PHOT 222: Quantum Photonics
LECTURE 14B

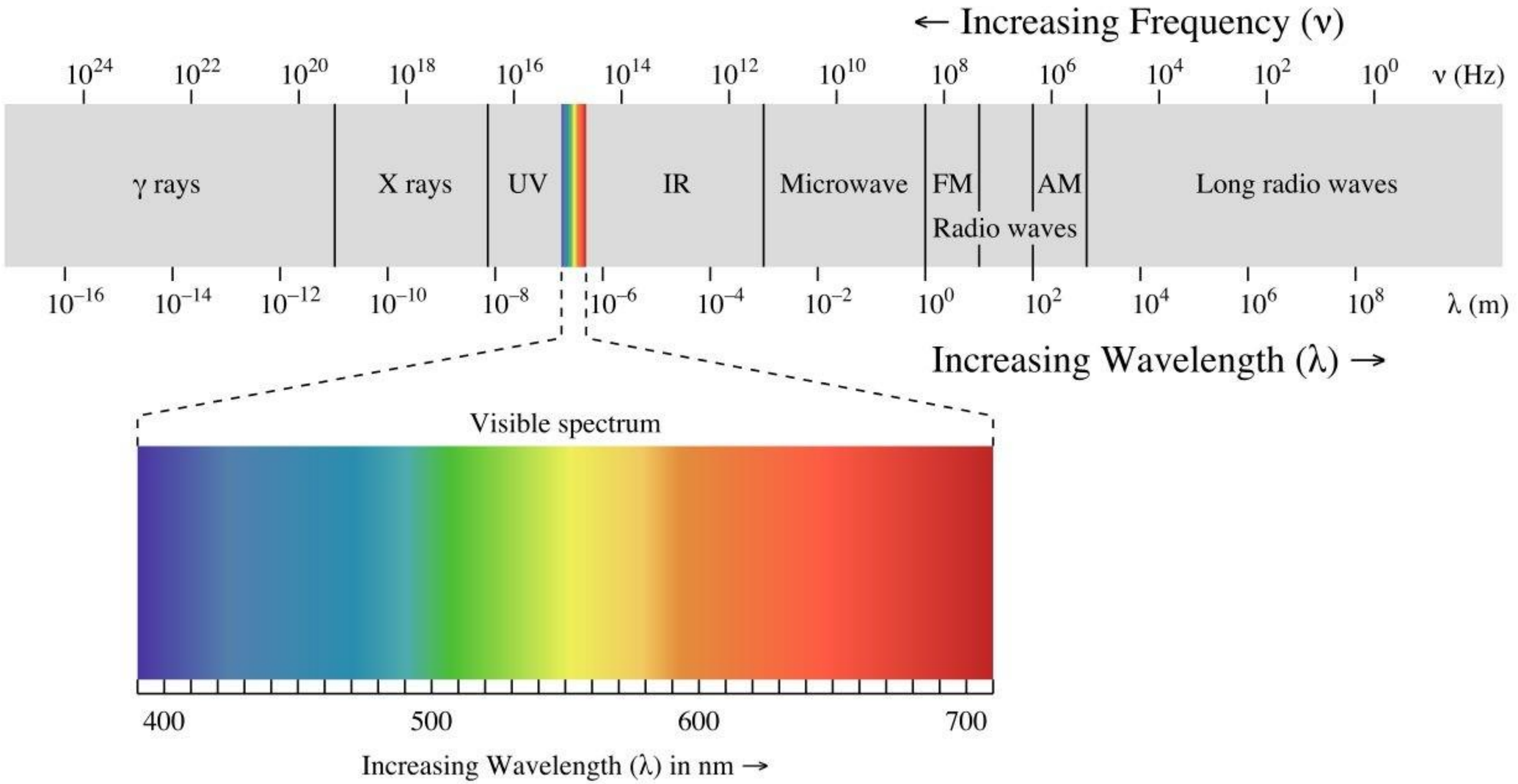
Michaël Barbier, Spring semester (2024-2025)

