Aharonov-Casher Effect in Bi_2Se_3 Square-ring Interferometers

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Bi_2Se_3 nanoplates were synthesized via a chemical vapor deposition method and square-ring-loop devices were fabricated by micro-fabrication tools and reactive ion etching. Electrical control of spin dynamics was investigated in the ring-type interferometers. Aharonov-Bohm (AB) and Altshuler-Aronov-Spivak (AAS) resistance oscillations against magnetic field, and Aharorov-Casher (AC) resistance oscillations against gate voltage were observed in the presence of a Berry phase of π. While the AAS oscillations appear at low fields, the AB oscillations last to rather high fields, 8 T.
More importantly, a very large spin precession tunability by gate voltage has been obtained. By a comparison of the AC oscillations in AB and AAS regions with theoretical predications, the tunability was estimated to be an order of magnitude larger than that of InAlAs/InGaAs devices, and more than two times larger than that of HgTe/HgCdTe devices, indicating that Bi_2Se_3-related materials are promising candidates with strong spin-orbit coupling for constructing novel spintronic devices. Moreover, electrical control of spins in Bi_2Se_3 also provides a powerful tool to investigate the surface states of topological insulators.