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Geometric and topologic imprints on spin dynamics

Research on spin geometric (Berry) phases in mesoscopic systems has been active for about 30 years [1]. Still, incontrovertible evidence of their presence was found only recently [2] in mesoscopic rings subject to spin-orbit coupling (Rashba rings) in agreement with a previous theory [3], giving a new impulse to the field. Here, we discuss some new prospects for electronic manipulation based on the control of the spin geometric phases by effective-field engineering in nanodevices such as Rashba interferometers. The possibilities run from a purely geometric manipulation of electron spins (weak fields) [4] to topological transitions (large fields) [5]. Moreover, we notice that similar physics plays a role in spin resonance under driving fields that undergo a topological transition. We find [6] that, despite the strongly non-adiabatic effects dominating the spin dynamics, the field's topology appears clearly imprinted in the spin states. This has remarkable consequences on the spin resonance condition, suggesting a whole new class of experiments to spot topological transitions in the dynamics of spins and other two-level systems (from nuclear magnetic resonance to strongly-driven superconducting qubits).

[1] D. Loss, P. Goldbart, and A. V. Balatsky, Phys. Rev. Lett. 65, 1655 (1990).
[2] F. Nagasawa, J. Takagi, Y. Kunihashi, M. Kohda, and J. Nitta, Phys. Rev. Lett. 108, 086801 (2012); K. Richter, Physics 5, 22 (2012).
[3] D. Frustaglia and K. Richter, Phys. Rev. B 69, 235310 (2004).
[4] F. Nagasawa, D. Frustaglia, H. Saarikoski, K. Richter, and J. Nitta, Nature Comm. 4, 2526 (2013).
[5] H. Saarikoski, J.E. Vázquez-Lozano, J.P. Baltanás, F. Nagasawa, J. Nitta, and D. Frustaglia, Phys. Rev. B 91, 241406(R) (2015).
[6] A.A. Reynoso, J.P. Baltanás, H. Saarikoski, J.E. Vázquez-Lozano, J. Nitta, and D. Frustaglia, New J. Phys. 19, 063010 (2017).