Units of Chapter 2 – Part 2

Spectroscopy

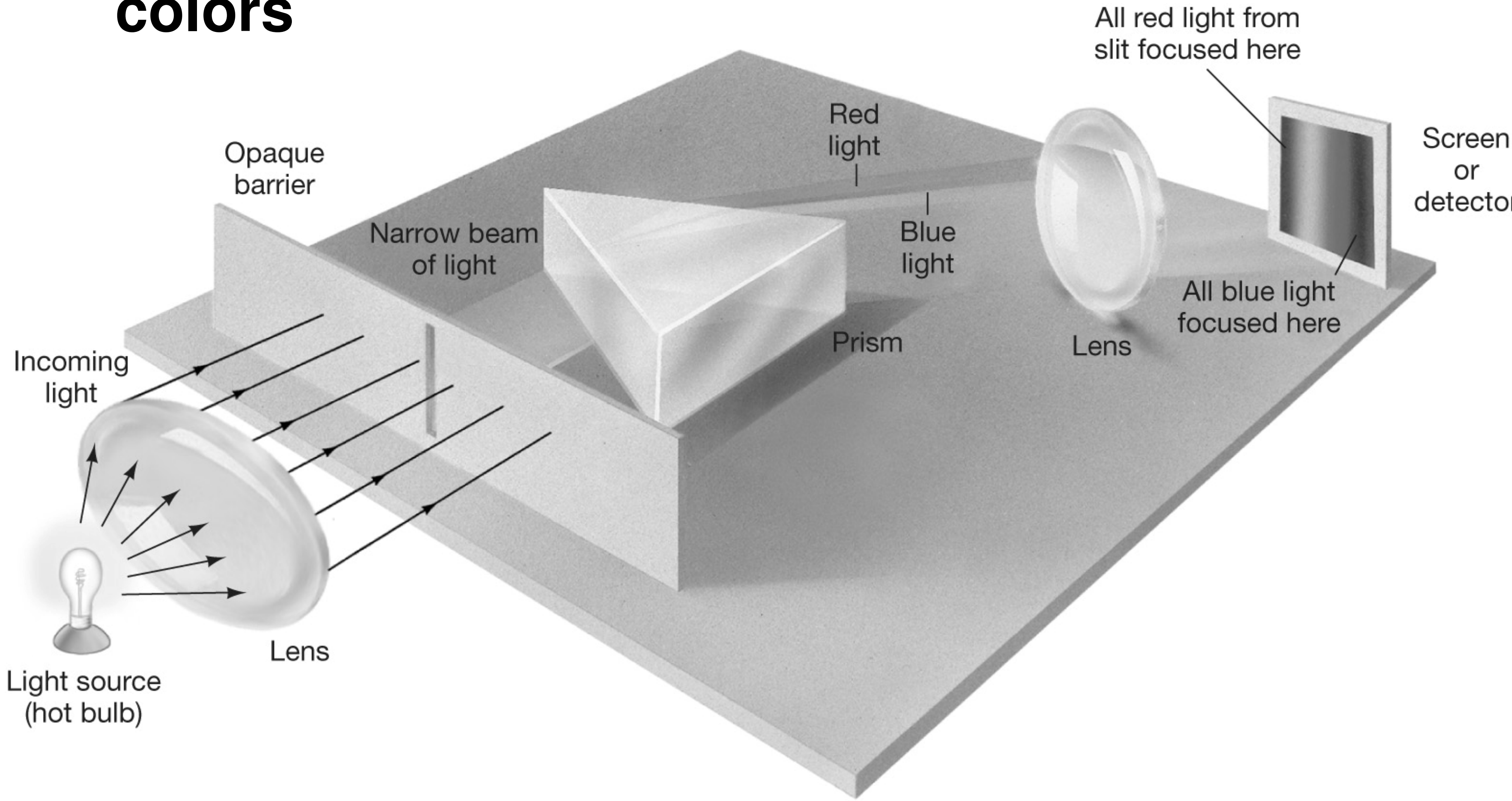
The Formation of Spectral Lines

The Doppler Effect

Spectral-Line Analysis

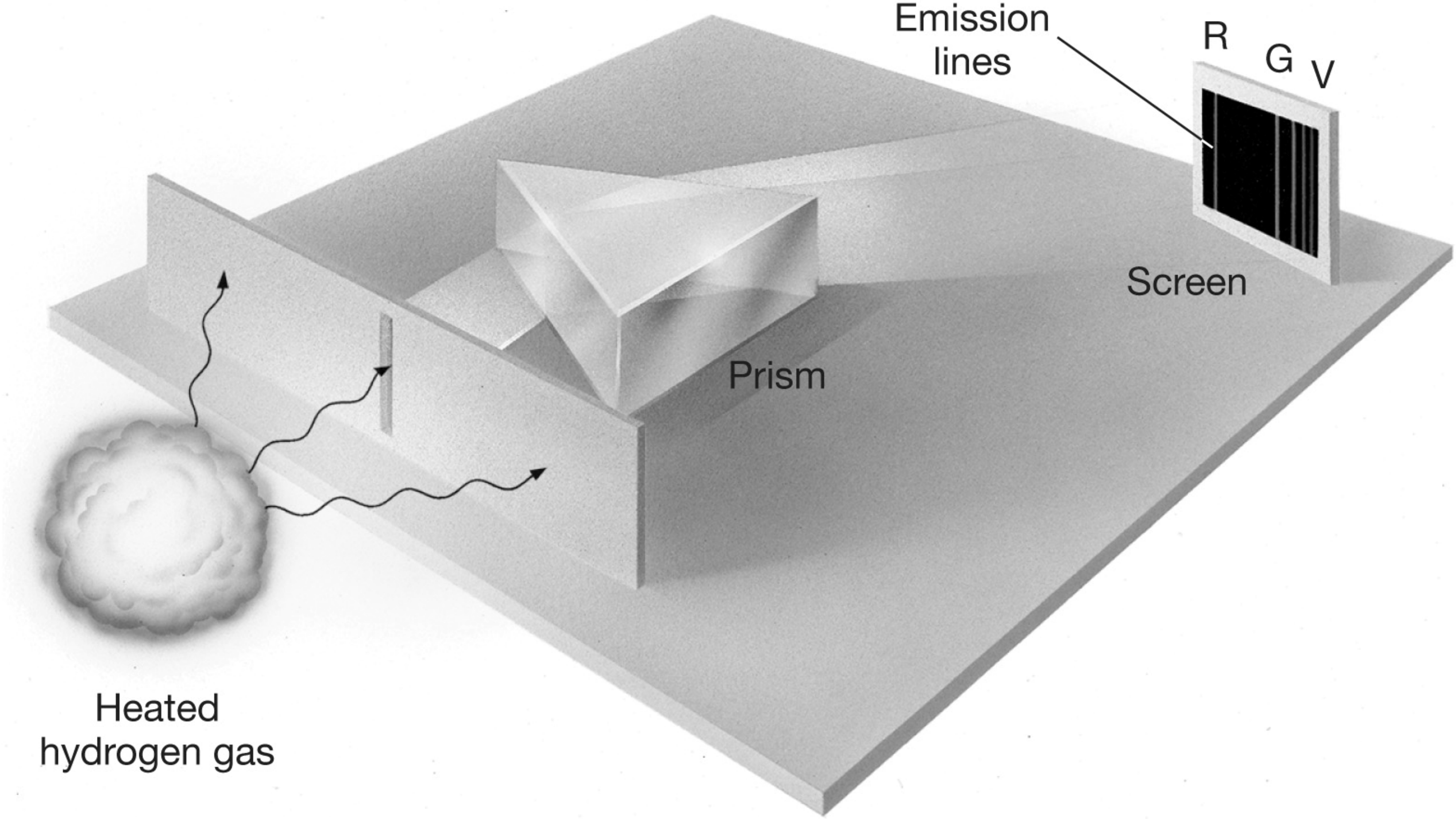
2.5 Spectroscopy

