2.8.1 What is an electron

The Cave Allegory of Plato

human reality = projection into the space of human imagination
Opening of a new dimension does not mean to see the reality but to see more of the reality.
The *old reality* is part of the *new reality.*

The electron is nothing we can imagine!

Measuring means

the projection of the quantum mechanical particle into the human imagination.
Just when we measure a quantum mechanical property, a state is generated which is an Eigenstate of the observable we have asked for.
If we for example ask for the location of an electron, we will find it with a probability at one special place. In the rest of the time it is *not* "somewhere else".
An electron can not be described in time and space.
An electron is described in the space of energy and rotational momentum. This is the correct description of an atom and therefore of the sum of all electrons of an atom. But who can imagine and think in the space of energy and rotational momentum.
In every complete orthonormal system of state functions we can describe and calculate entirely. But it does not tell us what an electron is.

The task and the potential of quantum mechanics

For every question related to measurements, we can imagine to ask about an electron, the quantum mechanics allows us to calculate the answer (although it may be very difficult to calculate).

$\Rightarrow$ Thus all quantum mechanical particles can be handled

Until now quantum mechanics is not completely relativistic: For very fast particles the quantum mechanics fails (We do not have the right imagination/picture).
Some examples, how strange quantum mechanics can be:

Can an electron walk though a wall? Yes! (It is tunneling)
How does an electron reach the other side of a wall? This question can not be answered in time and space! May be, through an unknown and not visible dimension!
How many particles exist in "nothing"'. (99.9% of all matter in universe: since the uncertainty relation $\Delta E \Delta t \rangle h$ holds)
Superconductivity: It took 50 years to imagine Cooper-pairs. Using this picture, it is "easy" to do all calculations.

Problems of modern High Temperature Superconductivity:

- Do we ask the right questions?
- Or: Are we just not able to calculate the existing models adequately?

Quantum Hall-Effect: Nobody had thought about it. But after the experiments had been performed, the principle theory had been "understood"' quite rapidly.

Superstring-Theory: New model using 13 dimensions and a projection in the 4 dimensions we can imagine.

If you don't want to accept this

i.e., if we can not imagine all this stuff; think of Albert Einstein who sad: "God does not dice!"

Of course Einstein perfectly understood quantum mechanics and how to use it for calculations. But he did not accept the basic interpretation.

Why can't we imagine quantum mechanics?

The evolution optimized us to understand macroscopic particles which move very slowly; i.e. one part of our imagination is inherited.

Our imagination is dominated by the Greeks antique:

- All matter is dividable into atoms.
- The properties of matter are deduced from the properties of the atoms (analytic method, very successful!).
- Properties are coupled to matter.
- The Einstein-Equation
$$E = mc^2 \tag{2.26}$$
allows to generate matter out of energy, but how can we imagine this?
- **But**: Matter occurs also out of "nothing"
- The "nothing" exhibits all the properties of matter.
- The properties of an electron are not coupled to its "being in space".

Asians are not genetically different people, but they are better prepared for quantum mechanics because of the different philosophical background.

Aim of their philosophical education is an integral understanding. They do not focus on the properties of a single object but on the interaction of "particles".

The ideal state is,

- not having to take a decision,
- to be neither Yin nor Yang,
- to be neither good nor bad.

The Nirvana "The not being", not "Nothing").

- That what we cannot explain in words.
- That what is not a category of thinking.
- That what we cannot imagine.

For many Asians the world of quantum mechanics is very natural.

⇒ **You do not have to have problems with quantum mechanics.**

- You get used to quantum mechanics very quickly.
- You generate your own pictures and imaginations (which is necessary!).
- But you will often be surprised by the properties of quantum mechanical particles.