

Wave-packet dynamics of Bloch electrons — role of Berry phase

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Motivated by a recent proposal on the possibility of observing a monopole in the band structure, and by an increasing interest in the role of Berry phase in spintronics, we reconsidered the problem of adiabatic motion of a wave packet of Bloch functions, under a perturbation varying slowly and incommensurately to the lattice structure. We showed, using only the fundamental principles of quantum mechanics, that the effective wave-packet dynamics of Bloch electrons is conveniently described by a set of equations of motion (EOM) in which a *nonabelian* Berry phase associated with an internal degree of freedom appears. We then apply our wave-packet dynamics to the analyses on transport phenomena such as charge/spin Hall-type/polarization currents. We also discuss its relevance to the physics of orbital current as well as transport through a magnetic domain wall, which may serve as a probe for detecting and controlling Berry phase.

13.4 cm

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9.7 cm