



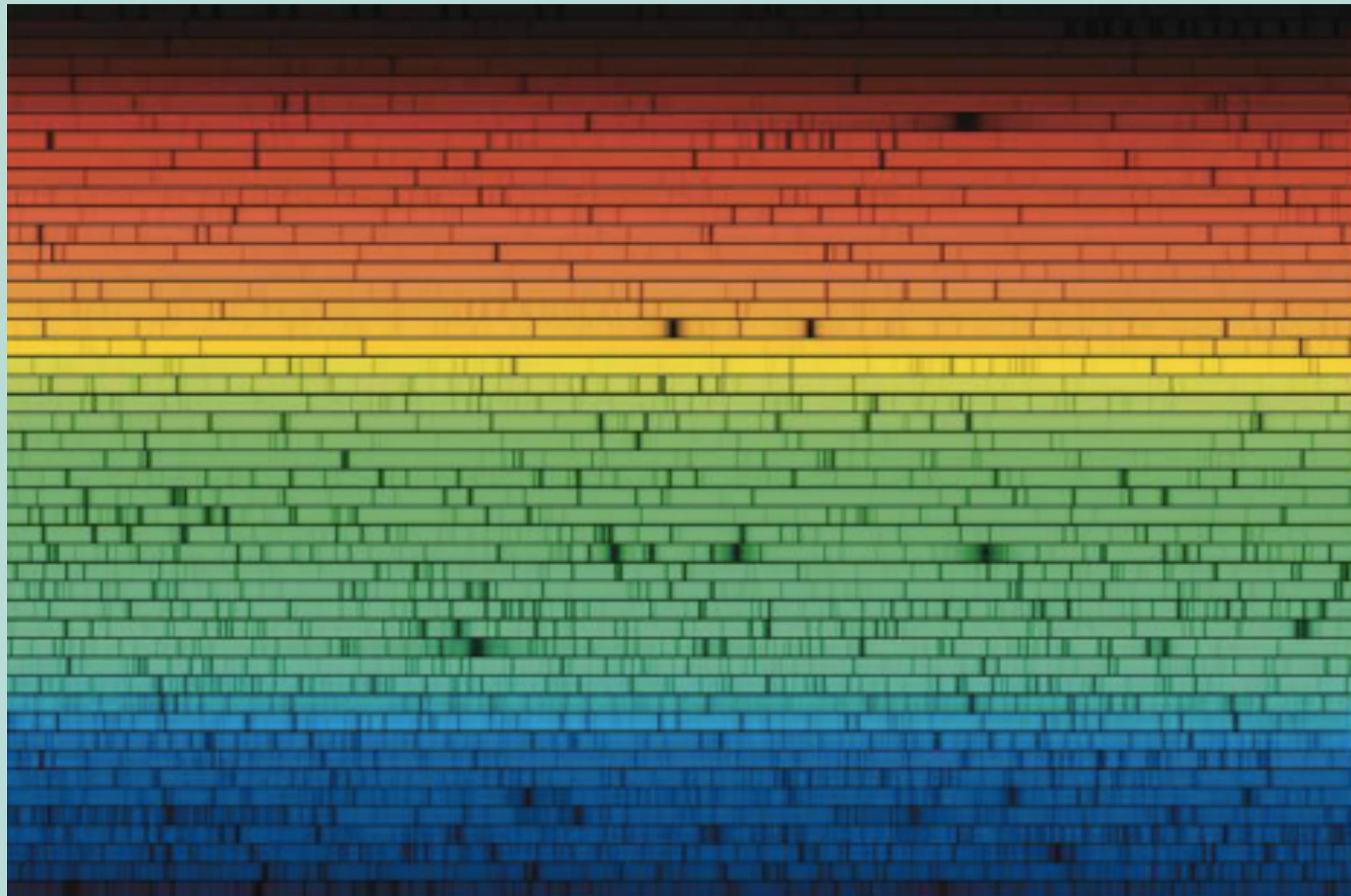
with your host:



