SFB 767
Colloquium

July 5, 2018
Coffee and tea 15:15
Talk 15:30
P 603

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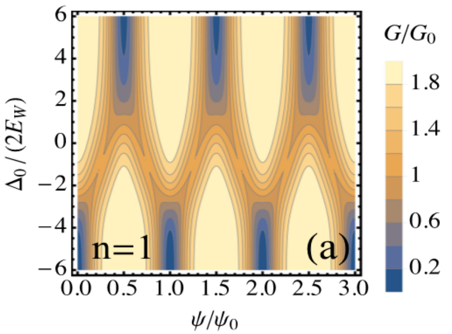
Dirac electrons in quantum rings



Two-terminal conductance for the lowest ring subband as a function of magnetic flux and the 2D-Dirac gap. The shift in the positions of the minima indicates the transition between Dirac-like and Schrödinger-like behaviour.

Quantum rings are paradigmatic systems to study phenomena associated with geometrical phases such as the Aharano-Bohm and Aharonov-Casher effects as well as their non-Abelian generalisations. We present a unified approach [1] to study of quantum rings realised in materials where the charge carriers mimic two-dimensional Dirac electrons, including single-layer graphene, single-layer transition-metal dichalcogenides and quantum wells in narrow-gap semiconductors. We develop a general theoretical description of the ring sub-band structure based on a **k • p** approach. This theoretical framework is used to derive an effective Hamiltonian for the azimuthal motion of the charge carriers in the ring that yields a deeper insight into the physical origin of the observed transport effects. In particular, we consider the ring attached to leads and we calculate the two-terminal conductance by means of the scattering approach to mesoscopic transport. We focus on the effect of the interplay of pseudospin chirality and quantum confinement on the geometric phase, a quantity experimentally accessible through conductance measurements. For example, the transition between massless-Dirac and Schrödinger-like behaviour manifests itself clearly in the interference pattern of the conductance. The dependence of interference effects on the charge carriers' flavour degree of freedom opens up the possibility to use quantum rings as *flavourtronic* devices.

[1] L. Gioia, U. Zülicke, M. Governale, and R. Winkler, Phys. Rev. B 97, 205421 (2018).

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