Spectroscope: splits light into component colors



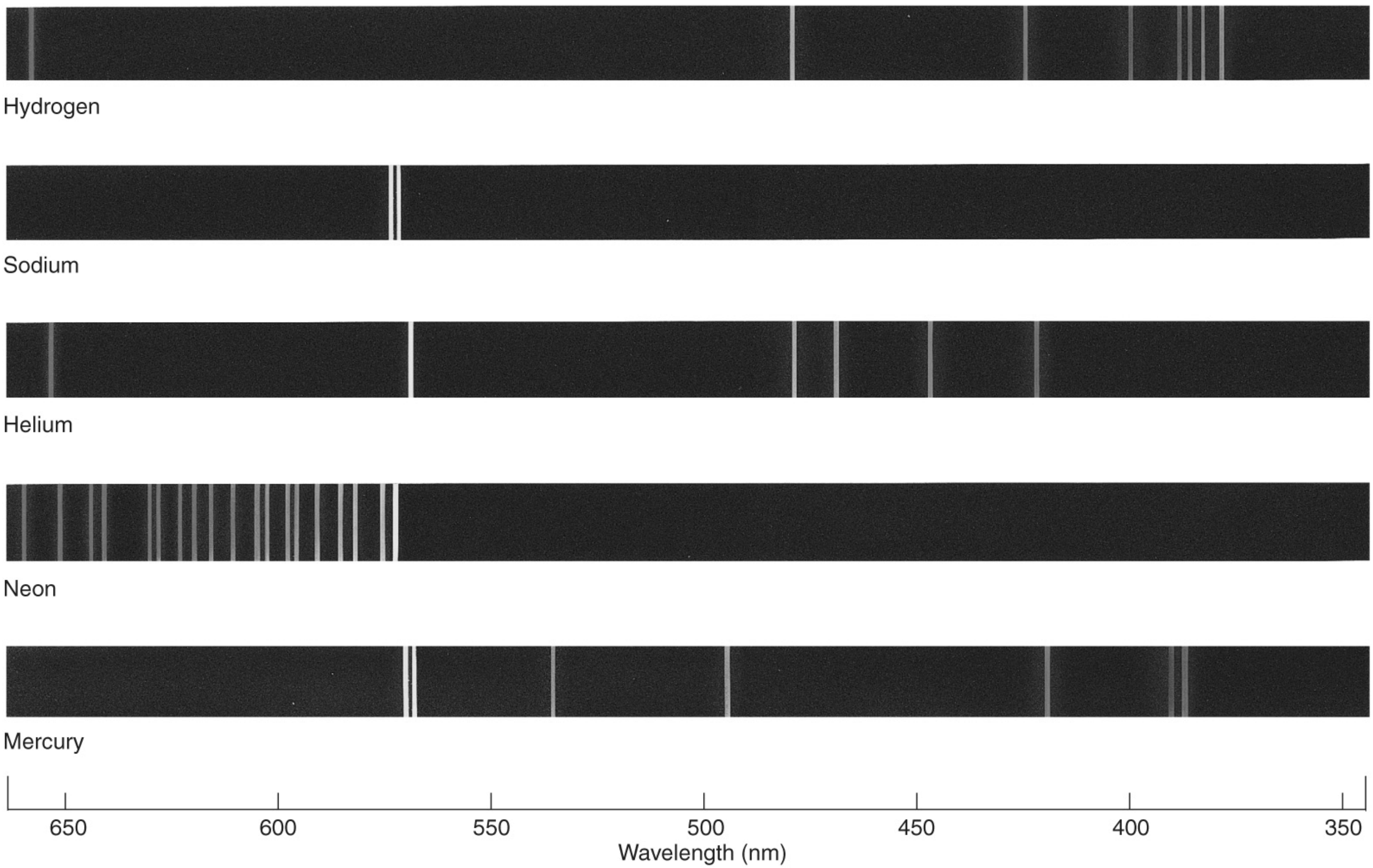
2.5 Spectroscopy

Emission lines: single frequencies emitted by particular atoms



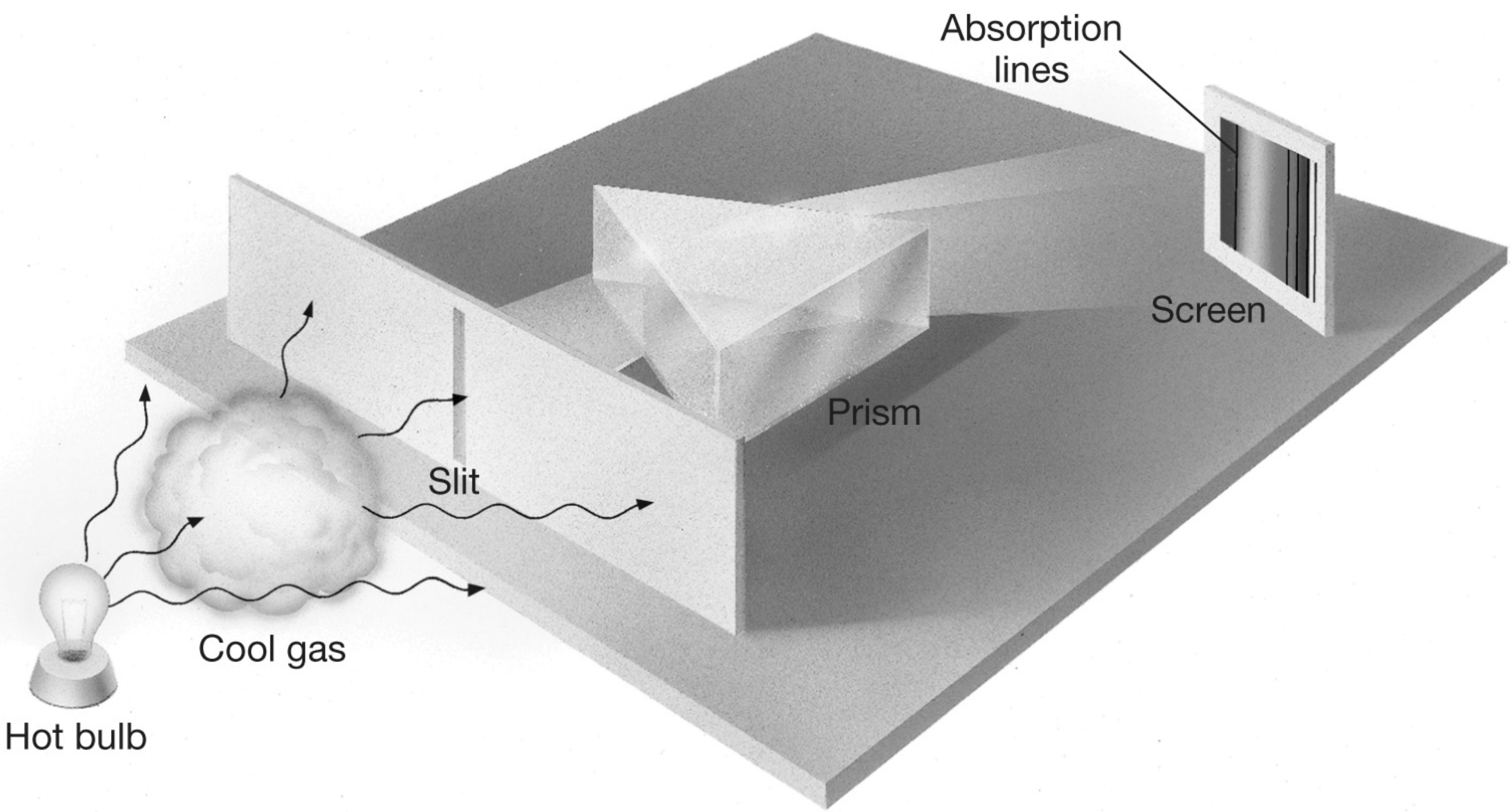
2.5 Spectroscopy

