A Bit of Quantum Mechanics

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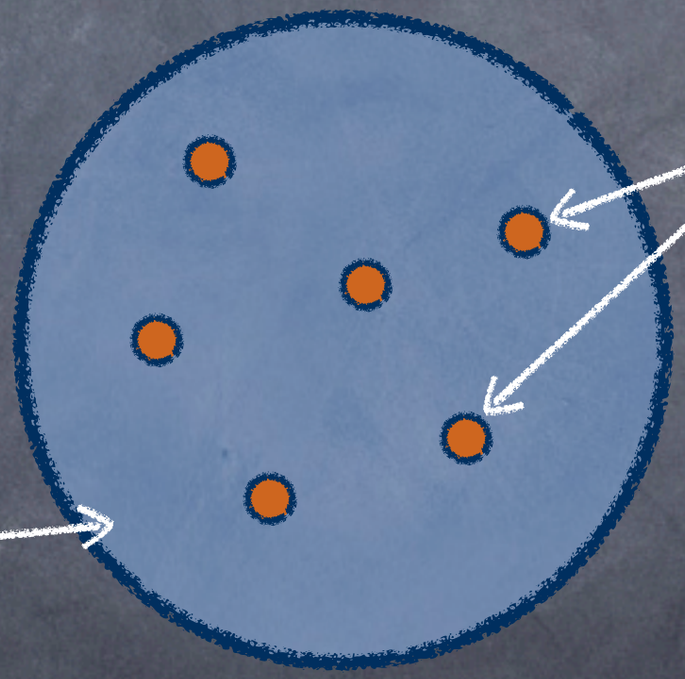
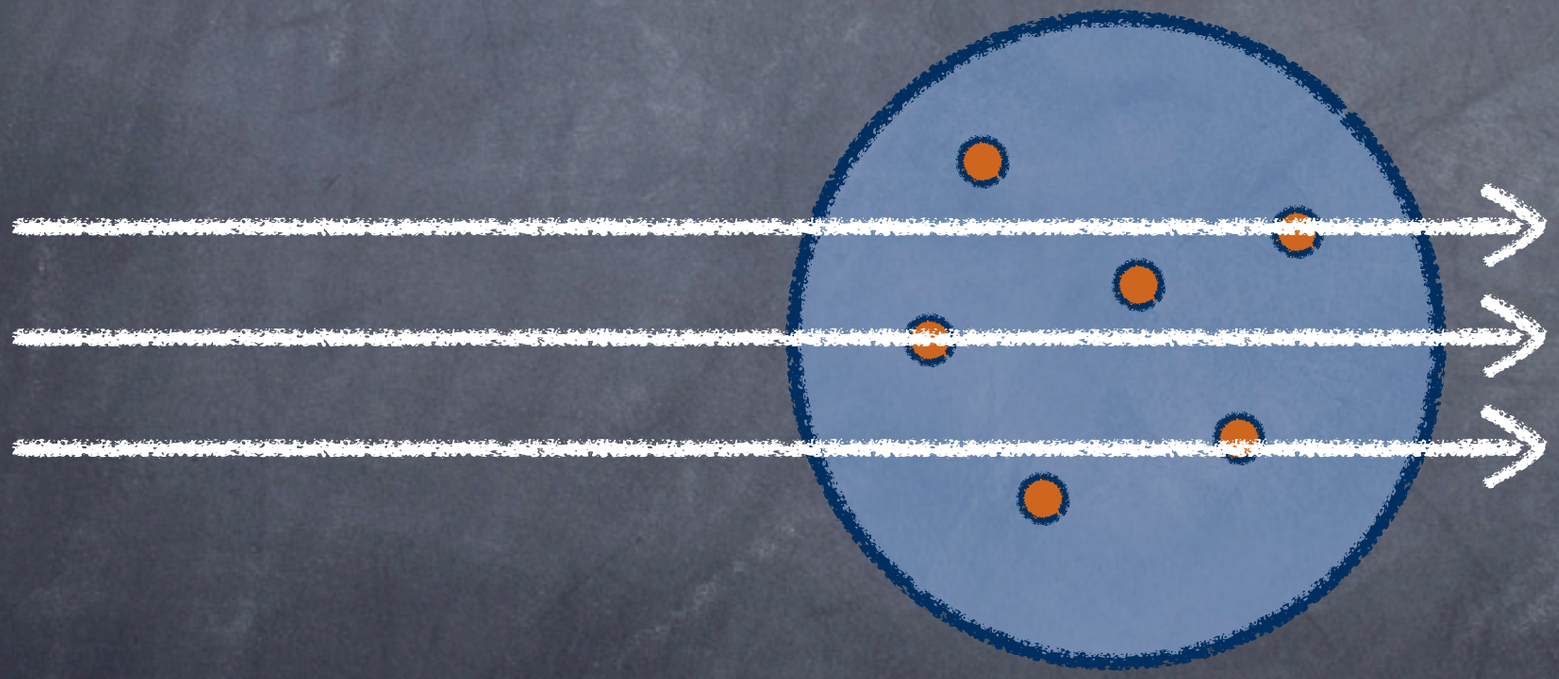
Thompson's 'Plum Pudding' atom



