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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' andsymmetric 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.

Keyword-1

Magnetism

Keyword-2

Topology

Keyword-3

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