Emission spectrum can be used to identify elements:



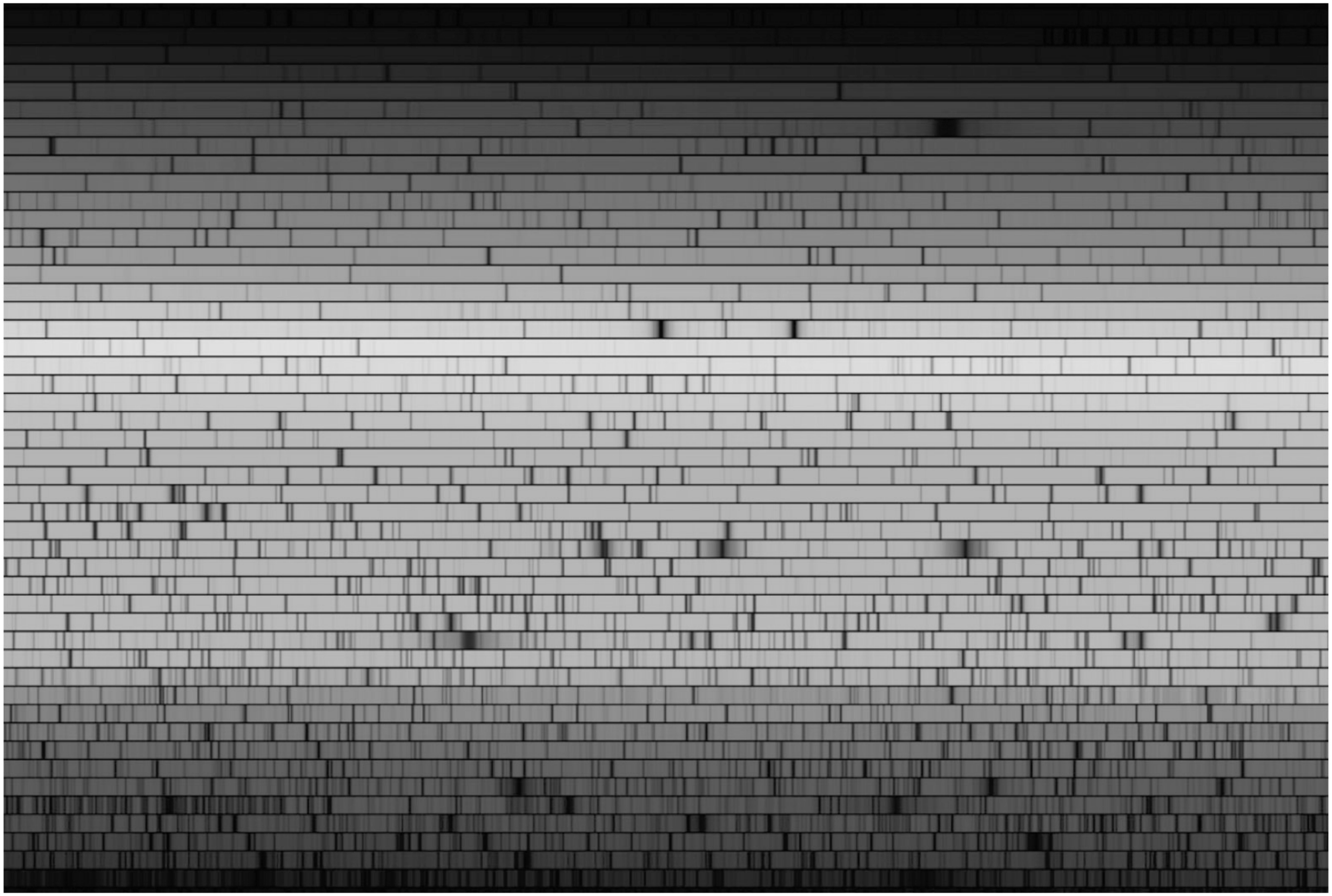
2.5 Spectroscopy

Absorption spectrum: if a continuous spectrum passes through a cool gas, atoms of the gas will absorb the same frequencies they emit



