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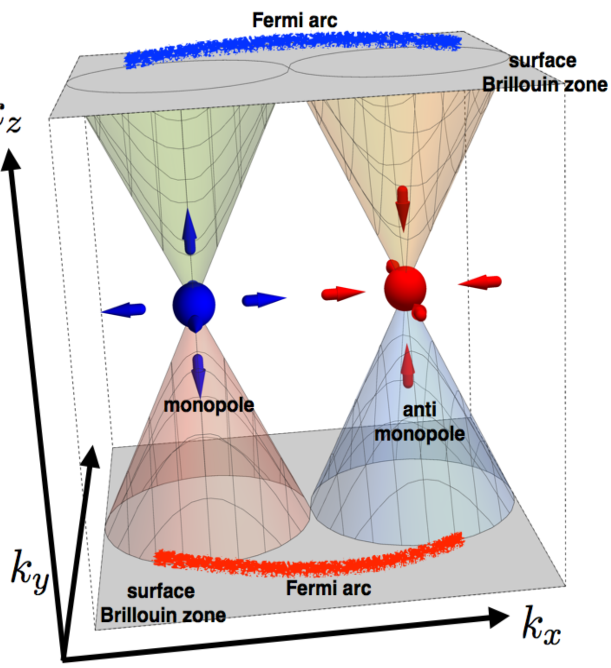
IM HÖRSAAL HERMANN-HERDER-STR.6

DIRAC FERMIONS: TOPOLOGY MEETS QUANTUM CRITICALITY

Dr. Lars Fritz
Institute for Theoretical Physics, Universiteit Utrecht

Throughout the last ten years Dirac materials have been an extremely active topic in condensed matter research. The enormous activity was triggered by the discovery of the single layer carbon material graphene where Dirac fermions have appeared as emerging quasiparticles in the band structure at band touching points. Since then many systems with emerging Dirac theories have been observed, the latest addition to this list being three dimensional Weyl fermions, Figure [1]. Early on it was pointed out that Dirac points in band structures constitute topologically non-trivial objects with potentially exotic boundary theories.

Figure 1: Splitting a Dirac fermion by breaking time reversal or inversion symmetry leads to 2 Weyl nodes. One can associate a monopole or anti-monopole charge with their chirality. Overall the system remains charge neutral. The surface Fermi arcs are a surface manifestation of the separation in momentum space.



In this talk I will first give a short introduction to the rich physics of the Dirac equation, its relation to topology, and resulting surface physics.
In a second part I will point out the relation between a Dirac theory and quantum critical systems: I will present effects of quantum criticality ranging from quantum critical transport to a quantum critical version of the Kondo effect. Furthermore, I will speculate about interaction and disorder effects in Dirac systems and how to tune them.
In a last part I will give an overview over other research projects as well as an outlook on future activities.