Atomic Structure

Examples of Hydrogen Spectral Lines

Hydrogen spectral lines are a series of lines corresponding to the transitions of an electron between energy levels in a hydrogen atom. These lines are grouped into different series, each corresponding to transitions ending at a particular energy level.

1. Lyman Series (Ultraviolet Region)

- **Transitions:** $n \geq 2$ to $n = 1$
- **Wavelength Range:** 91.2 nm to 121.6 nm

Examples:

- $n = 2$ **to** $n = 1$**:** 121.6 nm (Lyman-alpha)
- $n = 3$ **to** $n = 1$**:** 102.6 nm (Lyman-beta)
- $n = 4$ **to** $n = 1$**:** 97.3 nm (Lyman-gamma)

2. Balmer Series (Visible Region)

- **Transitions:** $n \geq 3$ to $n = 2$
- **Wavelength Range:** 364.6 nm to 656.3 nm

Examples:

- $n = 3$ **to** $n = 2$**:** 656.3 nm (Balmer-alpha, H-alpha)
- $n = 4$ **to** $n = 2$**:** 486.1 nm (Balmer-beta, H-beta)
- $n = 5$ **to** $n = 2$**:** 434.0 nm (Balmer-gamma, H-gamma)
- $n = 6$ **to** $n = 2$**:** 410.2 nm (Balmer-delta, H-delta)

3. Paschen Series (Infrared Region)

- **Transitions:** $n \geq 4$ to $n = 3$
- **Wavelength Range:** 820.4 nm to 1875.0 nm

Examples:

- $n = 4$ **to** $n = 3$**:** 1875.0 nm (Paschen-alpha, P-alpha)
- $n = 5$ **to** $n = 3$**:** 1281.8 nm (Paschen-beta, P-beta)
- $n = 6$ **to** $n = 3$**:** 1093.8 nm (Paschen-gamma, P-gamma)

4. Brackett Series (Infrared Region)

- **Transitions:** $n \geq 5$ to $n = 4$
- **Wavelength Range:** 1458.0 nm to 4052.0 nm

Examples:

- $n = 5$ **to** $n = 4$**:** 4052.0 nm (Brackett-alpha, B-alpha)
- $n = 6$ **to** $n = 4$**:** 2625.9 nm (Brackett-beta, B-beta)
- $n = 7$ **to** $n = 4$**:** 2165.5 nm (Brackett-gamma, B-gamma)

5. Pfund Series (Far Infrared Region)

- **Transitions:** $n \geq 6$ to $n = 5$
- **Wavelength Range:** 2279.0 nm to 7460.0 nm

Examples:

- $n = 6$ **to** $n = 5$**:** 7460.0 nm (Pfund-alpha, Pf-alpha)
- $n = 7$ **to** $n = 5$**:** 4654.0 nm (Pfund-beta, Pf-beta)
- $n = 8$ **to** $n = 5$**:** 3741.0 nm (Pfund-gamma, Pf-gamma)

6. Humphreys Series (Far Infrared Region)

- **Transitions:** $n \geq 7$ to $n = 6$
- **Wavelength Range:** 3281.4 nm to 12368.0 nm

Examples:

- $n = 7$ **to** $n = 6$**:** 12368.0 nm (Humphreys-alpha, H-alpha)
- $n = 8$ **to** $n = 6$**:** 7460.0 nm (Humphreys-beta, H-beta)
- $n = 9$ **to** $n = 6$**:** 6575.0 nm (Humphreys-gamma, H-gamma)

Summary

These series and their respective spectral lines are crucial for understanding the electronic structure of hydrogen and for applications in spectroscopy. Each transition corresponds to a specific photon energy, which translates to the observed spectral line's wavelength.