Semirelativity in semiconductors

Włodzimierz Zawadzki[1]

[1] *Institute of Physics, Polish Academy of Sciences, Al. Lotnikow 32/46, 02-668 Warsaw, Poland*

An analogy between behavior of electrons in narrow-gap semiconductors (NGS) and relativistic electrons in vacuum is presented. It is indicated that special relativity for vacuum is analogous to a two-band description for NGS. In HgCdTe alloys and in graphene one has vanishing energy gap at which electrons and light holes become 3D and 2D massless Dirac fermions, respectively. A wavelength in defined for NGS in analogy to the Compton wavelength for quantum relativity in vacuum. It is demonstrated that the relativistic analogy (RA) holds for orbital and spin properties of electrons in the presence of magnetic field. Electrons in crossed electric and magnetic fields are described experimentally and theoretically and it is shown that this configuration provides a spectacular example of RA. The phenomenon of Zitterbewegung (ZB, trembling motion) is considered in vacuum and NGS following RA. Finally, graphene and topological insulators are considered. These systems, with their linear energy – quasimomentum dispersions, illustrate the extreme semirelativistic regime. Approximations and restrictions of RA are emphasized.