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An Exact SU(2) Symmetry and Persistent Spin Helix in a Spin-Orbit Coupled System

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Spin-orbit coupled systems generally break the spin rotation symmetry. However, for a model with equal Rashba and Dresselhauss coupling constant (the ReD model), and for the [110] Dresselhauss model, a new type of SU(2) spin rotation symmetry is discovered. This symmetry is robust against spin-independent disorder and interactions, and is generated by operators whose wavevector depends on the coupling strength. It renders the spin lifetime infinite at this wavevector, giving rise to a Persistent Spin Helix (PSH). We obtain the spin fluctuation dynamics at, and away, from the symmetry point, and suggest experiments to observe the PSH. Recent experimental efforts have already discovered signs of the Persistent Spin Helix. Although reaching the Rashba equal to Dresselhauss point is difficult, the Persistent Spin Helix manifests itself in a long-lived spin-density wave even away from this point, making its discovery especially suitable for optical techniques such as transient spin-grating spectroscopy. The SU(2) symmetric point allows one to obtain the exact analytic transport equations from the diffusive to the ballistic regime, which has previously been accessible only through numerical work.