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SPIN-ORBIT ECHO

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Abstract:

The relativistic spin-orbit interaction (SOI) is essential to manipulate the electron spins by electric field, which is the most important goal in spintronics. However, on the other hand, SOI leads to the finite spin lifetime and destroys the quantum information of spins. To attack this problem, we have reexamined the origin of the SOI from the very beginning. In the non-relativistic approximation, the electron-positron pair creations can be neglected leading to the projection of the Hilbert space to the positive energy solutions to the Dirac equation. Therefore, the spin-orbit interaction can be regarded as a non-Abelian Berry gauge field. This geometrical nature of SOI leads to a new conservation law, called twisted spin conservation. This further leads to a novel phenomenon, i.e., the spin-orbit echo, where the spin is recovered when the SOI is switched-off adiabatically even after the spin relaxation has been completed. This work has been done in collaboration with Naoyuki Sugimoto.