Wahlpflicht-Modul
Quantum Materials

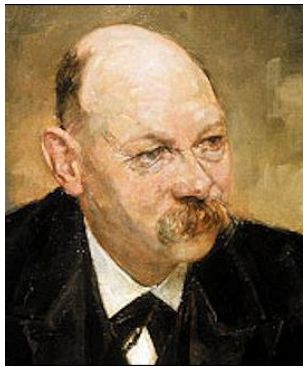
Verschiedene einsemestrige Vorlesungen (2 SWS) mit Übungen (1 SWS) :

- **Superconductivity**
- **Advanced Magnetism**
- **Topological Aspects of Cond. Matter**
- **Low-dimensional materials**

die beliebig kombiniert werden können.

Vertiefung mit unterschiedlichen Spezialvorlesungen / Blockpraktikum (2 SWS) möglich.

Superconductivity (WS 20/21)

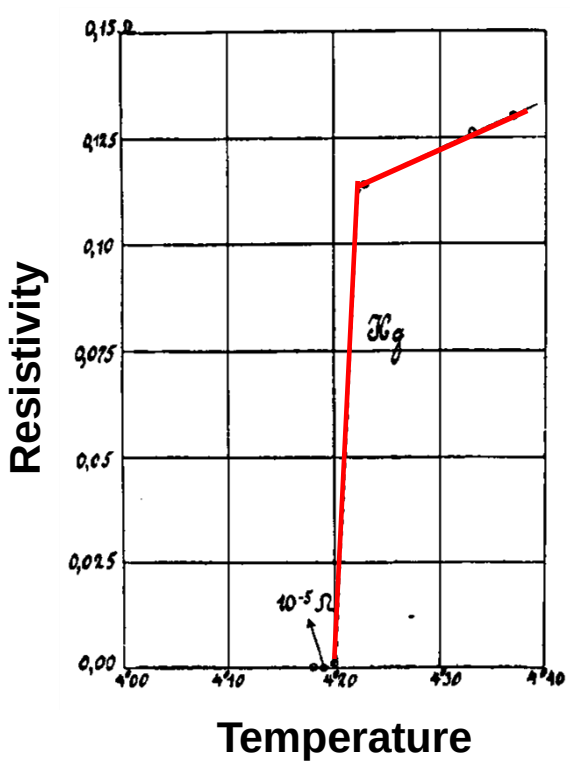


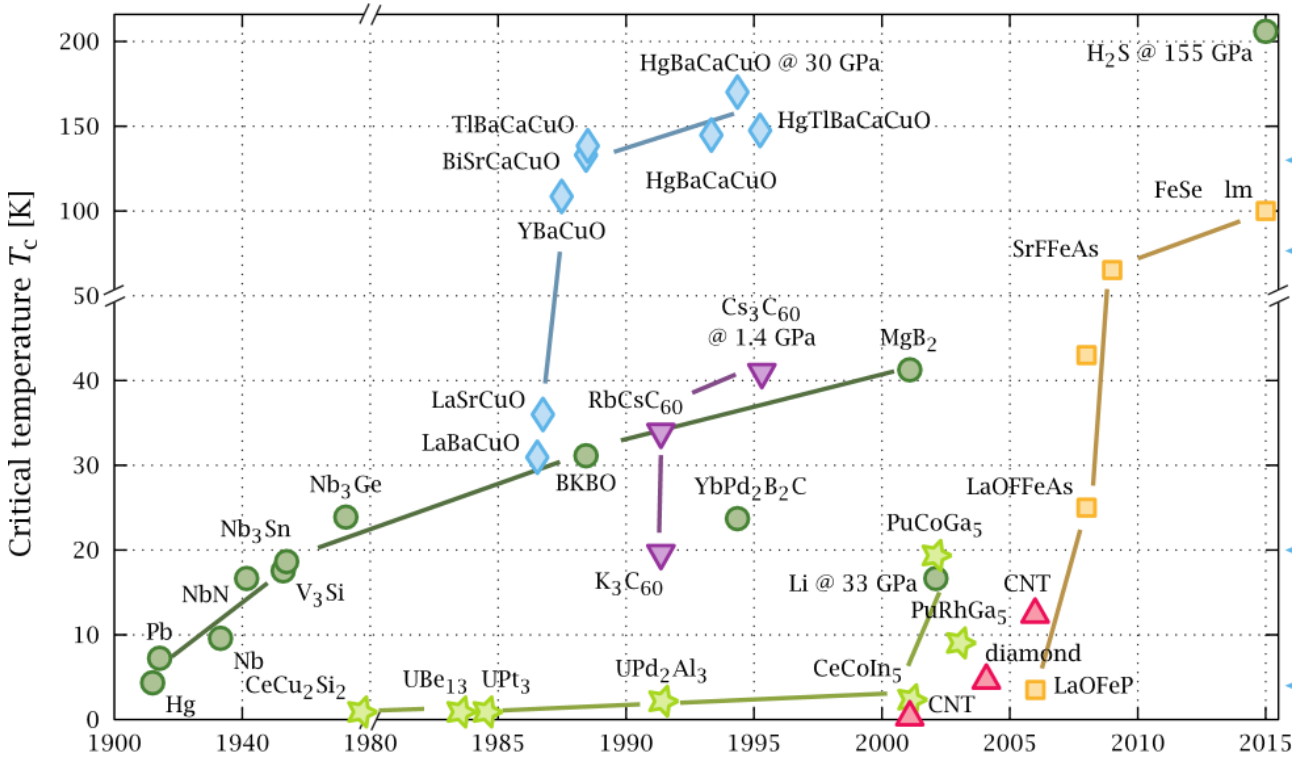
Vanishing resistivity

In 1911 Heike Kamerlingh Onnes first observed the vanishing resistance of Hg [Leiden Communications **124c** (1911)]

