1.1 What has to be explained by Quantum mechanics?

- The most famous quantum mechanical relation is the uncertainty relation, e.g. for space x and momentum p

$$\Delta x \Delta p \geq \hbar \tag{1.1}$$

- Pauli Principle
- principally non distinguishable particles $\Leftrightarrow$ classical particles
- Fermi statistics
- Bose Statistics
- Tunneling
- Why are atoms stable?
- Quantization:
- "Chemistry": Period system of elements
- sp^3 hybridization
- Spin
- Band structure: Why is $E(k)$ an adequate description of the energy of a crystal
- Transport of electrons: from occupied state $\Rightarrow$ free state
  Only reasonable for Fermions following the Pauli principle!
  But "free" and "occupied" states within a band, sizes of band gaps, etc. classify metals, semiconductors, and insulators.
- Why, in contrast, **must** photons be Bosons?!? (One single QM state macroscopically measurable)
- What is:
  Schrödinger equation, Operator, commutator, probability function, wave function, quantum number, ...

Not discussed in this lecture

- Current flow: Drift (classical forces), Diffusion (Fick's laws, no $E(k)$!)
- pn-junction (Poisson equation)
- Devices (are temperature dependent!)
- ...

This are topics of Thermodynamics (mainly described classically!)
Quantum Mechanics
Are 5 Axioms: Extremely compact information, nearly not to understand from the beginning
$\Rightarrow$ We will need some time to interpret the axioms
Before we will need some time to discuss the mathematics necessary for understanding the phrases in the axioms.
Operators, wave function, expectation values, measurable quantities, ...