**Lecture 4:  
Spectroscopy**

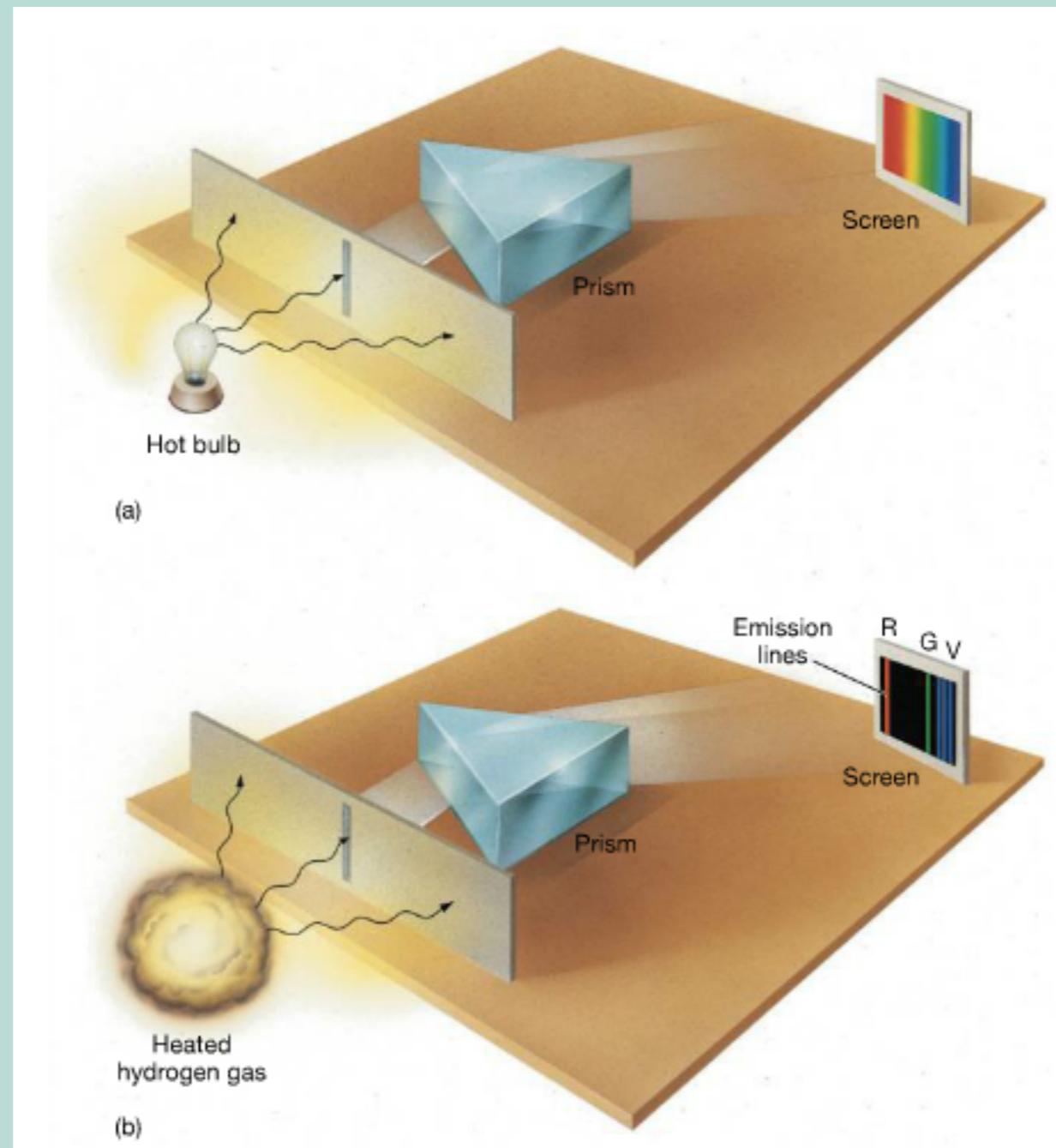
Coop

# Spectroscopy: Ch 4



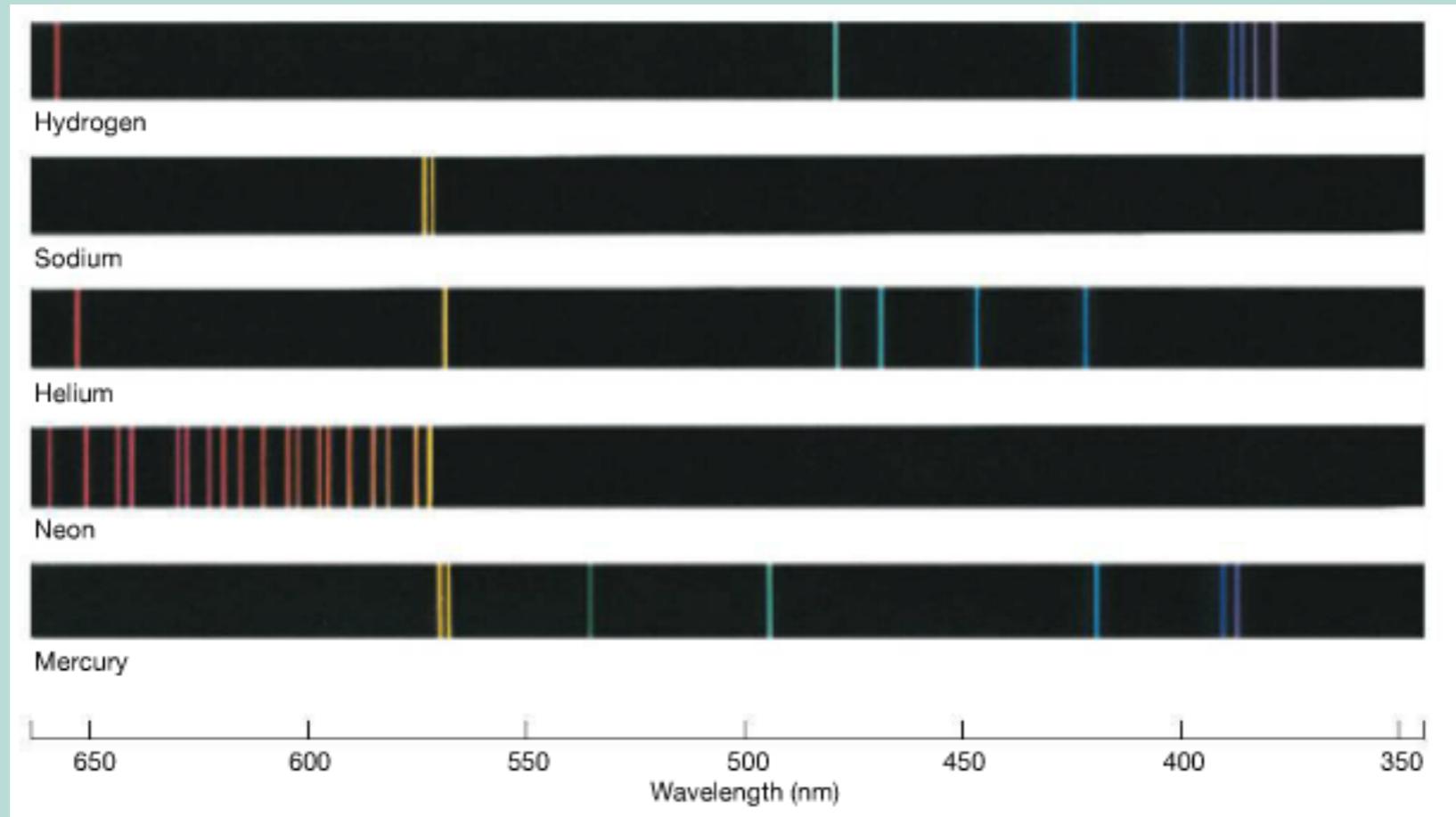
