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Topological transitions of spin geometric phases in quantum rings

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Topological phenomena in condensed matter physics have recently attracted much interest. In spintronics, topology of the path that a spin-steering field subtends is related to the geometric phase the spin acquires. Geometric phase of spin is tolerant against noise and imperfections in the system which offers robust ways for spin manipulation [1]. We study topological transitions in the spin geometric phase in quantum rings. These transitions are predicted to give a discontinuous change in the current through the system [2]. We show that decoherence due to time reversal asymmetry and diabatic band transitions change this picture. We find a smoothly changing current in numerical calculations and 1D exact models. In ballistic systems Aharonov-Casher conductance oscillations vanish in the regime where the geometric phase drops to zero. We discuss possible signatures of topological transitions in the experimental data.

[1] F. Nagasawa et al. Nat. Commun. 4:2526 (2013).
[2] Y. Lyanda-Geller, Phys. Rev. Lett. 71, 657 (1993).

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