Anomalous Velocity and Geometry in Wave Mechanics

E. J. Mele
Department of Physics and Astronomy
University of Pennsylvania
Philadelphia PA 19104

In electronic band theory the dynamics of electrons in crystal lattices can exhibit novel phenomena associated with the anomalous velocity**.** Modern work on this subject revives an idea which appeared in its primitive form fifty years ago to interpret anomalous Hall effects in magnetically ordered states of matter, namely the appearance of a Hall conductivity in materials that have spontaneously broken time reversal symmetry without an applied magnetic field. The signature of the anomalous velocity is the coupling of electron motion to applied static and time-dependent fields through a family of transverse response functions with driving terms that are geometrical in origin. This idea has been revived by a modern focus on the topological nature of degenerate points and lines in the band structures of crystals and their observable consequences in electron dynamics. Remarkably in this context the concept of anomalous velocity reappears with some unexpected consequences for both gapped "topological" states of matter and for special gapless topological semimetallic states. This talk will present a brief overview of these ideas and illustrate them with examples drawn from work on two dimensional electronic systems.