Topological Transitions in Spin Interferometers and Resonators by Geometric Phase Engineering

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Research on spin geometric (Berry) phases in mesoscopic systems has been active for about 25 years already. During this time, several proposals were put forward for the detection of topological effects in spin interferometers subject to magnetic textures, accompanied by experimental attempts of modest success. Incontrovertible evidence of spin geometric phases was found only recently [1] in mesoscopic rings under the action to spin-orbit coupling (Rashba rings) in agreement with theoretical predictions [2], giving a new impulse to the field. Here, after a brief account of previous achievements, we discuss some new possibilities for electronic manipulation based on the control of the spin geometric phases in nanodevices such as Rashba interferometers subject to additional magnetic fields. These run from a purely geometric manipulation of electron spins (for weak fields) [3] to topological transitions (for large fields) [4]. Moreover, similar physics plays a role in spin resonance under driving fields that undergo a topological transition. There we find [5] that, despite the strongly non-adiabatic effects dominating the spin dynamics, the field's topology appears clearly imprinted in the quasienergy of Floquet 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).

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