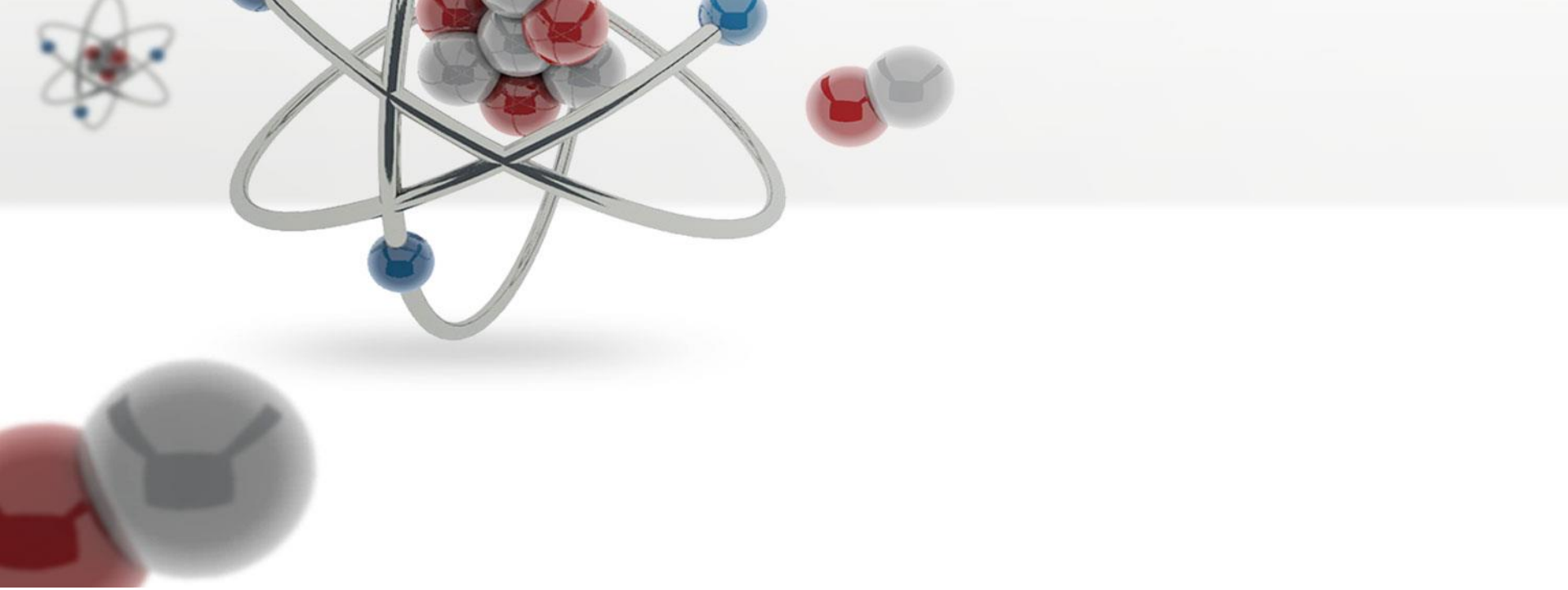


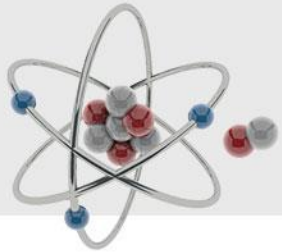
Computational Methods for Quantum Many-Body Systems (CMQMB) - from artificial atoms to high-temperature superconductors

6 CFUs

UNIVERSITÀ DEGLI STUDI DI TRIESTE

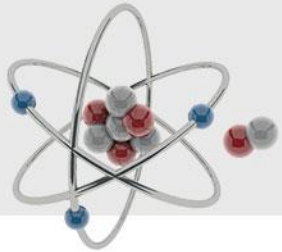
Dr. Thomas Schäfer
Università degli studi di Trieste (UNITS), Winter Semester 2025

Fascinating physics from electron-electron interactions

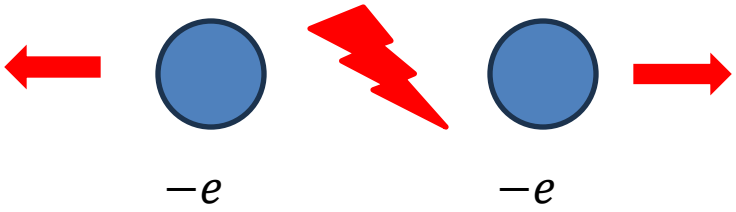


Classical electrostatics:
Coulomb force

Fascinating physics from electron-electron interactions



→ **repulsion**



$$F = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2}$$

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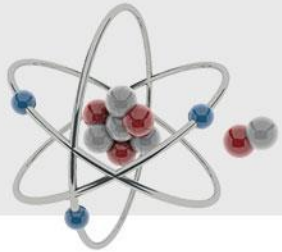

