NANOSPINTRONICS MEETS RELATIVISTIC QUANTUM PHYSICS: UBIQUITY OF *ZITTERBEWEGUNG* EFFECTS

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Zitterbewegung (German for *trembling motion*) is a highly oscillatory component in the orbital motion of free electrons in vacuum, 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 [1-3] for a possibly observable *Zitterbewegung*-like dynamics of band electrons in solids have lifted this discussion onto a new level. Motivated by this recent interest in the 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 [4]. 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 [5,6] spin precession of electrons in asymmetric 2D semiconductor 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 [7,8] will also be discussed.

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