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(I) Berry phase in the rigid rotor: the emergent physics of odd antiferromagnets

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The rigid rotor is a classic problem in quantum mechanics, describing the dynamics of a rigid body with its centre of mass held fixed. It can be viewed as the quantum mechanics of a particle moving in $SO(3)$, the space of all rotations in three dimensions. The particle can move along two types of closed loops: trivial loops that can be adiabatically shrunk to a point and non-trivial loops that cannot. This topology can lead to new consequences. With time-reversal symmetry, a Berry phase of π can be attached to all non-trivial loops. We solve this problem by exploiting the connection between $SO(3)$ and $SU(2)$ spaces. Remarkably, this framework is realized in the low-energy physics of certain quantum magnets. We demonstrate this result in a family of Heisenberg antiferromagnets defined on polygons with an odd number of vertices. At each vertex, we have a spin- S moment that is coupled to its nearest neighbours. Their quantum spectra, at low energies, correspond to spherical top' and symmetric top' rigid rotors. For integer values of S , we recover traditional rigid rotor spectra. With half-integer- S , we obtain rotor spectra with a Berry phase.

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Keyword-2

Topology

Keyword-3

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