Quantum field theory for correlated many-body systems

- Introduction to correlated many-body systems
- Second Quantization
- One- and two-particle Green's functions, Matsubara Formalism
- Diagrammatic perturbation theory and Feynman diagrams
- (Fermi liquid theory)
- Linear response theory
- Applications: Magnetism and (Super)conductivity
- Outlook: Dynamical mean field theory and beyond

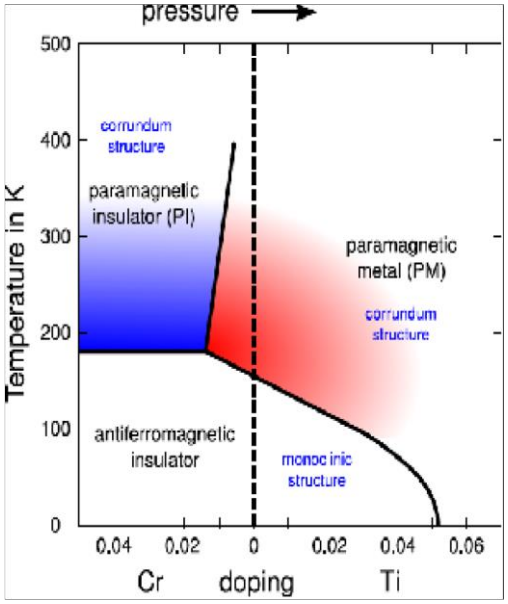
Literature

- A. A. Abrikosov, L. P. Gorkov, I. E. Dzyloshinski, Methods of Quantum Field Theory in Statistical Physics, Dover Publications, Inc. New York, 1963
- A. Altland and B. Simons, Condensed Matter Field Theory, Cambridge University Press, 2010.
- K. Elk und W. Gasser, Die Methode der Greenschen Funktionen in der Festkörperphysik, Akademia Verlag, Berlin 1979
- A. L. Fetter and J. D. Walecka, Quantum Theory of Many-Particle Systems, Dover Publications, 2003.
- A. M. Zagoskin, Quantum Theory of Many-Body Systems, Springer Science+Business Media New York, 1998.

Why are correlated many-body (many-electron) systems interesting?

- Interesting physical phenomena
- Potentially of technological rlevance

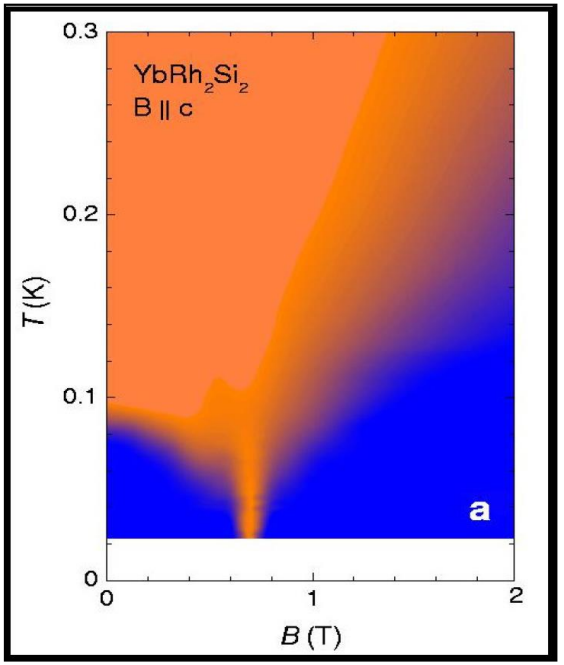
Mott-metal-insulator transition in V_2O_3



Mc Whan et al., PRB (1973)