1904

The Gold Foil Experiment



What they expected...

1909

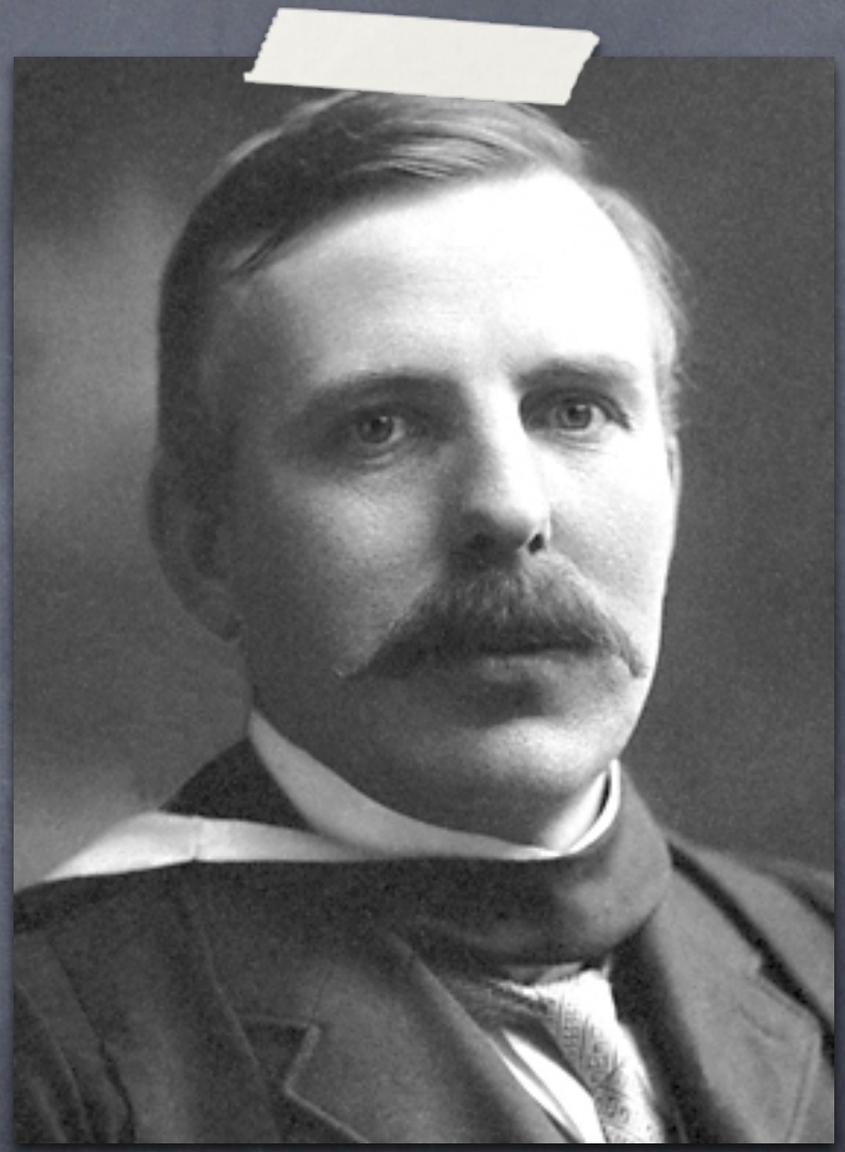
The Gold Foil Experiment

...What they found!

1909