# Spectroscopy: Ch 4

## Black Body Radiation vs Hot Atomic Cloud



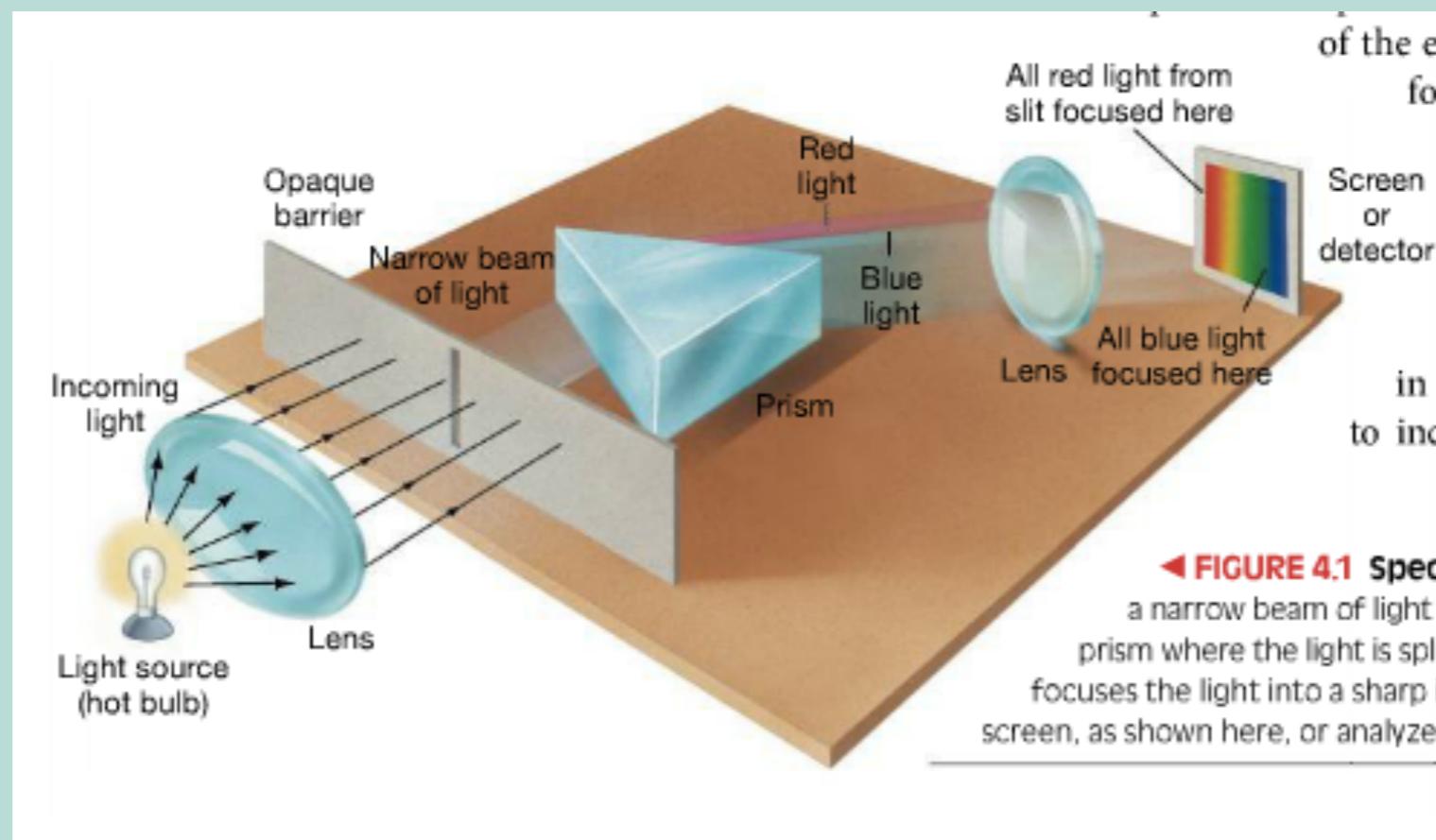
# Spectroscopy: Ch 4

## Atomic Fingerprints!