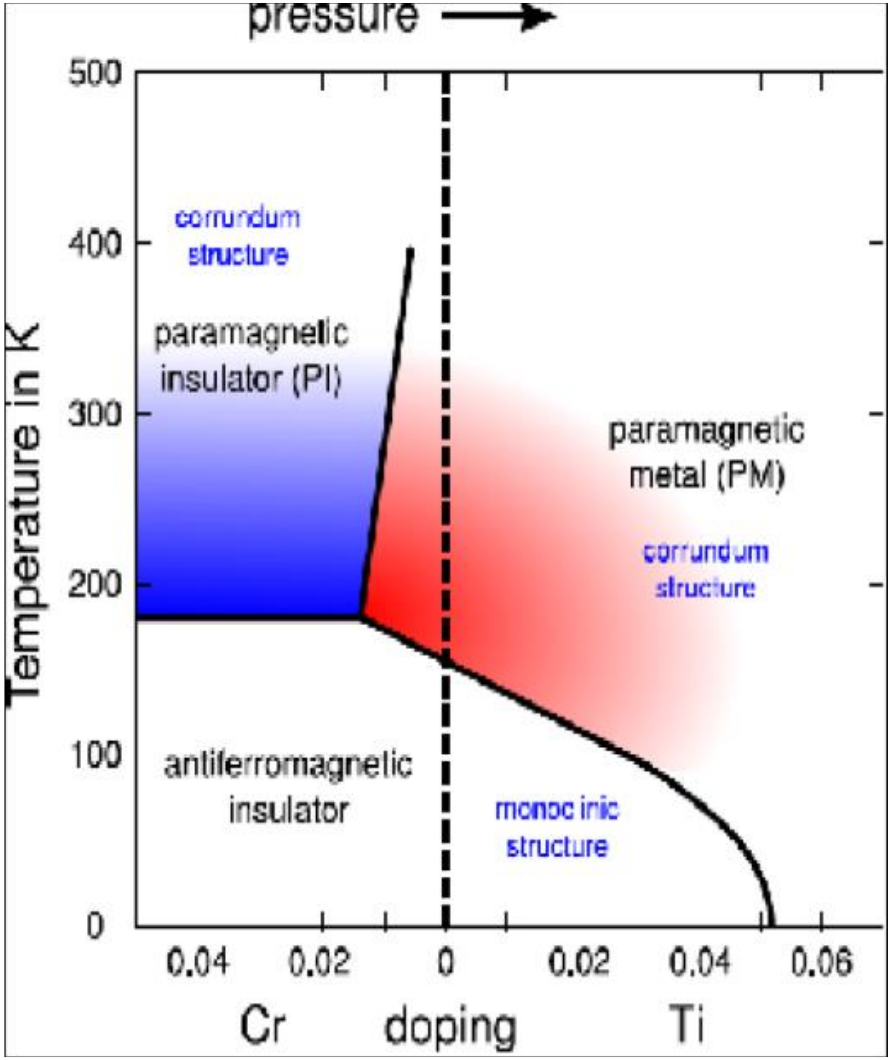
High-temperature superconductivity

Quantum critical points



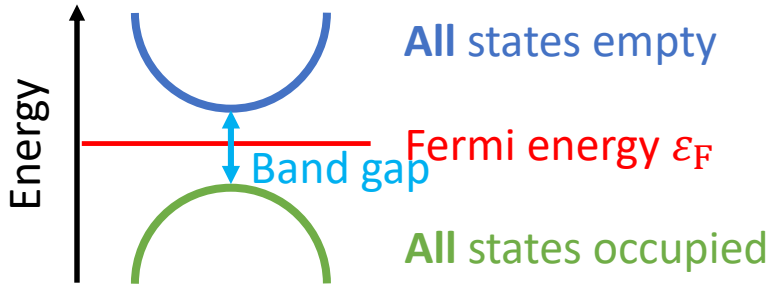
J. Custer et al., Nature (2003)

Mott-metal-insulator transition in V_2O_3



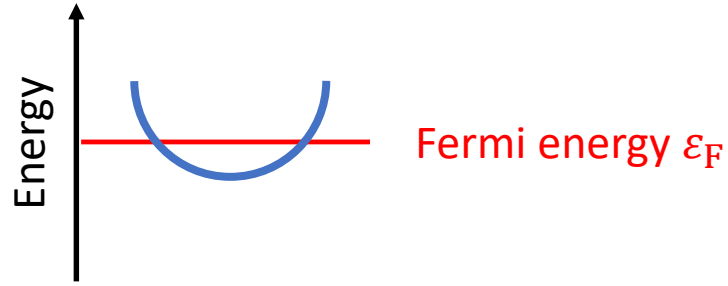
Mc Whan et al., PRB (1973)