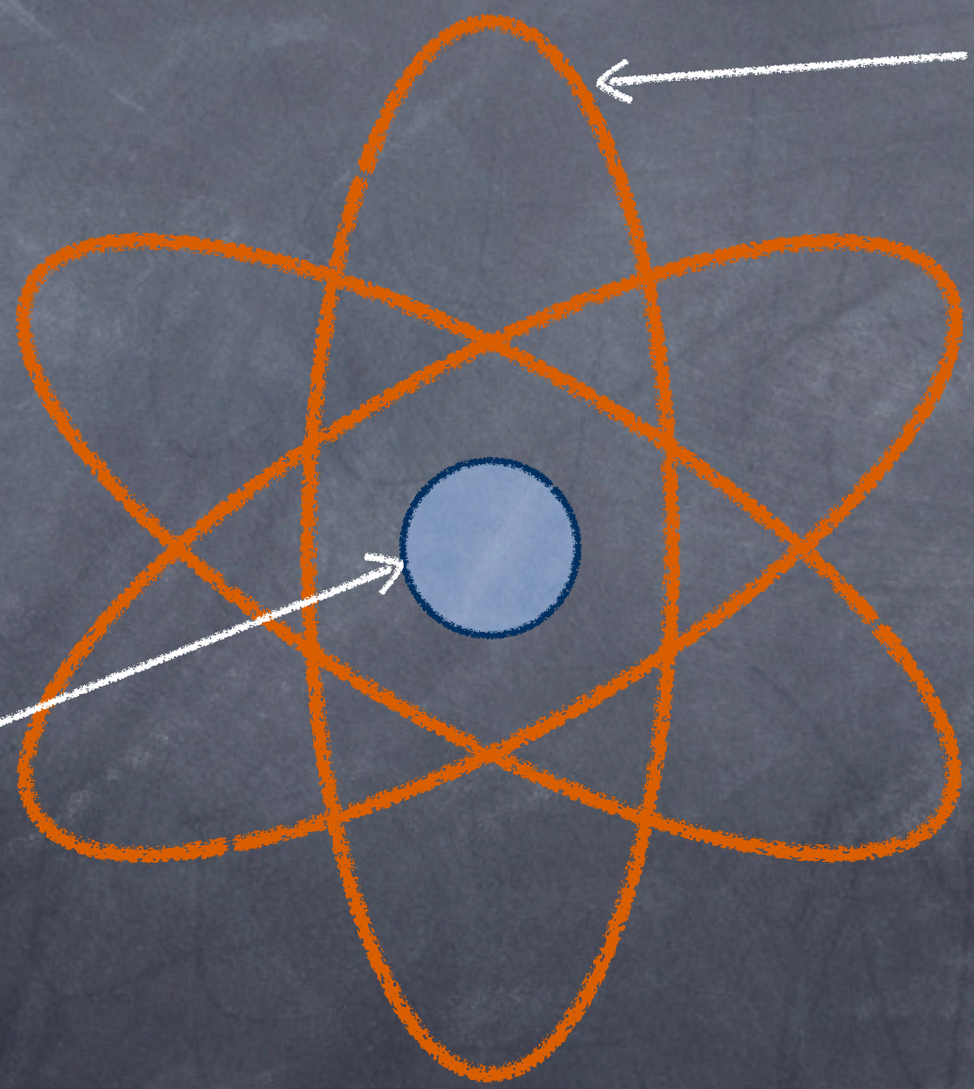
It was almost as incredible as if you fired a cannon at a piece of tissue paper and it came back and hit you.