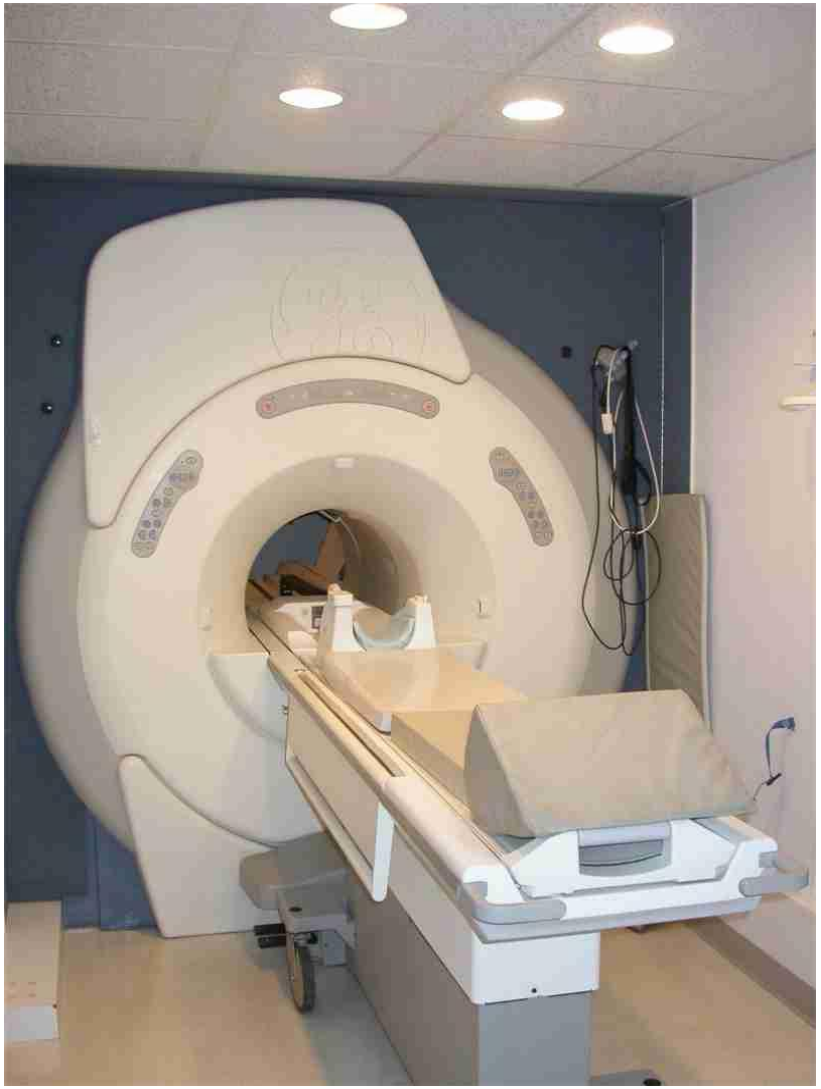
2020: T_c ~ 260 K
LaH_{10}, 200 Gpa

2020: T_c ~ 160 K
ambient pressure





Superconductivity: applications



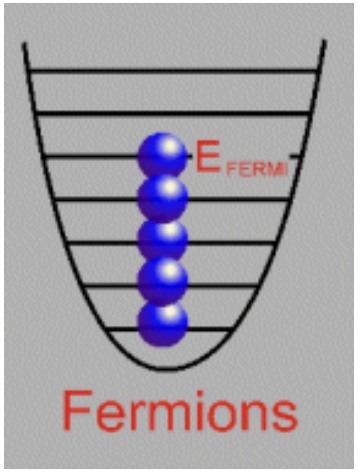
Current:

- magnets for magnetic resonance tomography
- power transmission (short distances)
- magnets for particle accelerators and other research (e.g. SQUIDs)

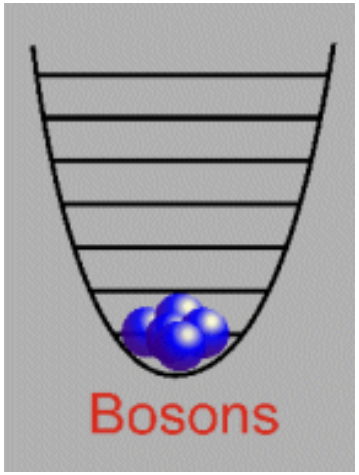
Potential:

- levitating trains
- long-distances power transmission
- …

Electrons form a Bose condensate



2 electrons bound together and form Copper pairs, which are bosons

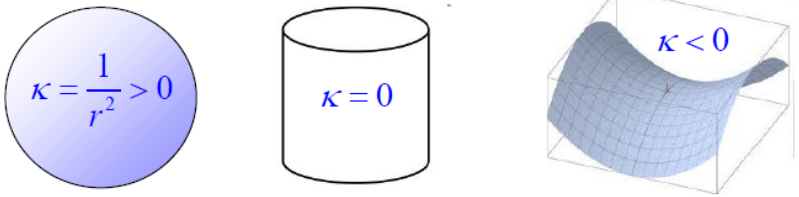


Bardeen–Cooper–Schrieffer (BCS) theory:
the first microscopic theory of superconductivity (1957)

Topological aspects of solid state physics (SS 2021)