# Spectroscopy: Ch 4

## Measuring the emission spectrum



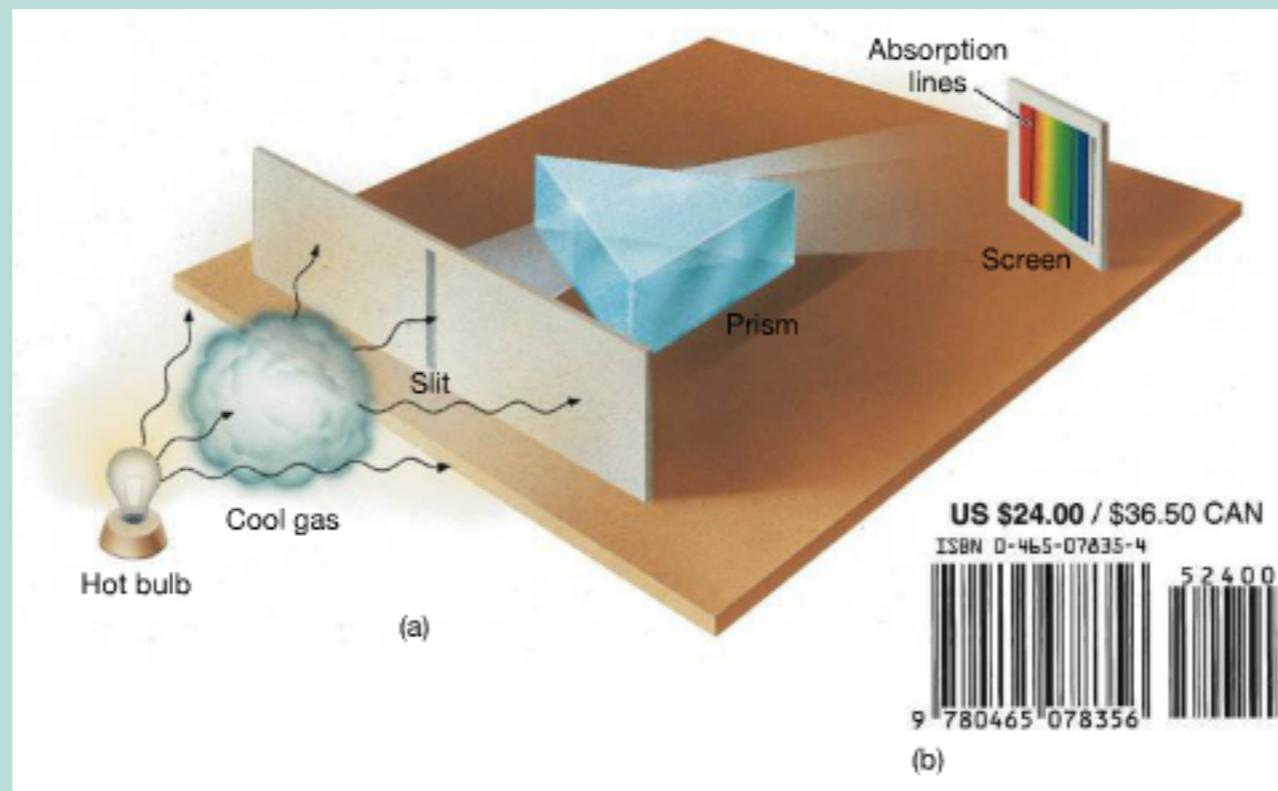
# Spectroscopy: Ch 4

## Old