shape deformations in Rashba spin-orbit coupled (RSOC) nanostructures can be employed for tailoring spin textures, spin transport properties, and geometrically driven topological phases. The recent advances in this framework bring to the fore the fundamental and challenging problem of understanding which type of superconducting (SC) state may emerge when varying the nanoscale shape of RSOC nanostructures, and how this is linked to the spin textures in the normal state. We addressed this question and uncovered the subtle interrelation between nanoscale shape deformations and the nature of superconductivity in RSOC nanostructures. While in systems with constant curvature (e.g. quantum wires or circular rings) the RSOC is monotonously affecting the superconductivity, spatial variation of the Rashba field through curvature of the nanostructure can yield either a local enhancement or a suppression of the SC order parameter. We demonstrate this effect by employing elliptically shaped quantum rings. Apart from driving the SC spin-singlet amplitude, the inhomogeneous profile of the curvature generates non-trivial spatial patterns of the spin-triplet pairs. We show that the geometric curvature can tailor the spin-triplet pairing by yielding three-dimensional spatial textures, and the d-vector, contrary to the uniform curvature profiles, i.e. straight and circular nanostructures (Fig. 1(e),(f)), exhibits windings (Fig. 1(g),(h)) similarly to the electron spin-orientation in the normal state (Fig. 1(c),(d)). Such findings indicate that geometric curvature can be exploited to effectively yield a spin-torque on the electron spin of the superconducting pairs.

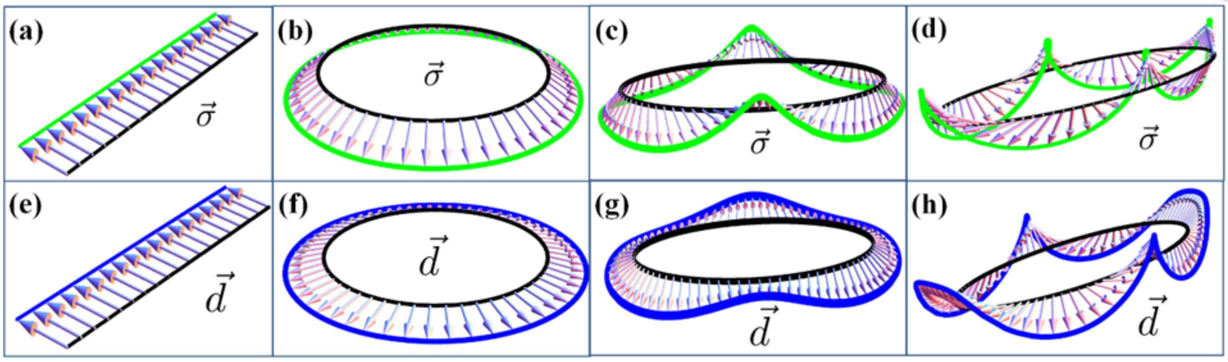

Fig.1: Electron spin orientation σ in the normal state and spin-triplet d-vector in the superconducting state for different types of low dimensional nanostructures.