OVERVIEW OF THE COURSE

week	topic	Serway 9th	Young
Week 1	Relativity	Ch. 39	Ch. 37
Week 2	Waves and Particles	Ch. 40	Ch. 38-39
Week 3	Wave packets and Uncertainty	Ch. 40	Ch. 38-39
Week 4	The Schrödinger equation and Probability	Ch. 41	Ch. 39
Week 5	**Midterm exam 1**		
Week 6	Quantum particles in a potential	Ch. 41	Ch. 40
Week 7	Bayram		
Week 8	Harmonic oscillator	Ch. 41	Ch. 40
Week 9	Tunneling through a potential barrier	Ch. 41	Ch. 40
Week 10	**Midterm exam 2**		
Week 11	Bohr’s hydrogen atom, absorption/emission spectra	Ch. 42	Ch. 41
Week 12	Quantum mechanical model of the hydrogen atom	Ch. 42	Ch. 41
Week 13	Exercises		
Week 14	Spin / Many-electron atoms	Ch. 42	Ch. 41
Week 15	Molecules	Ch. 43	Ch. 42
Week 16	Crystalline materials & energy band structure	Ch. 43	Ch. 42

X-rays

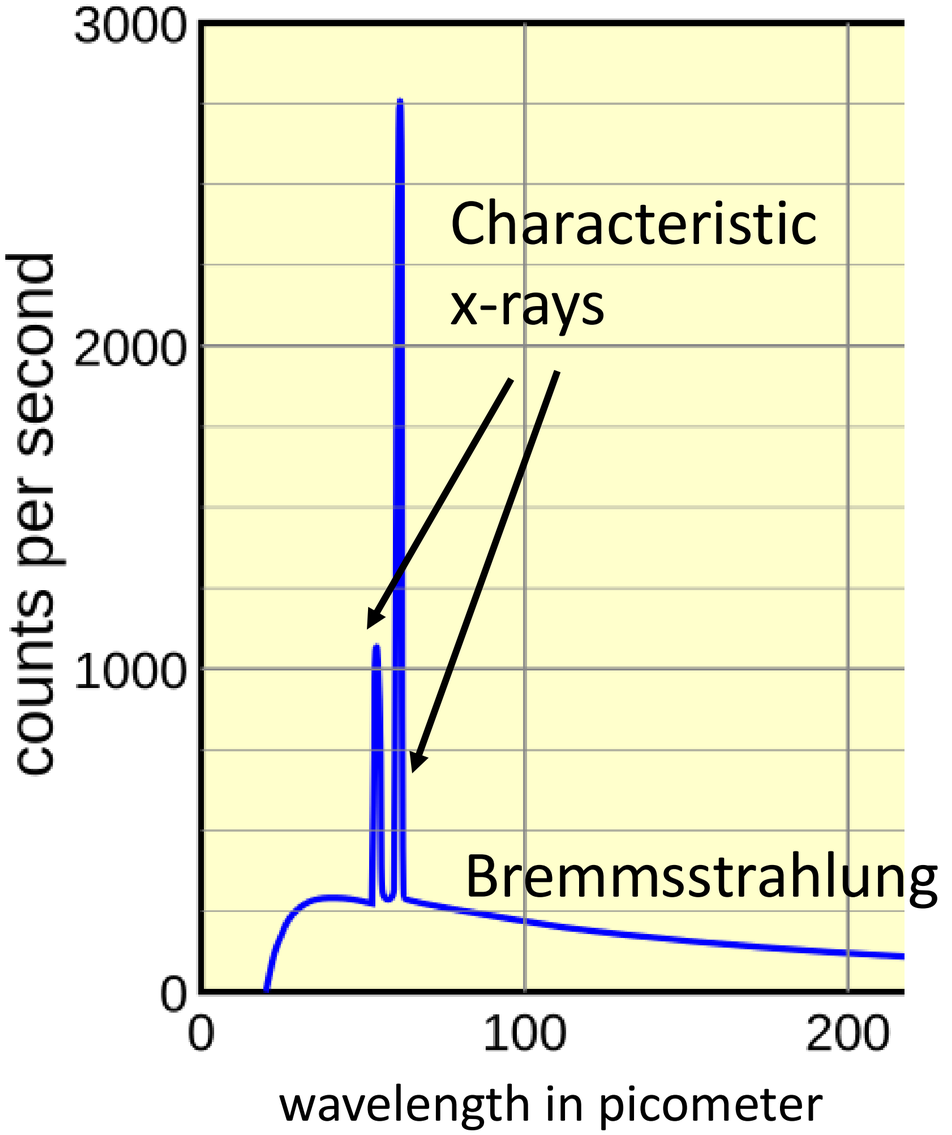
X-RAYS



Adapted from wikipedia

X-RAYS

- 1895: Rontgen found x-rays
- Two typical types of x-rays:
  - **Bremmsstrahlung**:
    electrons slowing down
    Broad continuous spectrum
  - 1908: **Characteristic x-rays**:
    Energy-levels in heavy atoms
    Sharp spectral lines