School Spectrograph



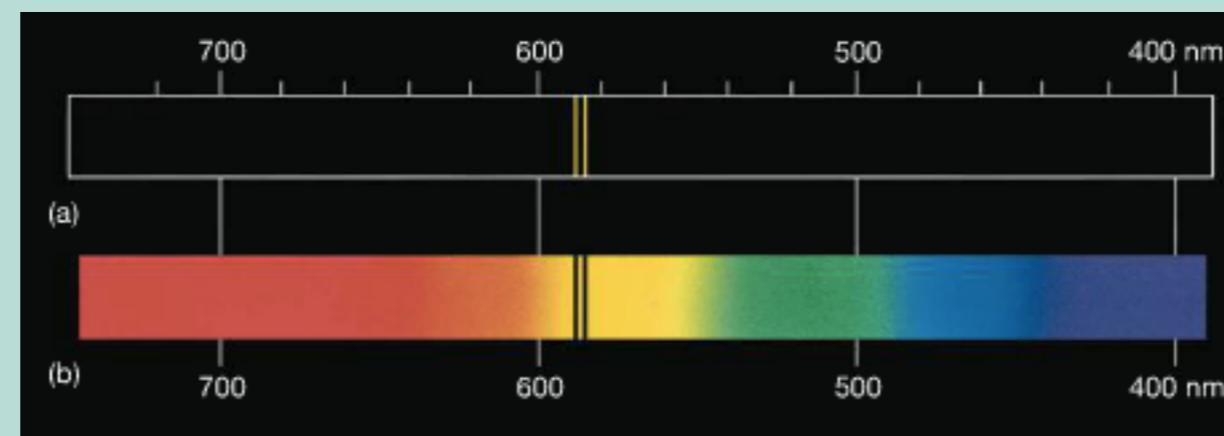
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## Absorption Spectrum