2.5 Spectroscopy

Absorption spectrum of the Sun:



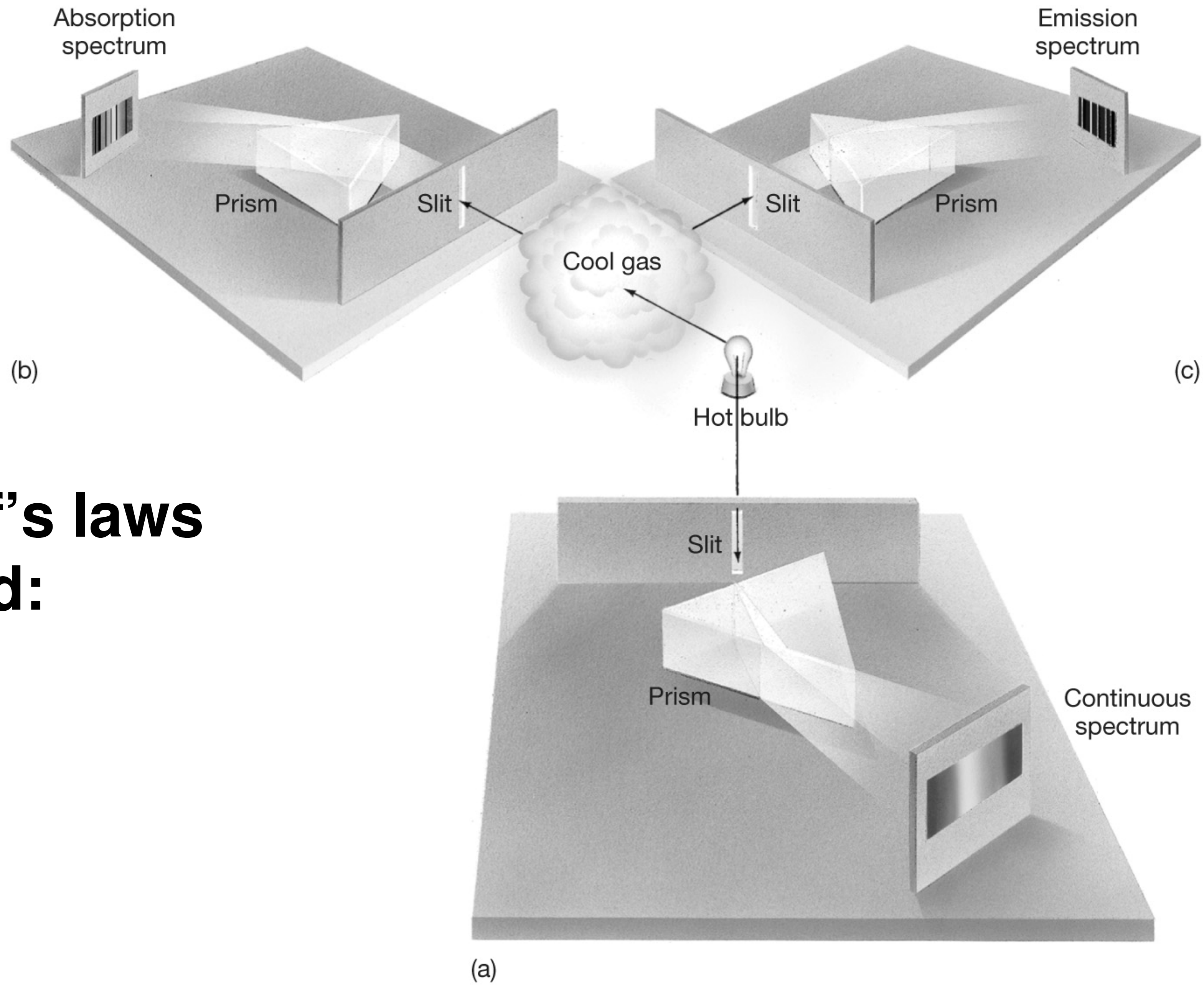
2.5 Spectroscopy

Kirchhoff's Laws:

- **Luminous solid, liquid, or dense gas produces continuous spectrum**
- **Low-density hot gas produces emission spectrum**
- **Continuous spectrum incident on cool, thin gas produces absorption spectrum**