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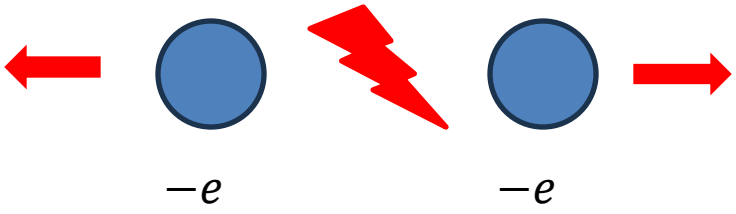

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Classical electrostatics:
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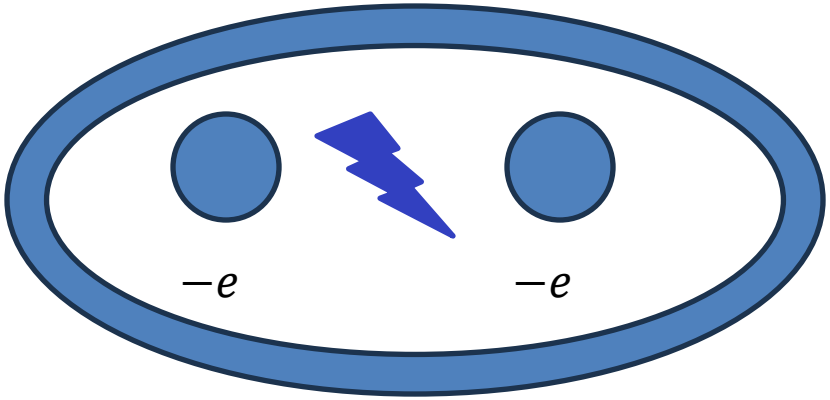
But Coulomb interaction can also lead to an (effective) **attraction!**



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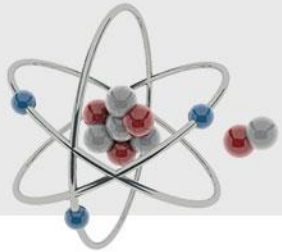

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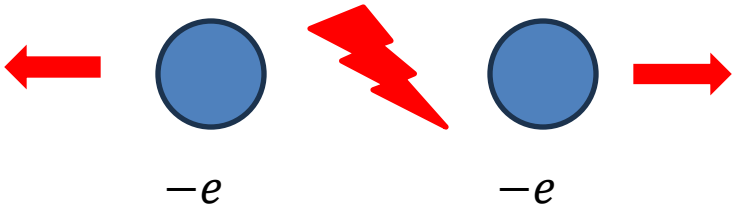

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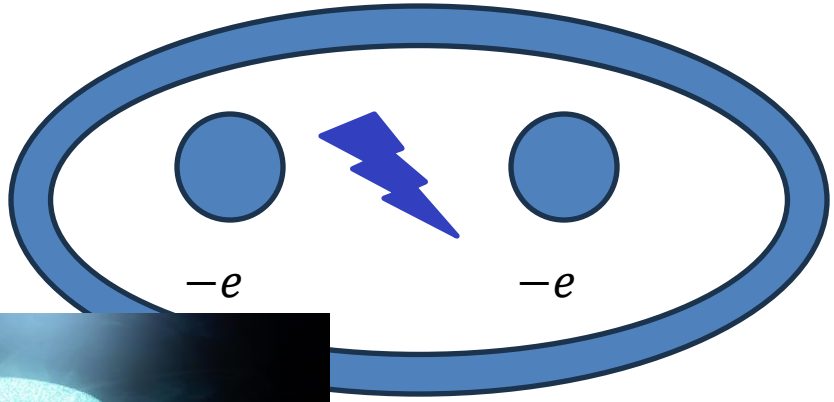
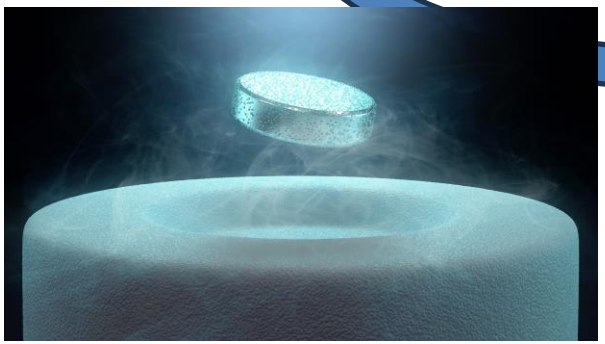
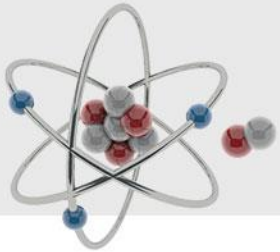


