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“Nanospintronics meets relativistic quantum physics: Ubiquity of Zitterbewegung effects”

Abstract
Zitterbewegung (German for trembling motion) is a highly oscillatory component in the orbital motion of free electrons which is commonly considered to be a quirk of the very successful Dirac theory of relativistic electron dynamics. Its physical significance has been discussed controversially over the years. Suggestions [1] for a possibly observable Zitterbewegung-like dynamics of band electrons in solids have lifted this discussion onto a new level. Motivated by recent interest in this subject, we have analysed theoretically the orbital motion of electrons in coupled bands for a variety of solid-state situations and find that all exhibit remarkable analogies with the Zitterbewegung of relativistic quantum mechanics [2]. It turns out to be a universal feature of Zitterbewegung-like dynamics that the spin degree of freedom performs an oscillatory motion, too. An example is the well-known and experimentally observable spin precession of electrons in asymmetric 2D heterostructures. We find that the oscillatory orbital motion is intrinsically linked with spin precession in all models studied. The relation of Zitterbewegung phenomena to novel spin-transport effects such as spin-dependent magnetic focusing [3] will also be discussed.

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