2.5 Spectroscopy

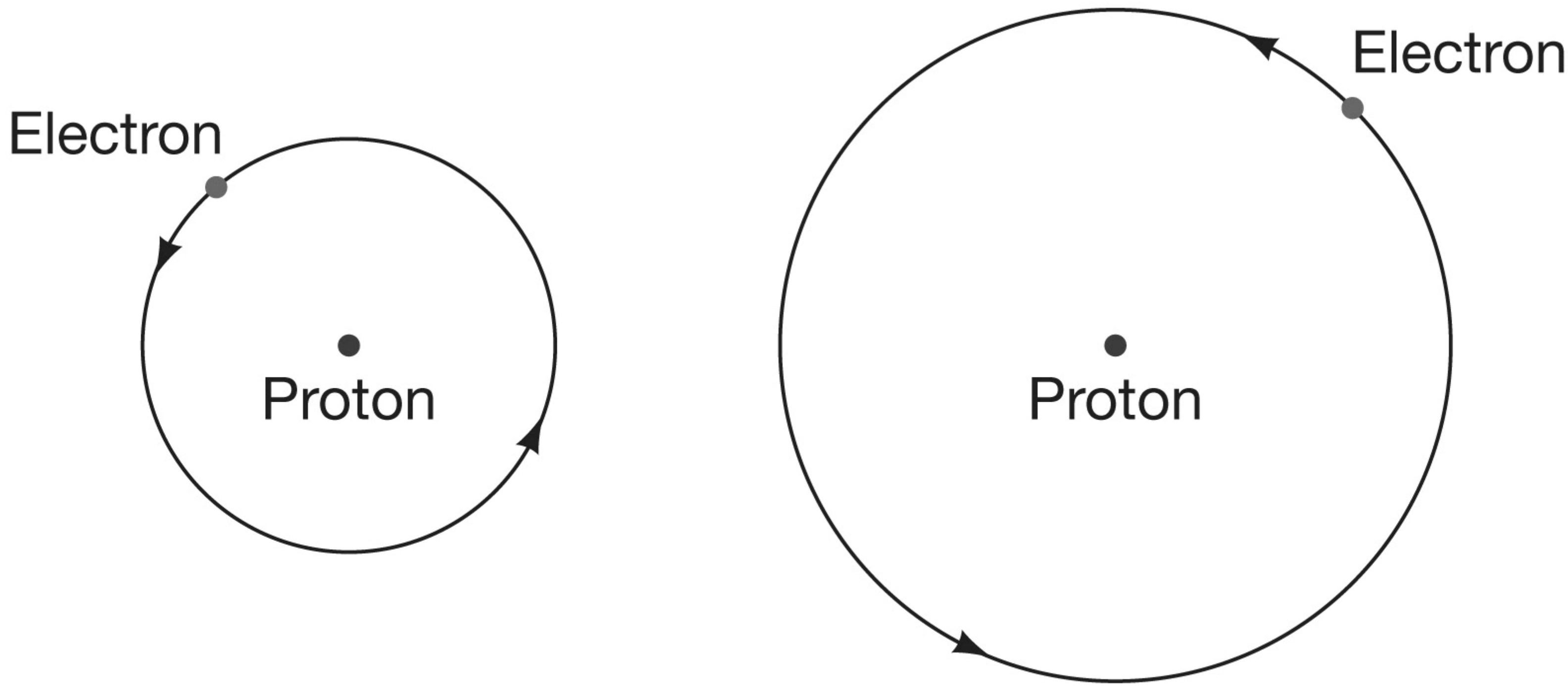
Kirchhoff's laws illustrated:



2.6 The Formation of Spectral Lines

Existence of spectral lines required new model of atom, so that only certain amounts of energy could be emitted or absorbed.

Bohr model had certain allowed orbits for electron:

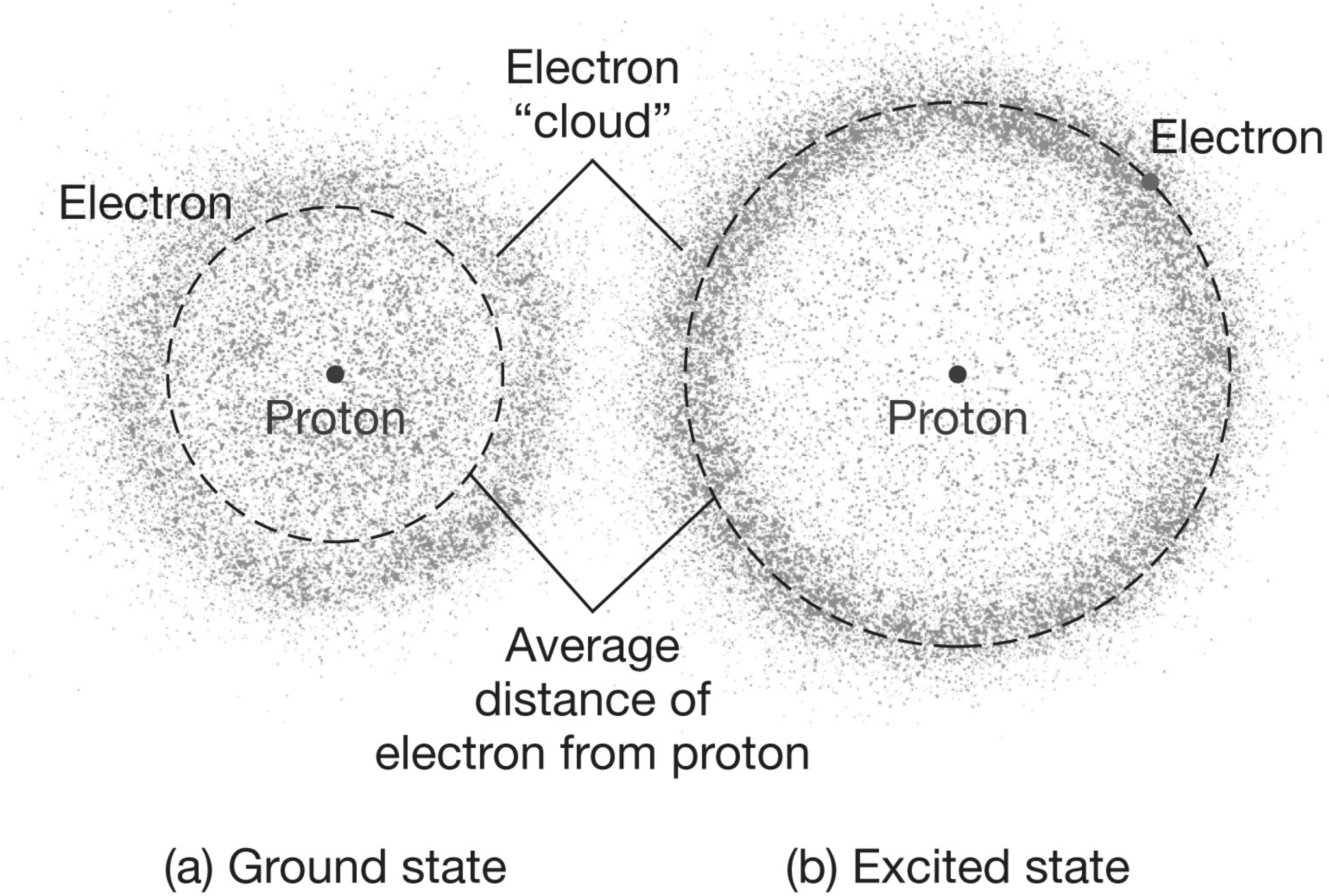


(a) Ground state (b) Excited state

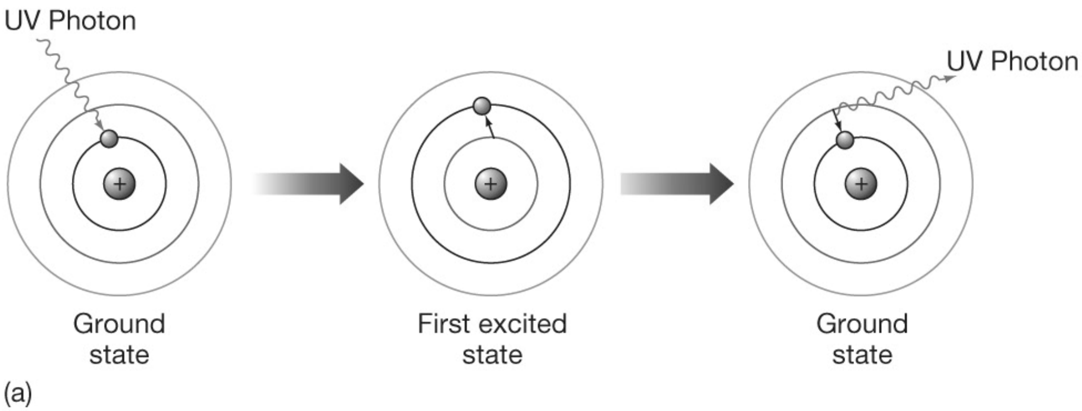
2.6 The Formation of Spectral Lines

Emission energies correspond to energy differences between allowed levels.

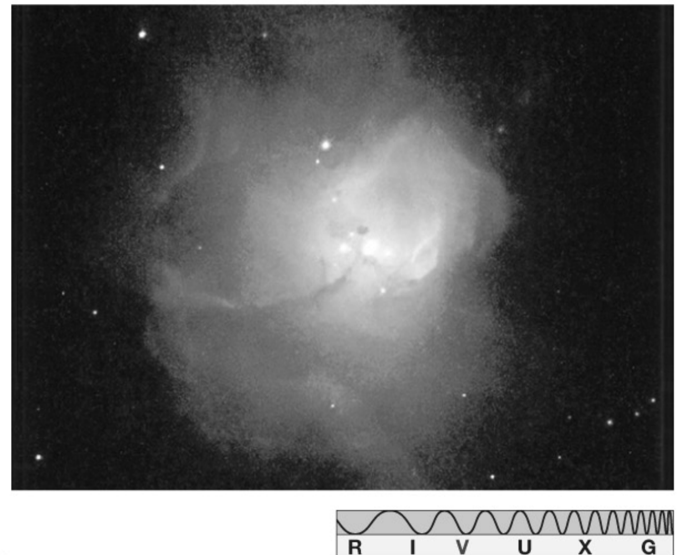
Modern model has electron "cloud" rather than orbit:



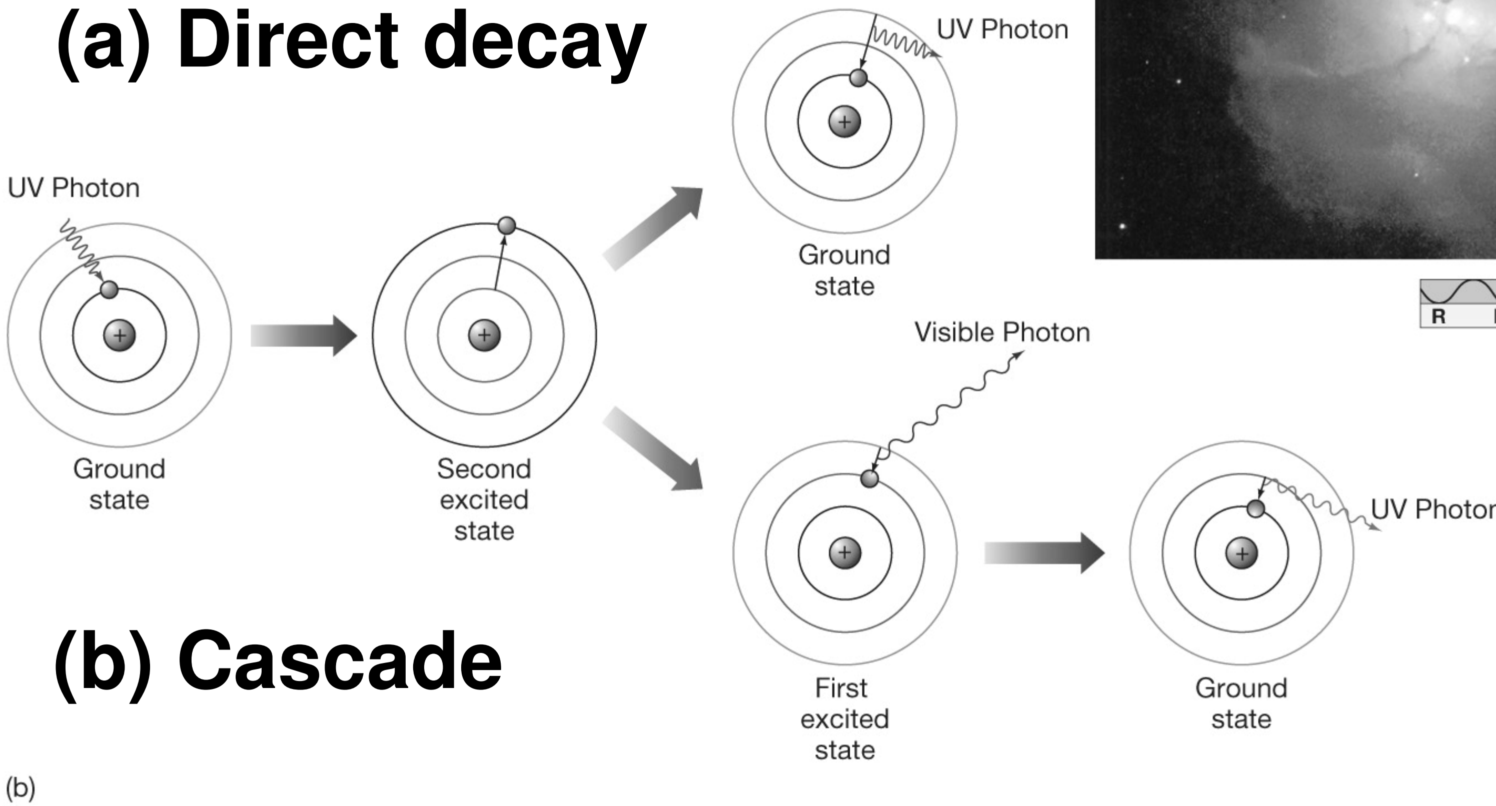
2.6 The Formation of Spectral Lines



Atomic excitation leads to emission:



(a) Direct decay



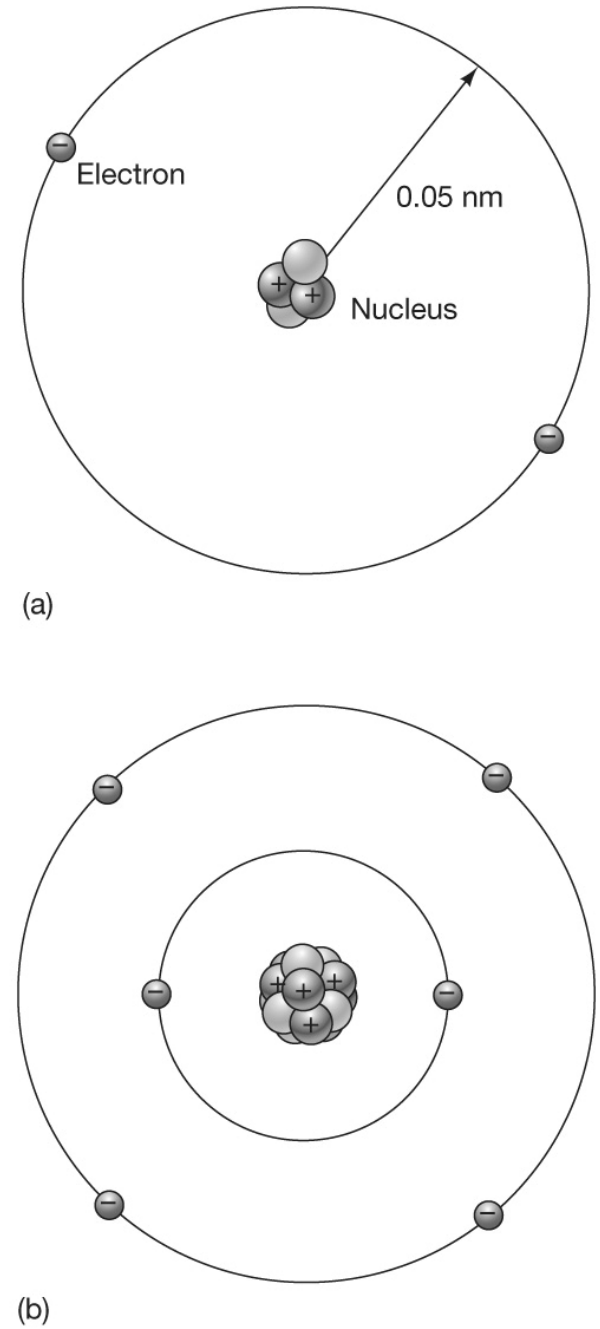
(b) Cascade

2.6 The Formation of Spectral Lines

Absorption spectrum: created when atoms absorb photons of right energy for excitation

Multielectron atoms: much more complicated spectra, many more possible states

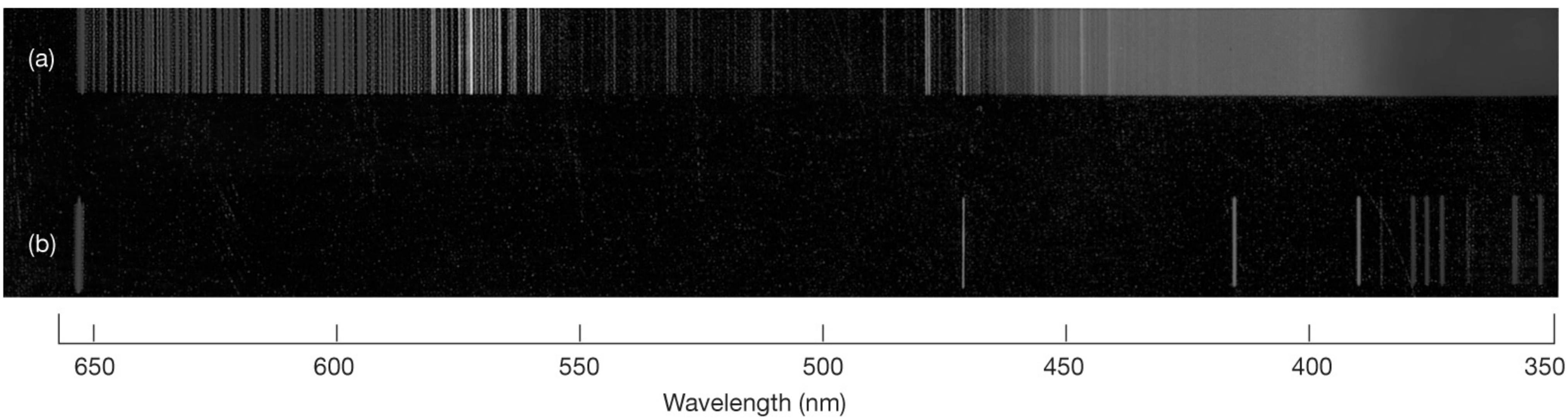
Ionization changes energy levels



2.6 The Formation of Spectral Lines

Molecular spectra are much more complex than atomic spectra, even for hydrogen:

(a) Molecular hydrogen **(b) Atomic hydrogen**



2.7 The Doppler Effect

If one is moving toward a source of radiation, the wavelengths seem shorter; if moving away, they seem longer