– Ernest Rutherford



Rutherford's atom

Orbiting Electrons



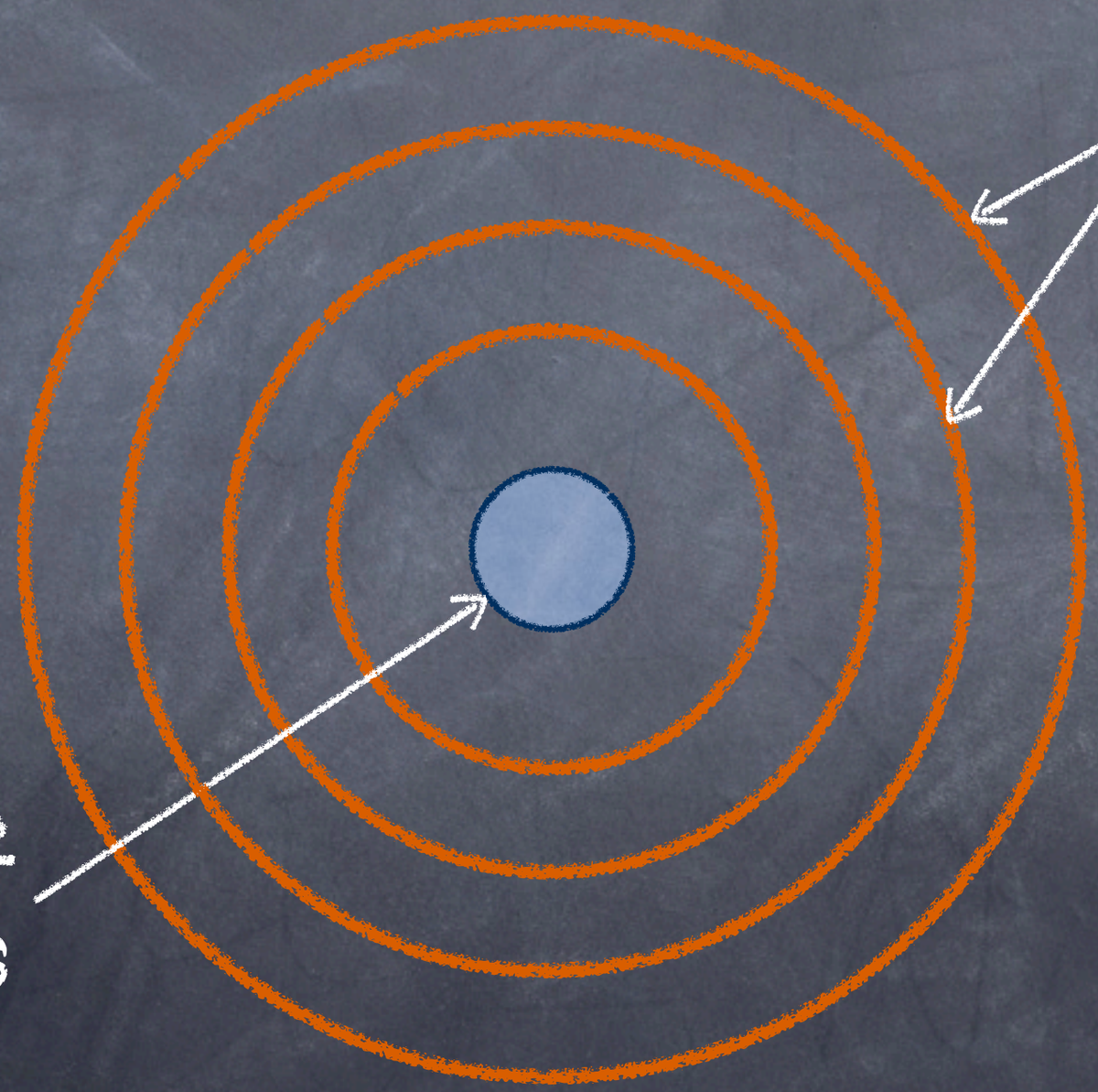
Positive Nucleus

1911

Rutherford's atom

A PROBLEM! Classical mechanics says that the electrons should lose energy and spiral into the nucleus in a fraction of a second – atoms should be very unstable. But we see that atoms around us are stable.

