

Berry phase effects on electronic properties

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Berry curvature and orbital moment of the Bloch state are two basic ingredients, in addition to the band energy, that must be included in the formulation of semiclassical dynamics of electrons in crystals, in order to give proper account of thermodynamic and transport properties to first order in the electromagnetic field. These quantities are gauge invariant and have direct physical significance as demonstrated by numerous applications in recent years. Generalization to the case of degenerate bands has also been achieved recently, with important applications in spin-dependent transport. The reader is assured that a knowledge of these ingredients of the semiclassical dynamics is also sufficient for the construction of an effective quantum theory, valid to the same order of the field, using a new quantization procedure that generalizes the venerable Peierls substitution rule.

For a recent review, see M. C. Chang and Q. Niu, *JOURNAL OF PHYSICS-CONDENSED MATTER*, 20, 193202 (2008)