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Observation of spin-tensor induced topological phase transitions of triply degenerate points with a trapped ion

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Topological transitions between different types of triply degenerate points are experimentally observed with a trapped ion. Recently, the remarkable discovery of topological semimetals with triply degenerate points in Fermionic systems provides an avenue for exploring new types of quasiparticles beyond quantum field theory. Such triply degenerate points are naturally characterized by high-rank spin-1 tensors, but not previously observed experimentally. Here, by simulating the electron momentum in solids with a spin-1 trapped ion system, we observe the topological transitions between triply degenerate points with different monopole charges and elucidate the crucial roles played by the spin tensors. We develop a measurement technique that reveals the role of geometric rotations connected to the famous Berry flux. Our work demonstrates the versatile controllability of multi-level ion for high-spin physics and paves the way to explore novel topological phenomena therein.

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