LC Quantum Mechanics

MSci Physics w/ Particle Physics and Cosmology
University of Birmingham

Year 1, Semester 1
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Lectures Index

Fri 24 Oct 2025 12:00

Lecture 4 - Atomic Energy Levels and Atomic Spectra

In this lecture:

- The spectra of light emitted and absorbed by electrons in:
  - Hydrogen (simple)
  - Larger atoms (not simple...)
- Electronic shells and orbits.

Spectra

Electrons in an atom can hold discrete values "levels" of energy. As electrons go up or down these levels they must absorb or will emit a photon. This emission causes a discrete spectra of emitted frequencies, unique to the element causing it.

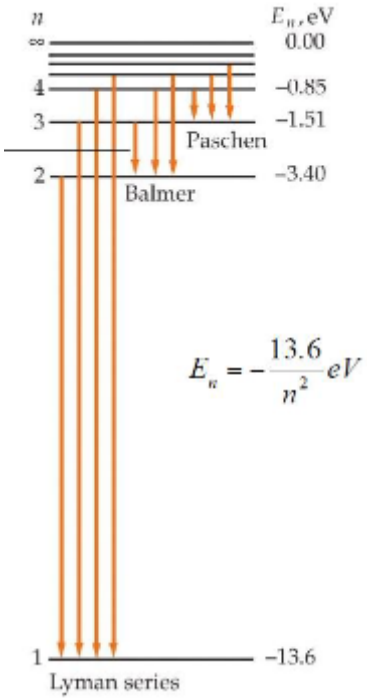

Figure 1: Example emission spectra.

Each of the transitions from one energy level to another have a discrete change in energy (measured in eV), therefore each transition will have a discrete wavelength of produced photons.

From the Bohr model, he postulated (from experimental observations) that light can *only* be absorbed or emitted when an electron goes up or down a discrete energy level (exitation or relaxation). At the lowest energy level (ground state).

It is important to note that the transitions in energy levels are not spatial - changing the energy level of an electron does not physically change its position (despite what the diagrams may imply).

Absorption and Emissions

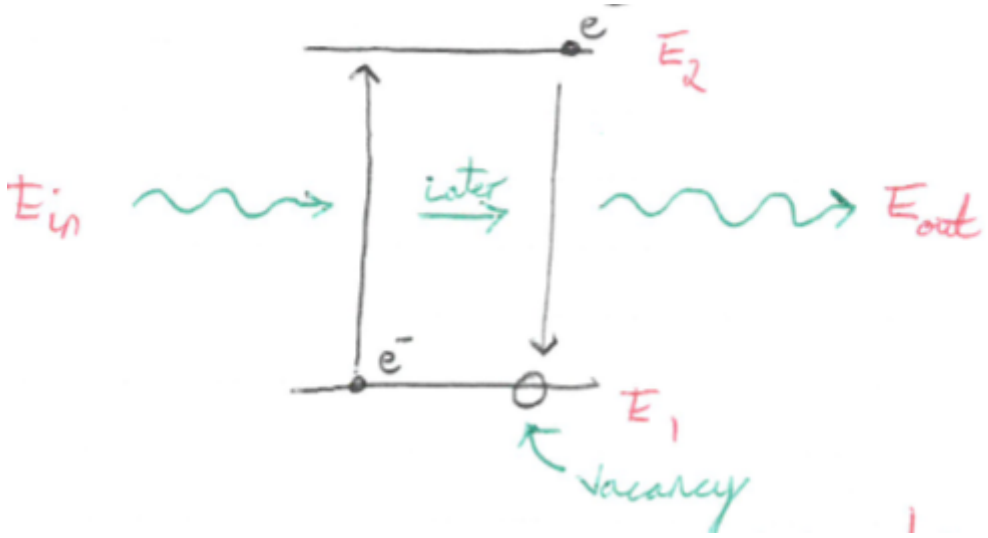

Figure 2

An electron is excited up an energy level, leaving a vacancy behind. Some time after, the electron drops back down into the ground state, emitting the energy in terms of a photon. By conservation of energy:

$$E_{\text{in}} = E_{\text{out}} = E_2 - E_1 = hf = \frac{hc}{\lambda}$$