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Effects of Berry Curvature in Ultracold Atomic Gases[1]

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Topological energy bands exhibit many fascinating physical phenomena. For instance, topological invariants underlie both the quantum Hall effect and more general topological insulators. There is currently great interest in exploring such physics in ultracold gases. Recent experiments have explored optical lattices with novel geometrical and topological features, and there is much ongoing activity to extend to other situations. Less widely appreciated is the fact that the energy bands of these new forms of optical lattice also have important geometrical properties. In particular, the Berry curvature is a geometrical property of the energy eigenstates, defined locally in the Brillouin zone. When integrated over the Brillouin zone of a two-dimensional band, it gives the Chern number, the topological invariant of the quantum Hall effect. The Berry curvature has many physical consequences in 2D and 3D systems, such as in the anomalous quantum Hall effect. I shall summarize how the Berry curvature can manifest itself in experimental measurements of transport and of collective modes in ultracold atomic gases.

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