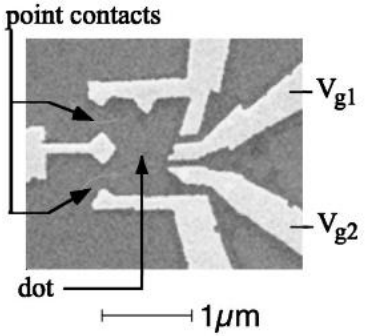


→ **Cooper pairs and superconductors**

Fascinating physics from electron-electron interactions

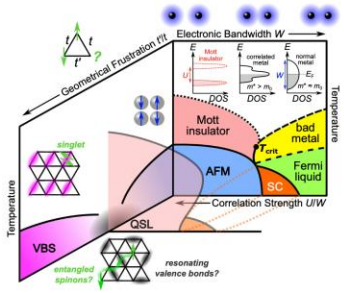


"Artificial materials"
(quantum dots, cold atoms, moiré, …)



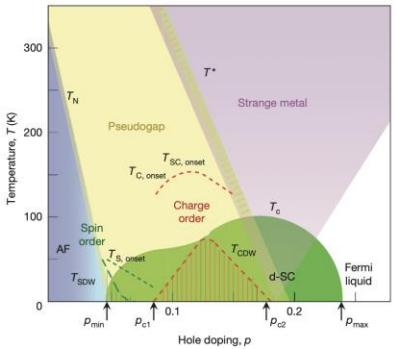
J. A. Folk, et al., Phys. Rev. Lett. (1996)

Mott metal-insulator transitions



A. Pustogow, et al., Nat. Comm. (2023)

Quantum magnetism and high-T_c superconductivity



B. Keimer, et al., Nature (2015)

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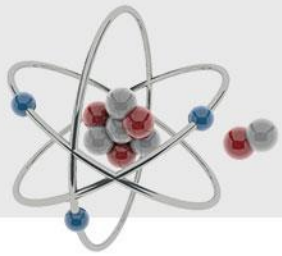

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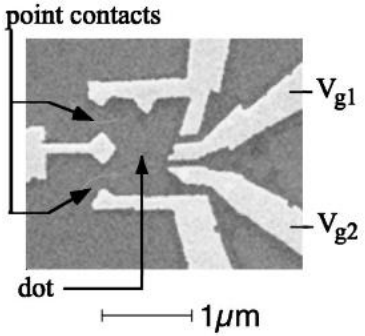

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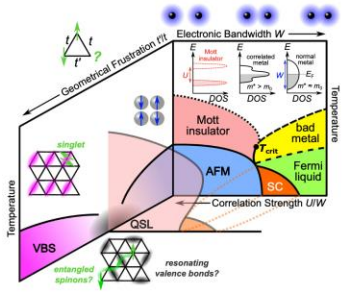

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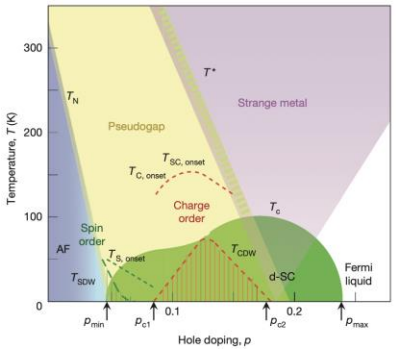

B. Keimer, et al., Nature (2015)

The course **Computational Methods for Quantum Many-Body Systems (CMQMB)**

- introduces the physics of these fascinating phenomena,
- provides analytical and numerical tools for the description and understanding of these systems at the forefront of current research,
- introduces the students to the open-source **T**oolbox for **R**esearch on **I**nteracting **Q**uantum **S**ystems (TRIQS), used in many research groups around the world working on the quantum many-body problem, and
- covers hands-on examples of state-of-the-art algorithms like the dynamical mean-field theory (DMFT) in classroom.

TRIQS

https://triqs.github.io/triqs

Interested in Computational Methods for Quantum Many-Body Systems?

Thomas Schäfer

Strada Costiera, 11 - 34151 Trieste
Office 252
thomas.schaefer@units.it

Mon 9:15 – 11:00
Aula B (Edificio F)
Tue 11:15 – 13:00
Aula A Idraulica (Edificio C2)
Via Valerio, 2 - 34127 Trieste