“Anomalous Velocity and Geometry in Wave Mechanics”

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 some fifty years ago to interpret the anomalous Hall effect 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 brought to the forefront 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.

BIO: Eugene Mele is Christopher H. Browne Distinguished Professor of Physics and Astronomy at the University of Pennsylvania. He is a condensed matter theorist recognized for his work on quantum electronic phenomena in low dimensional forms of matter: surface physics, conducting polymers, graphene and topological states of matter. Mele received his Ph.D. in Physics from the Massachusetts Institute of Technology. He worked in industry as Associate Scientist at the Xerox Webster Research Center before joining the faculty at the University of Pennsylvania. Mele is a fellow of the American Physical Society and a member of the National Academy of Sciences. He is a recipient of the Europhysics Prize of the European Physical Society, the Franklin Medal in Physics, the Breakthrough Prize in Fundamental Physics and the BBVA Frontiers of Knowledge Award in Basic Sciences. He has received the Ira Abrams Memorial Award and the Christian R. and Mary F. Lindback Award for distinguished teaching at the University of Pennsylvania.