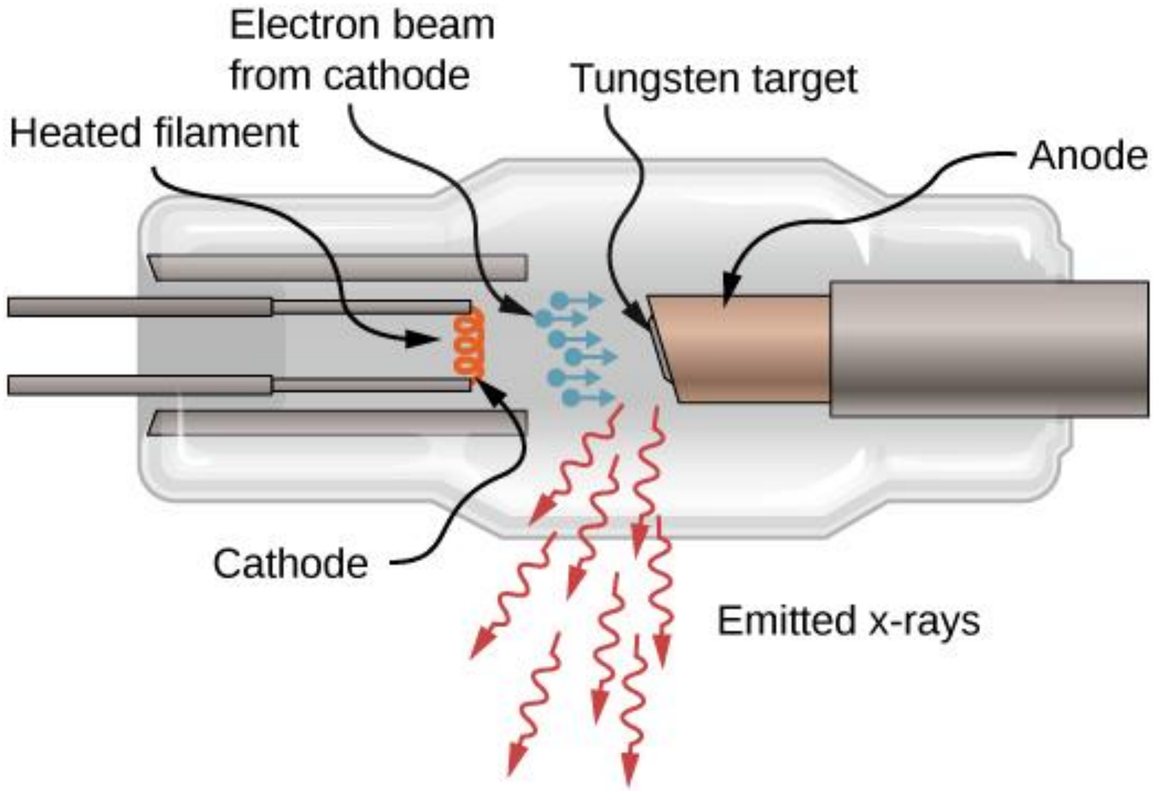


Adapted from wikipedia

X-RAYS: BREMMSTRAHLUNG

- **Bremmsstrahlung**: electrons slowing down
- Acceleration voltage V_{acc}
- Energy electrons $K = \mathrm{e}V_{\mathrm{acc}}$

- Interaction with matter/nuclei
- Loss of kinetic energy
- Emitted as EM radiation