Bohr's atom



1913

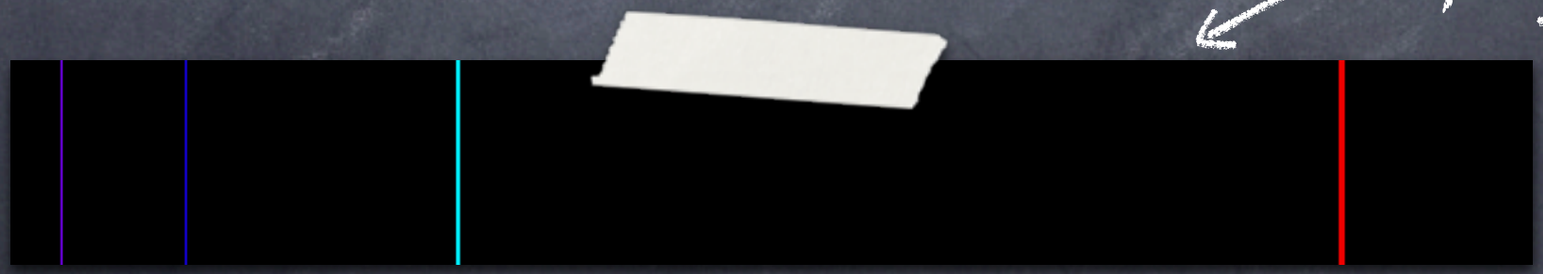
- Electrons can only travel in certain orbits, which have different energies.

- They can only gain or lose energy by absorbing or emitting a photon and jumping between levels.