„Normal“ Band insulator



⇒ No electrons available for conduction

Here: Correlation-driven insulator

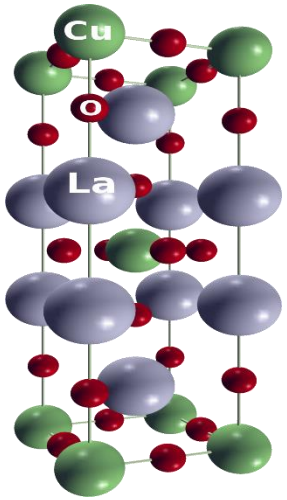


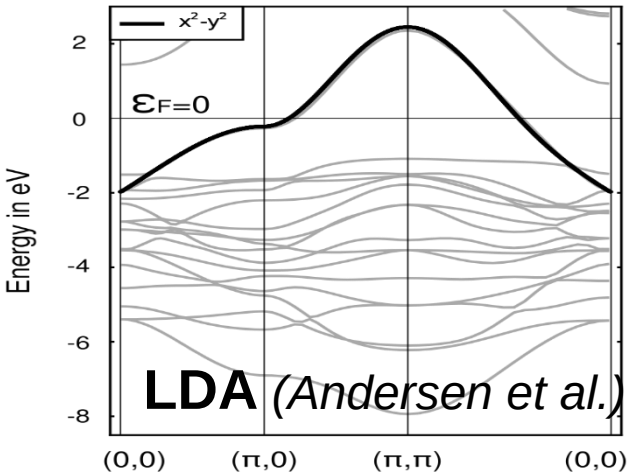
⇒ Band crosses the Fermi level:
electrons are available for conduction

⇒ Insulator due to Coulomb repulsion between the electrons!

High-temperature superconductivity – The Cuprates

e.g.: La_2CuO_4





- CuO_2 planes
- La,O layers

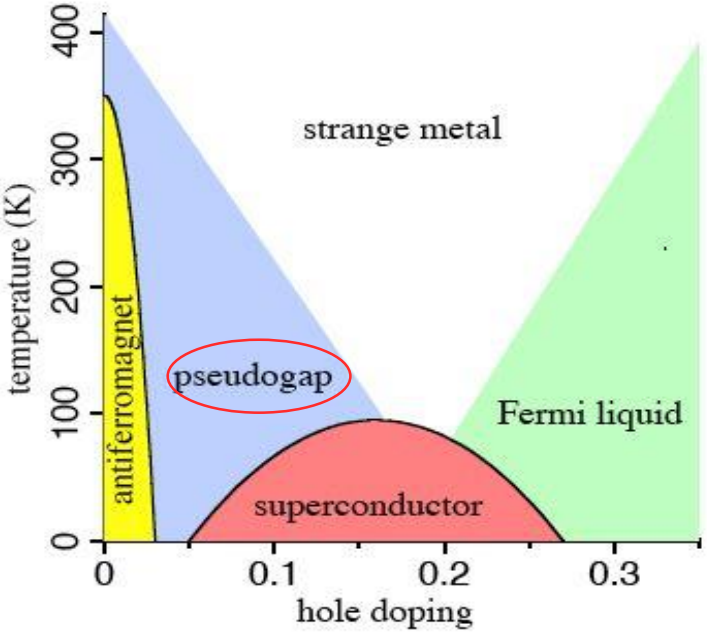
Cu^{2+} (Ar $3d^9$)

O^{2-} (He $2s^2\,2p^6$)

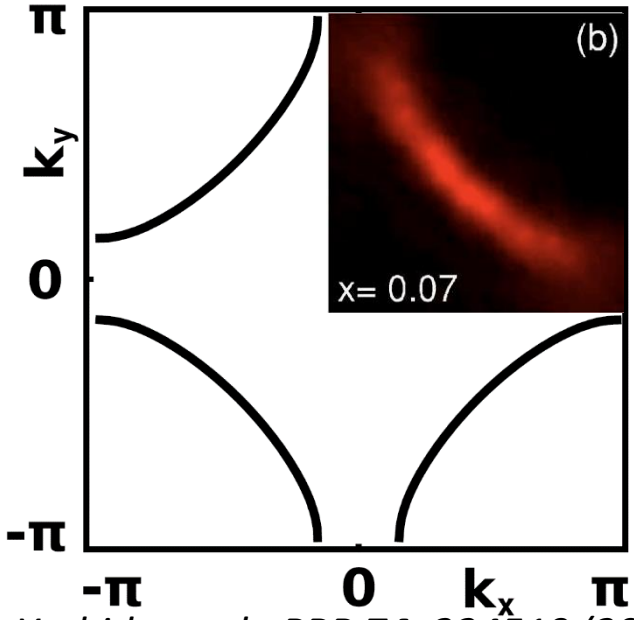
hole doping:

$La^{3+} \rightarrow Sr^{2+}$

$La_2CuO_4 \rightarrow La_{2-x}Sr_xCuO_4$



ARPES:



*Yoshida et al., PRB **74**, 224510 (2006).*