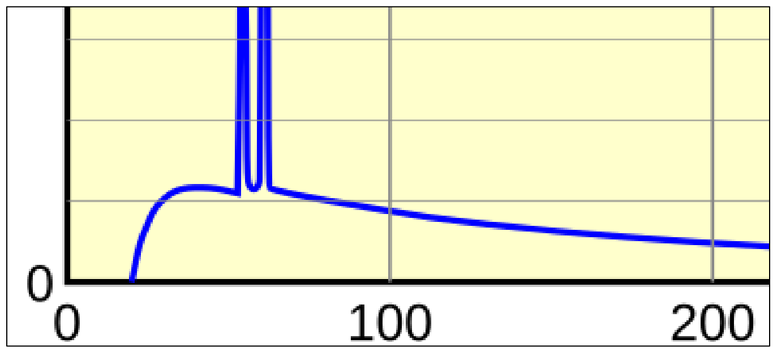
Adapted from wikipedia

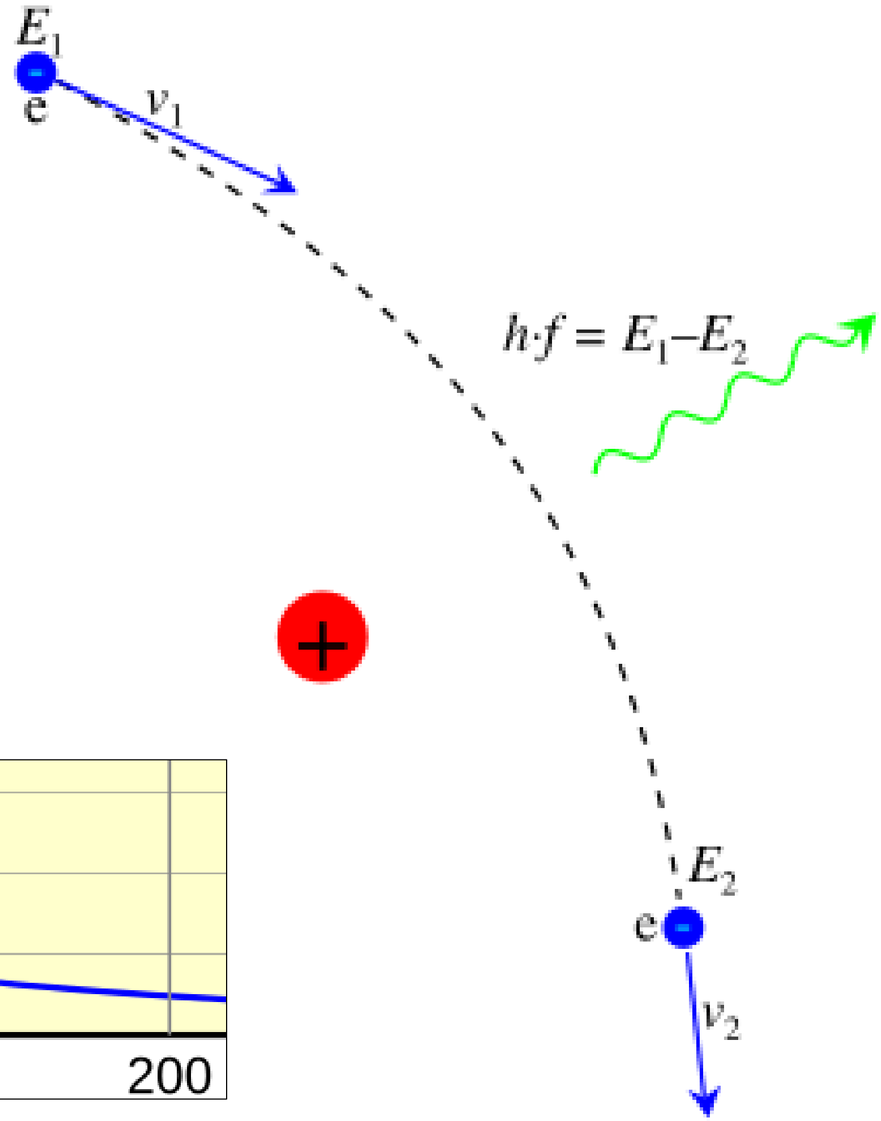
X-RAYS: BREMMSTRAHLUNG

- **Bremmsstrahlung**: electrons slowing down
- High energy (fast) electrons
- Interaction with matter/nuclei
- Loss of kinetic energy
- **Minimum wavelength $\lambda_{\min}$**:

$$\lambda_{\min} = \frac{hc}{e\,V_{\text{acc}}}$$

Acceleration voltage V_{acc}
Energy photon hc

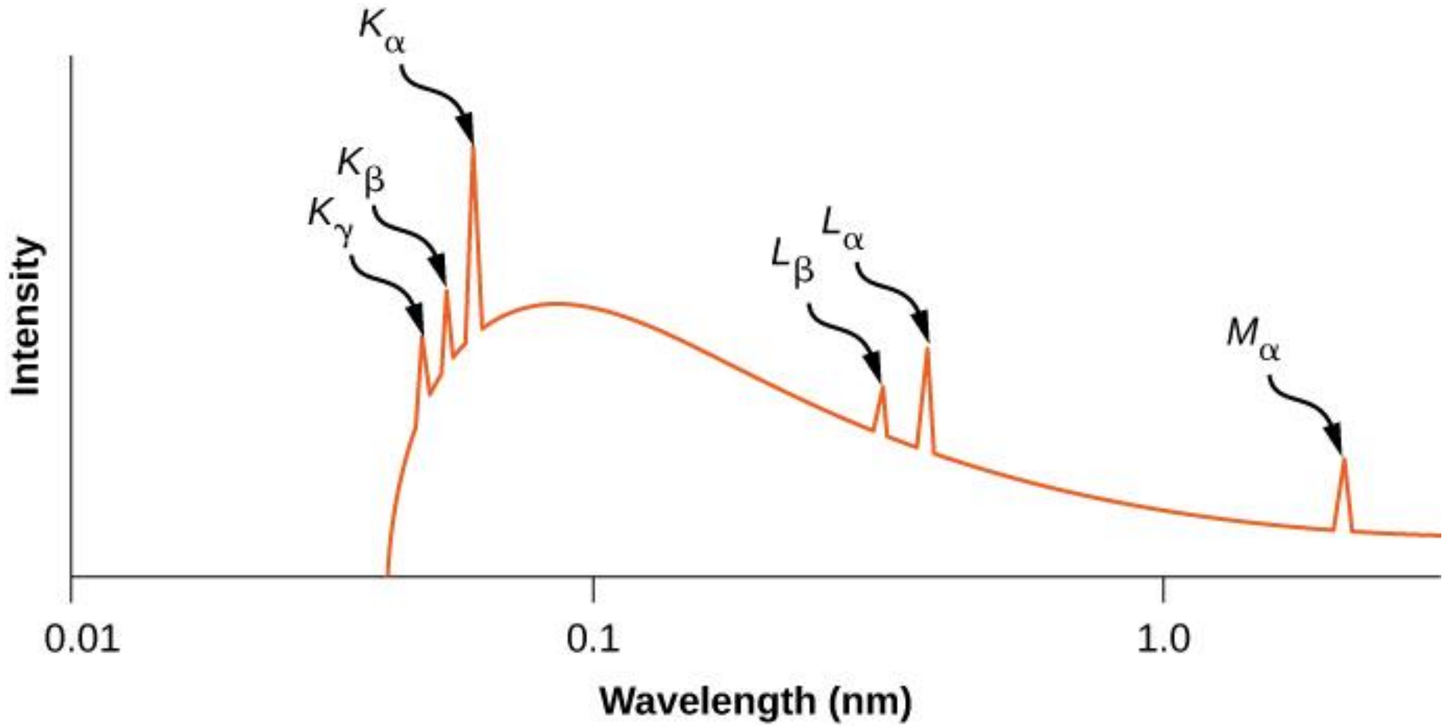


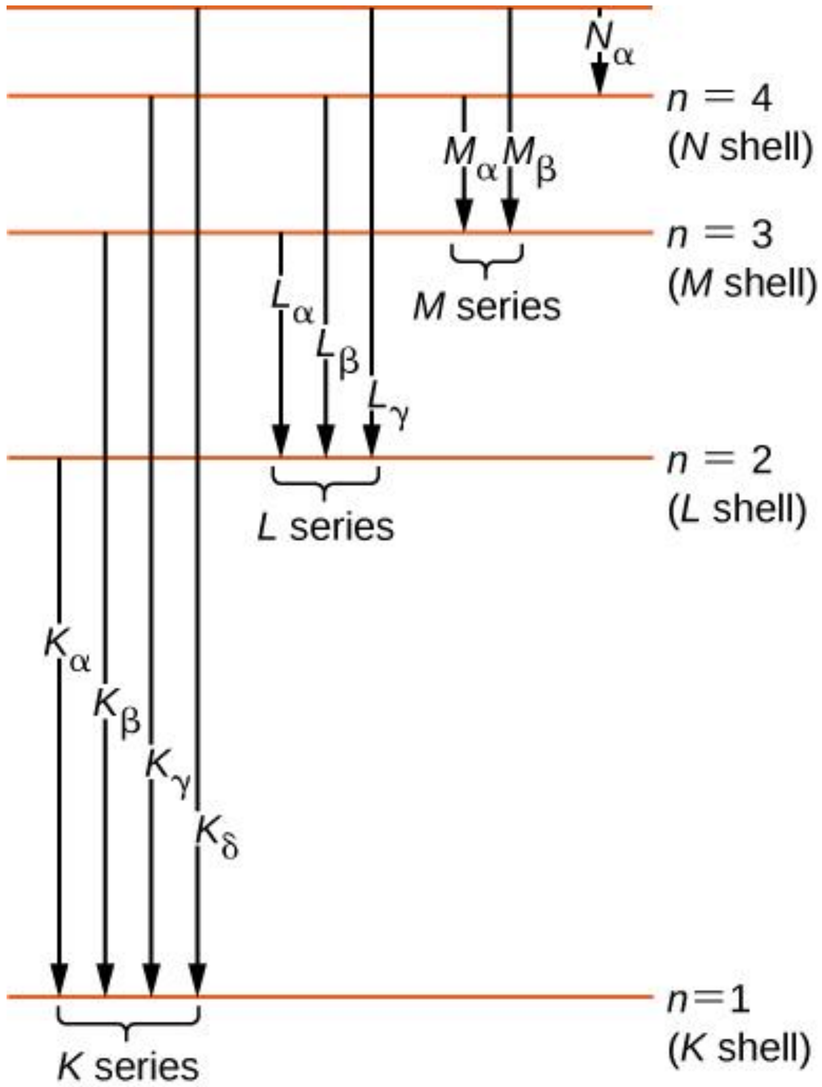


Adapted from wikipedia

X-RAYS: CHARACTERISTIC X-RAYS

- **Characteristic x-rays**
- Spectrum “characterizes” the target metal

