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Non-Abelian Geometric Phases Carried by the Quantum Noise Matrix BHARATH H. M. , MATTHEW BOGUSLAWSKI, MARYROSE BARRIOS, MICHAEL CHAPMAN, Georgia Inst of Tech — Topological phases of matter are characterized by topological order parameters that are built using Berrys geometric phase. Berrys phase is the geometric information stored in the overall phase of a quantum state. We show that geometric information is also stored in the second and higher order spin moments of a quantum spin system, captured by a non-abelian geometric phase. The quantum state of a spin-S system is uniquely characterized by its spin moments up to order 2S. The first-order spin moment is the spin vector, and the second-order spin moment represents the spin fluctuation tensor, i.e., the quantum noise matrix. When the spin vector is transported along a loop in the Bloch ball, we show that the quantum noise matrix picks up a geometric phase. Considering spin-1 systems, we formulate this geometric phase as an SO(3) operator. Geometric phases are usually interpreted in terms of the solid angle subtended by the loop at the center. However, solid angles are not well defined for loops that pass through the center. Here, we introduce a generalized solid angle which is well defined for all loops inside the Bloch ball, in terms of which, we interpret the SO(3) geometric phase. This geometric phase can be used to characterize topological spin textures in cold atomic clouds.

Bharath Hebbe Madhusudhana
Georgia Inst of Tech

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