Topological numbers (invariants) g – genus

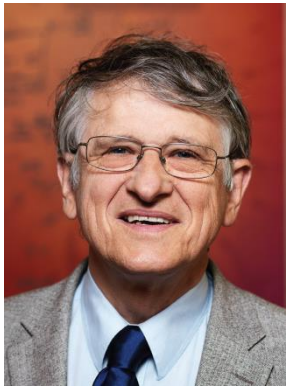
$$\kappa = \frac{1}{r_1 r_2}$$



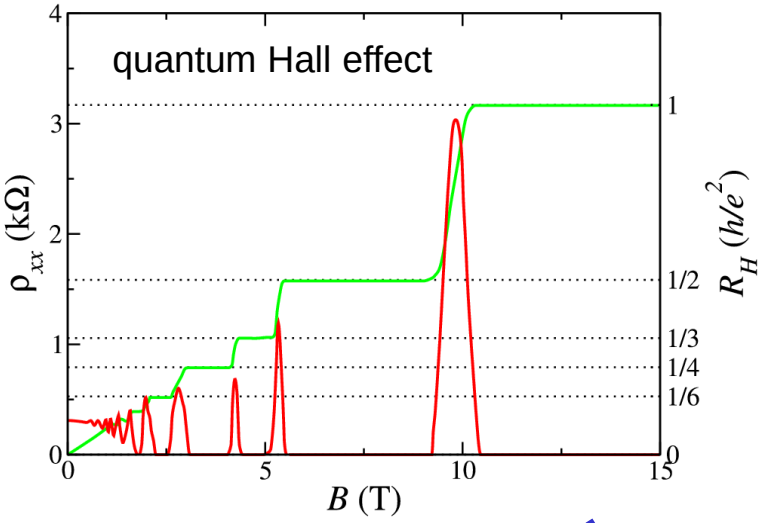
Gauss Bonnet Theorem : $\int_S \kappa dA = 4\pi(1-g)$

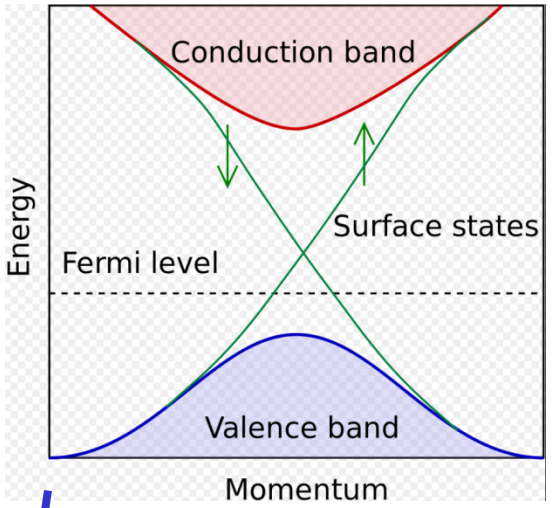
C. L. Kane, Lectures on Topology and Band Theory
https://www.physics.upenn.edu/~kane/

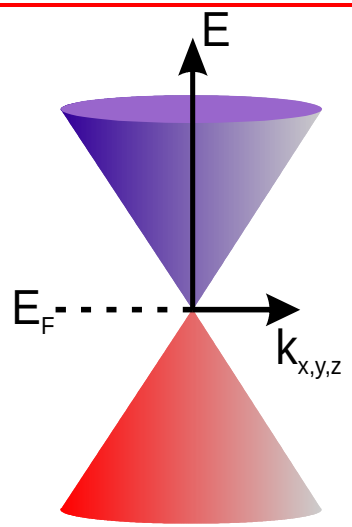
Topological aspects of solid state physics (SS 2021)



Klaus von Klitzing

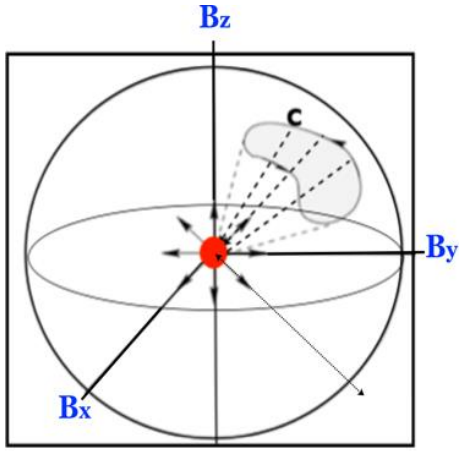






Weyl semimetals:
massless electrons
in the bulk

Topological invariants Berry phase



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