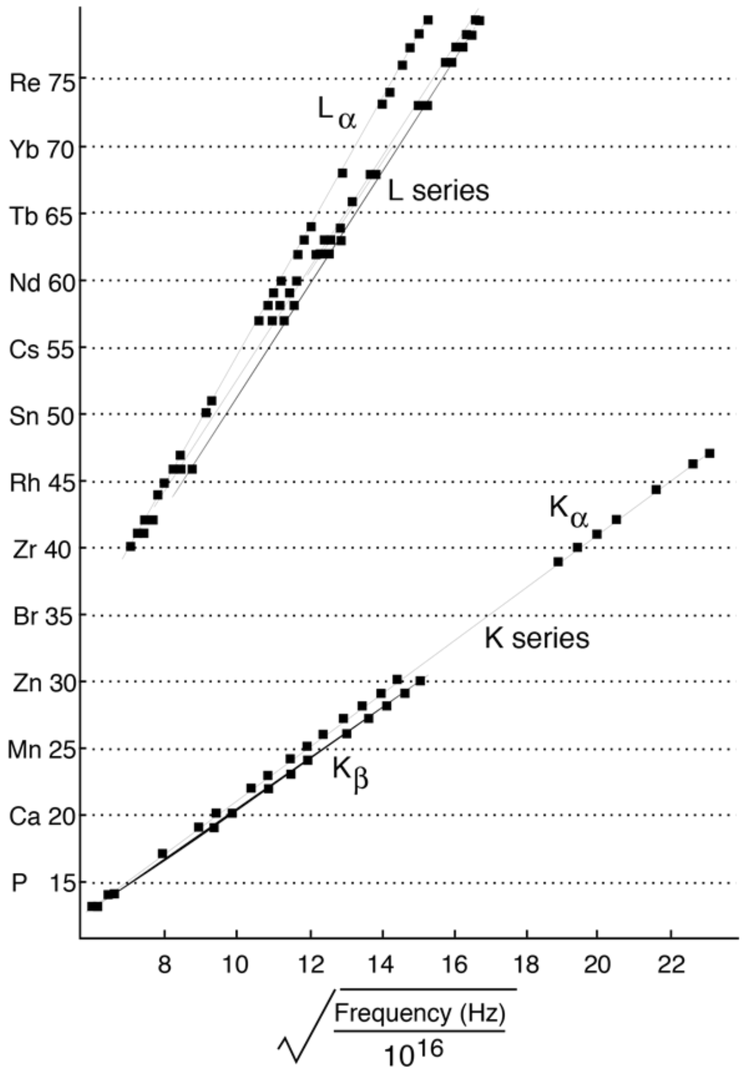




X-RAYS: CHARACTERISTIC X-RAYS

- **Characteristic x-rays**
- Moseley's law:

$$f = 2.48 \times 10^{15}\ \text{Hz}\ (Z - 1)^2$$



Adapted from Moseley's original data (H. G. J. Moseley, Philos. Mag. (6) 27:703, 1914)

Henry Moseley

Adapted from Wikipedia