Zitterbewegung (trembling motion) of electrons in crystalline solids

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ABSTRACT

Zitterbewegung (ZB, trembling motion) of electrons in semiconductors is introduced and reviewed. The original proposition of Schrodinger is presented, based on the Dirac equation for free relativistic electrons. An analogy between behavior of relativistic electrons in vacuum and that of charge carriers in narrow gap semiconductors is used to derive the phenomenon of ZB in crystalline solids. In particular, ZB of electrons in graphene and carbon nanotubes in absence of external fields and in the presence of a magnetic field is described. Nature of the trembling motion for electrons in a periodic potential is considered. It is shown that an analogue of ZB exists for waves propagating in periodic structures. It is concluded that the trembling motion is a universal phenomenon. The question of experimental observation of ZB in crystalline solids is examined and possible experimental verifications are proposed