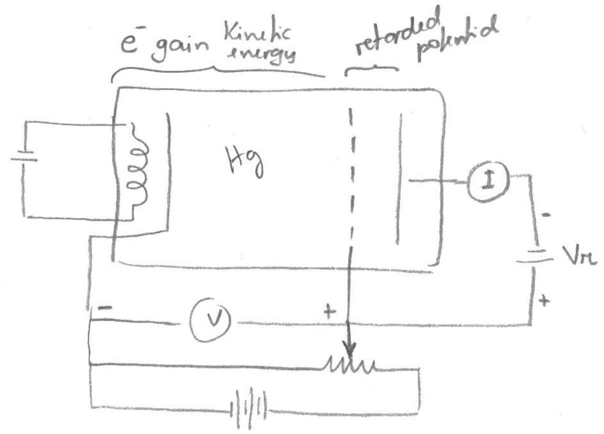
Franck-Hertz experiment (1914)

↳ confirmation that the internal energy states of an atom are quantized.



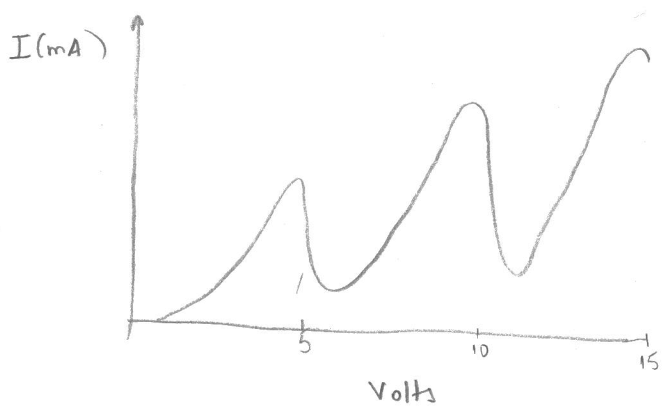
at ~4.9 eV I drops

9.8 eV – again

etc

4.9 eV → e⁻ has energy to excite Hg atom (from ground state to 1st excited state)

loses energy, cannot get enough to overcome Vr



9.8 eV → e⁻ has enough energy to excite ② Hg atoms

⋮

∘) Observing spectrum of Hg, Franck and Hertz saw emission line at 2536Å

$$E = h\nu = \frac{hc}{\lambda} \xrightarrow{2536\text{Å}} E = \underline{\underline{4.9\,eV}} \quad (!!)$$

∘) e⁻ may also gain enough energy to excite Hg atom from ground to 2nd, 3rd ... excited state → drops in I also verified

(2nd: 6.7eV)

→) can directly measure the energy differences of the quantum states of the atom

but

→) to find E of ground state, we need to ionize the atom

(DISCRETE SPECTRA is due to DISCRETE energy levels of the atom)

Old quantum theory

↳ improvements with respect to orbit → could be elliptical

↳ good predictions to several experiments

but it has limitations

- fails for atoms with more e^-
- cannot predict the rate of transitions $E_i \leftrightarrow E_f$

↳ is conceptually different from what we now call quantum mechanics

↓

(Schrödinger equation) → the idea of a precise orbit does not make sense anymore

Δx — there is always an uncertainty in x

What remains from old quantum theory:

- $\frac{E_i - E_f}{h} = \nu$
- L can be quantized
- CORRESPONDENCE PRINCIPLE

"In the limit of large quantum numbers, large energies (large temperatures), quantum calculations must agree with classical calculations" → which have worked so well in the macroscopic world

classical limit $\begin{cases} n \to \infty \\ E \to \infty \\ \hbar \to 0 \end{cases}$

HW
4.34, 4.36, 4.44
(Tipler)