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Non-Abelian Geometric Phases Carried by the Spin Fluctuation Tensor

The geometric information of the trajectory along which a physical system is transported is often accumulated in the system's gauge variables, and is known as geometric phase. This has been a subject of intense study, both theoretically and experimentally over the past three decades. Here, we develop a new non-Abelian geometric phase that is accumulated in the second order spin moments of a quantum spin system.

The expectation values of the first and second moments of the quantum mechanical spin operator can be used to define a spin vector and spin fluctuation tensor respectively. The former is a vector inside the unit ball in three space, while the latter is represented by an ellipsoid. By considering transport of the spin vector along loops in the unit ball we show that the spin fluctuation tensor picks up geometric phase information [1]. For the physically important case of spin one, the geometric phase is formulated in terms of an SO(3) operator. Loops defined in the unit ball fall into two classes: those which do not pass through the origin and those which pass through the origin. The former class of loops subtend a well defined solid angle at the origin while the latter do not and the corresponding geometric phase is non-Abelian. To deal with both classes, we introduce a *generalized solid angle*, which helps to clarify the interpretation of the geometric phase information.

[1]. H. M. Bharath, "Non-Abelian geometric phases carried by the spin fluctuation tensor", arXiv: 1702.08564