— Niels Bohr

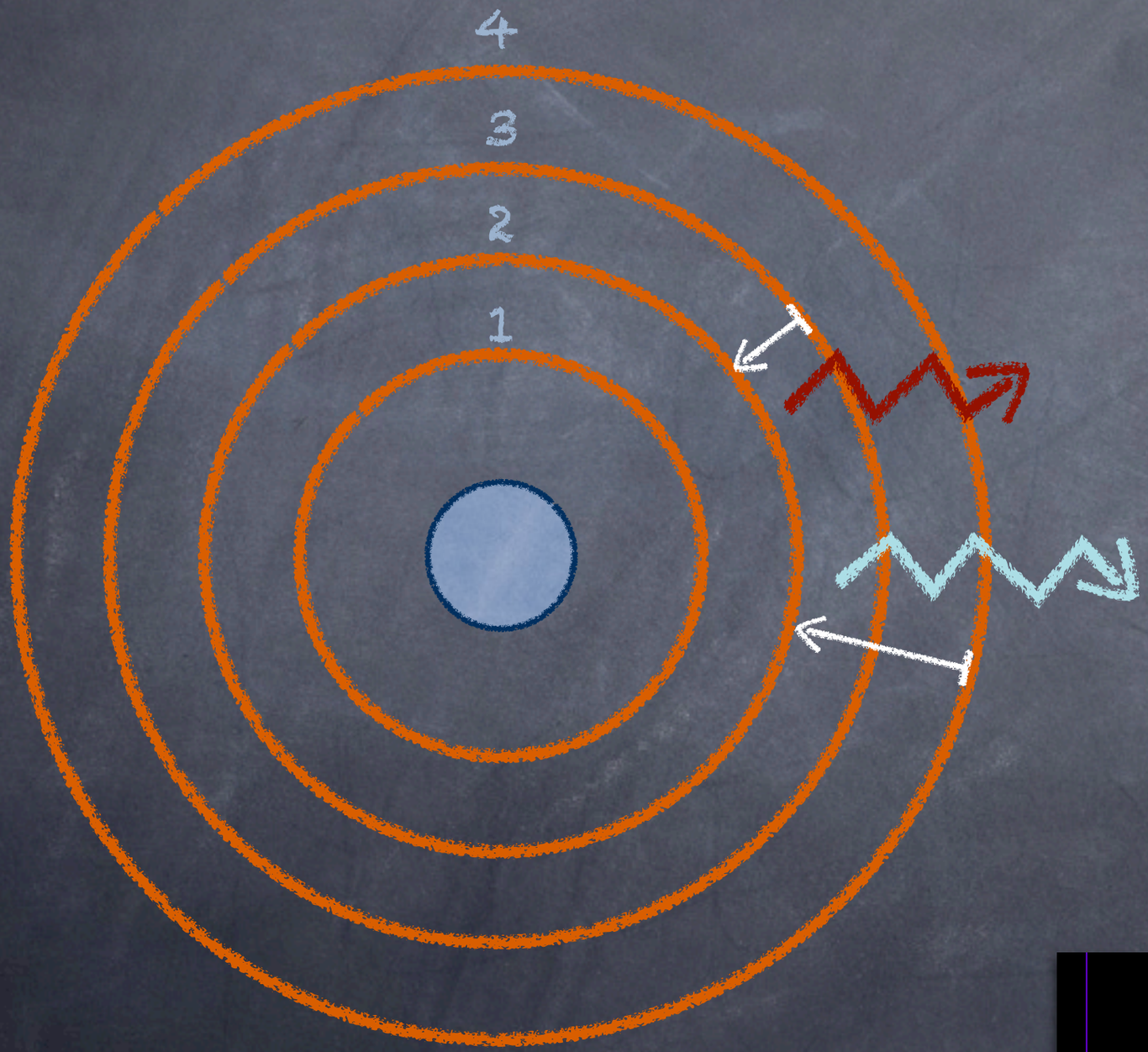
This also solved the puzzle of why the light seen coming from hydrogen – its emission spectrum – only showed a few distinct lines. These were the only energy jumps the electron could make.

Emission spectrum of hydrogen

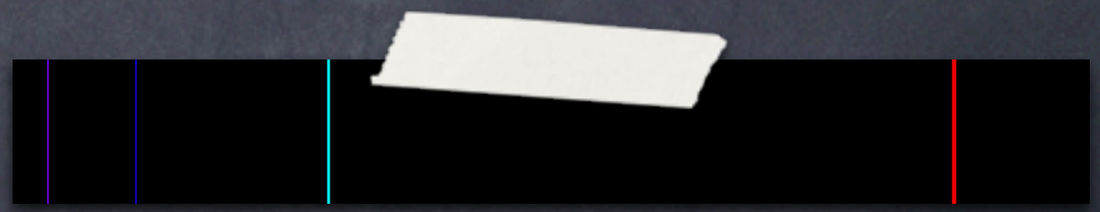


The hydrogen atom

(only one electron!)



- A jump from 3 to 2 results in a red photon.
- A jump from 4 to 2 results in a blue-green photon.



Our quantum world

- Bohr and many others had shown that matter & light can be described like **waves** as well as like **particles** – and they can only have certain 'quantised' energies.

- Physicists built on these new and strange ideas through the first half of the century. It turned out Bohr's model worked well for bigger atoms and **molecules** too...

Quantum Chemistry

- Here in Quantum Chemistry, we are interested in how we can use QM to describe molecules and how they behave – e.g. how they form bonds, how they react and how they vibrate.

- When molecules are large, the maths to describe them becomes incredibly complex, so we use computers to do a lot of the work.

- (We still need to learn plenty of maths though!)

I think I can safely say that nobody understands quantum mechanics.

– Richard Feynman