Highlights

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Designing electron spin textures and spin interferometers by shape deformations

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The manipulation and control of electron spin set fundamental challenges for the development of innovative solutions for quantum engineering. In our report we uncover a fundamental entanglement between the electron spin degree of freedom and the geometry of the system in which electrons reside. We find that the geometric curvature of a shape deformed one-dimensional nanostructure in the presence of Rashba spin-orbit coupling α_R can steer the electron spin texture and, in turn, the quantum interference that an electron acquires when moving in a closed circuit. Taking the paradigmatic example of an elliptically deformed quantum ring (Fig. 1 (d)) with Rashba spin-orbit coupling we provide a proof-of-principle of an all-geometrical-and-electrical control of electron spin and quantum spin transport (Fig. 2). We demonstrate that non-uniform geometric curvature drives spin textures with a tunable topological character with windings around the radial and the out-of-plane directions (Fig. 2). These topologically non trivial spin patterns affect the spin interference effect in the deformed ring, thereby resulting in different geometry-driven electronic transport. behaviors.

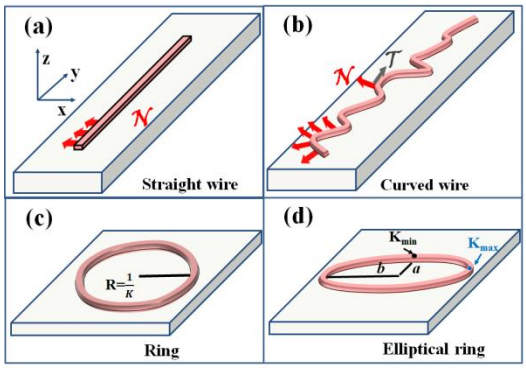

Figure 1. Schematics of the geometric profile of (a) straight, (b) planarly curved nanostructure, (c) ring, and (d) elliptically deformed ring with semi-axes *a* and *b*. Red (gray) arrows indicate the perpendicular (tangential) direction of the spin orientation with respect to the geometric profile. *K* is the curvature of the ring, e.g. the inverse of the its radius *R*. Black (blue) dots indicate a position with minimum K_{min} (maximal K_{max}) amplitude of the curvature in the elliptical ring.

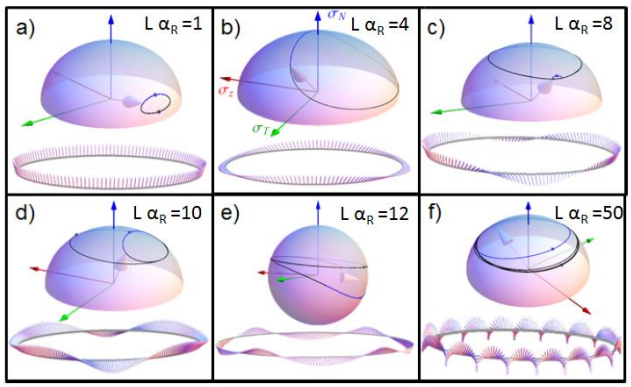

Figure 2. Evolution of the spin orientation trajectories on the Bloch sphere and of the three dimensional spin textures along an elliptically deformed ring (Fig. 1 (d)) with length *L* at a given ratio *a/b* = 0.4 and for various values of the Rashba spin-orbit coupling α_R. The blue portion of the trajectory stands for the part of the elliptical loop with larger curvature. The dots mark the positions on the loop with the maximum and minimum values of the local curvature.