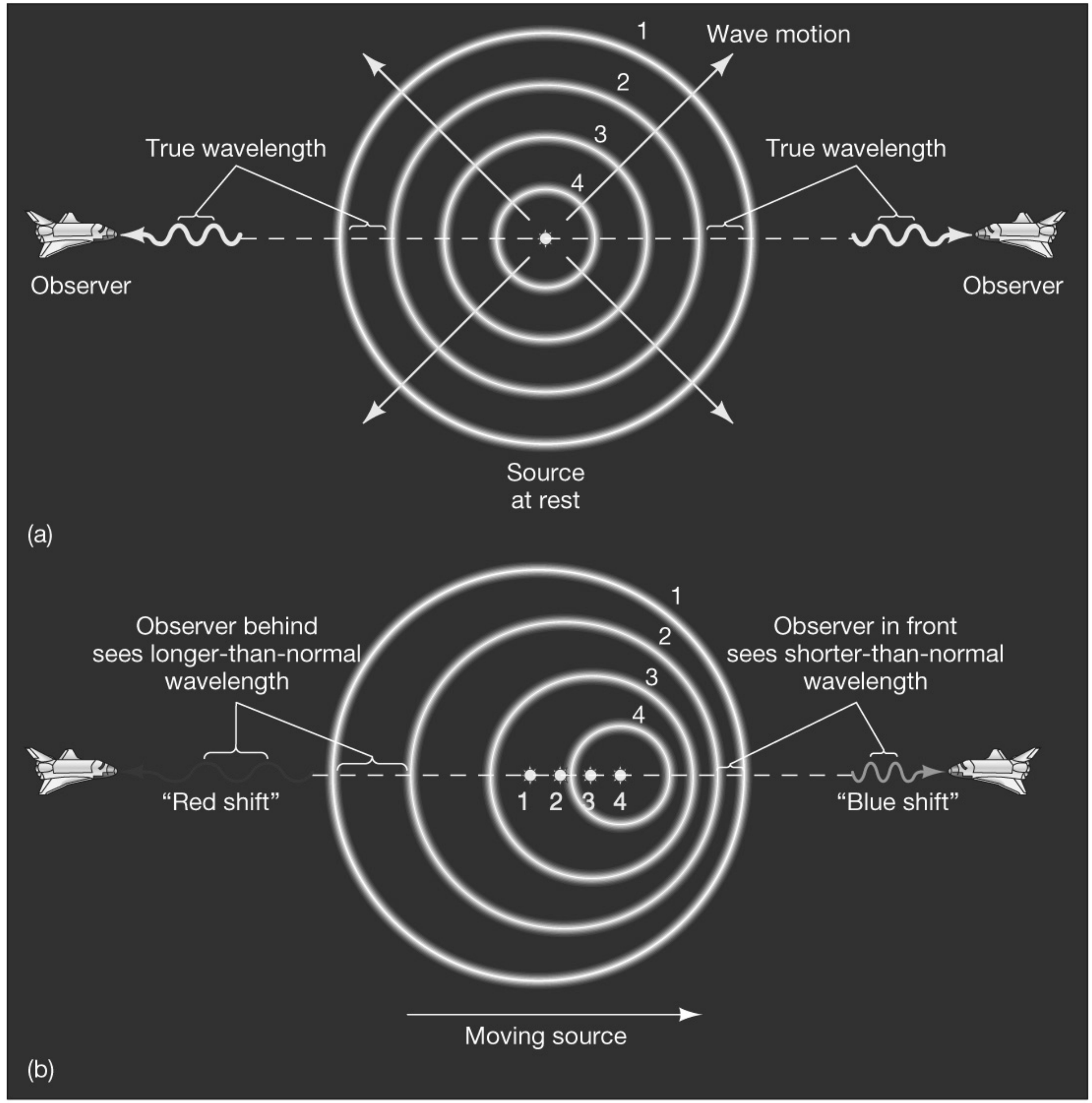
Relationship between frequency and speed:

$$\frac{\text{apparent wavelength}}{\text{true wavelength}} = \frac{\text{true frequency}}{\text{apparent frequency}}$$

$$= 1 + \frac{\text{recession velocity}}{\text{wave speed}}.$$

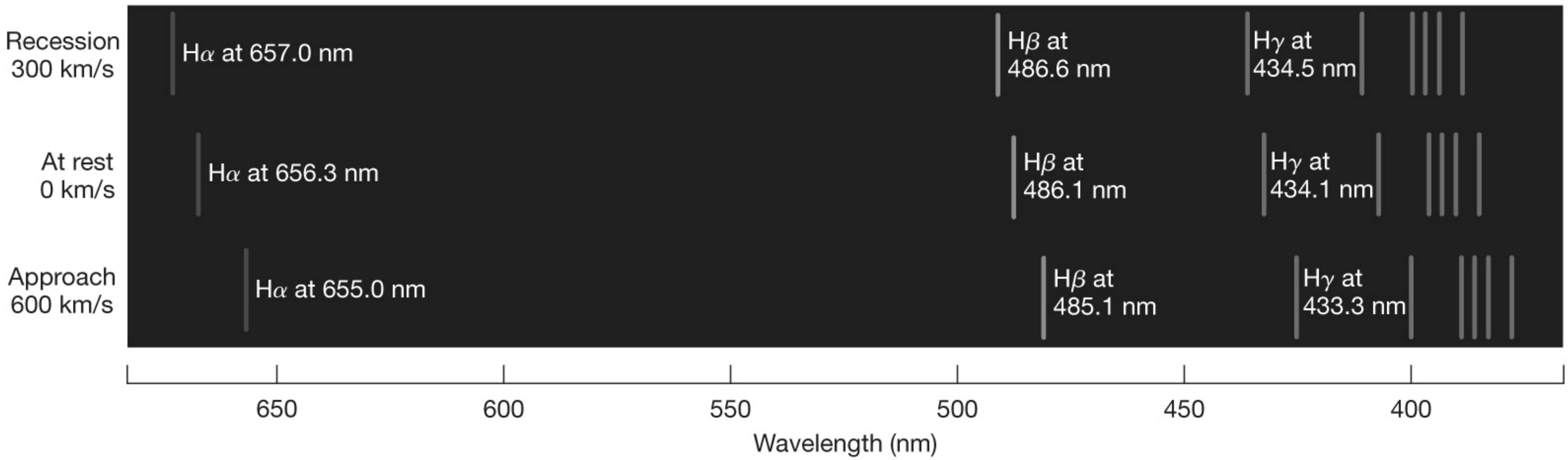
2.7 The Doppler Effect

Depends only on the relative motion of source and observer:



2.7 The Doppler Effect

The Doppler effect shifts an object's entire spectrum either towards the red or towards the blue:



Summary of Chapter 2

- Wave: period, wavelength, amplitude
- Electromagnetic waves created by accelerating charges
- Visible spectrum is different wavelengths of light
- Entire electromagnetic spectrum:
- radio waves, infrared, visible light, ultraviolet, X-rays, gamma rays
- Can tell the temperature of an object by measuring its blackbody radiation

Summary of Chapter 2, cont.

- Spectroscope splits light beam into component frequencies
- Continuous spectrum is emitted by solid, liquid, and dense gas
- Hot gas has characteristic emission spectrum
- Continuous spectrum incident on cool, thin gas gives characteristic absorption spectrum

Summary of Chapter 2, cont.

- Spectra can be explained using atomic models, with electrons occupying specific orbitals
- Emission and absorption lines result from transitions between orbitals
- Doppler effect can change perceived frequency of radiation
- Doppler effect depends on relative speed of source and observer