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Geometry, topology and control of spin-1 atoms BHARATH H. M., MATTHEW BOGUSLAWSKI, MARYROSE BARRIOS, LIN XIN, DENIZ KURDAK, MICHAEL CHAPMAN, Georgia Inst of Tech — Recent explorations of the physical manifestation of geometry and topology of the quantum phase space has been fruitful in that it revealed geometric, fault tolerant quantum control and topologically stable states of spatially extended traps of ultracold atoms. Here, we develop a new geometrical representation for spin-1 quantum states and show its applicability to a range of interesting problems. Spin-1 (and higher spin) quantum states are not simply defined with the spin vector, as in the spin-1/2 case. The spin vector for higher spin could be anywhere on or inside the Bloch sphere, and at each point, there is a family of different states with the same spin vector. For spin-1 systems, this ambiguity is resolved by considering the quantum spin fluctuations which, together with the spin vector, uniquely specify any spin-1 quantum state. These fluctuations are represented geometrically with an ellipsoid surrounding the head of the spin vector. Using this representation, we uncover a number of exotic topologically stable states of a ring trap including those with fractional topological charge. Additionally, we develop a protocol for holonomic, fault-tolerant, arbitrary control of the spin-1 state and discuss applications to spin squeezing experiments.

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