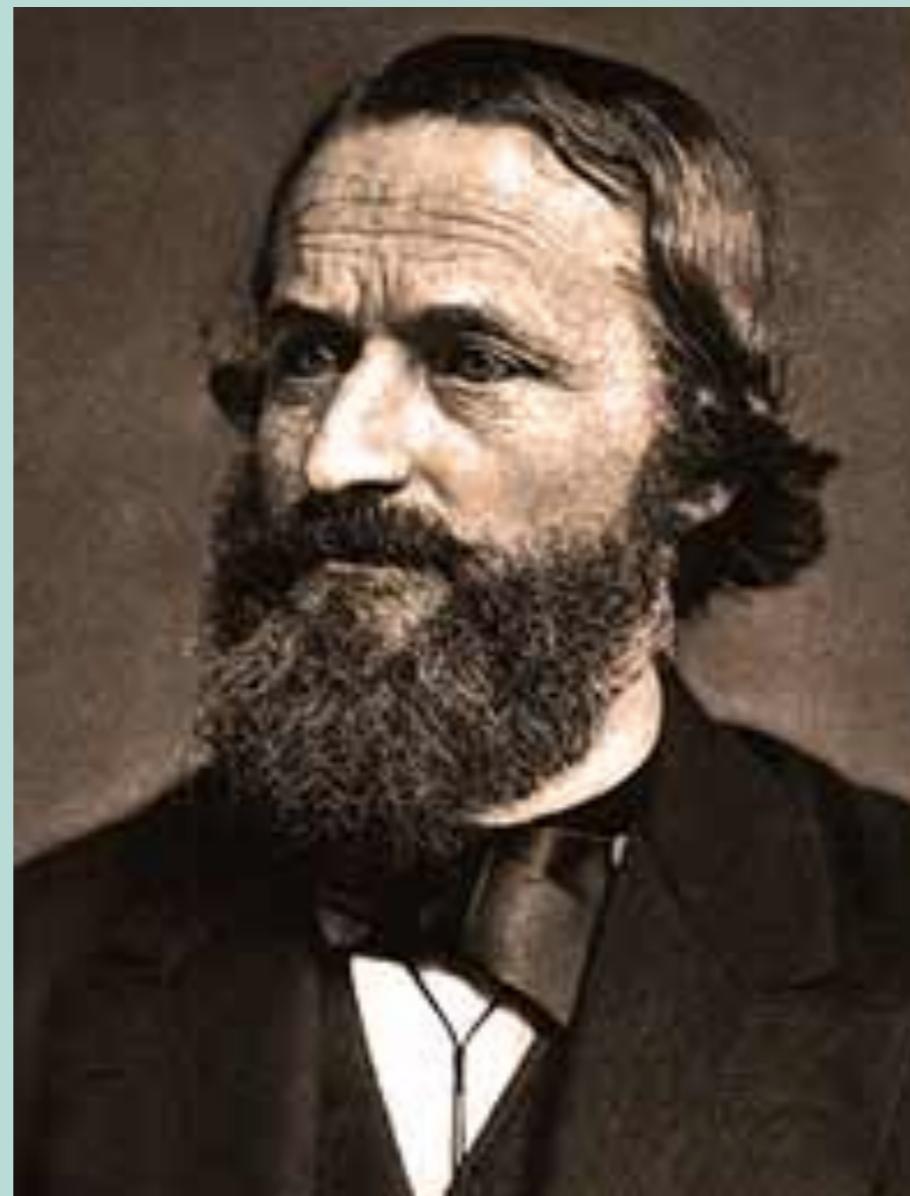
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## Absorption Emission Duality



# Spectroscopy: Ch 4

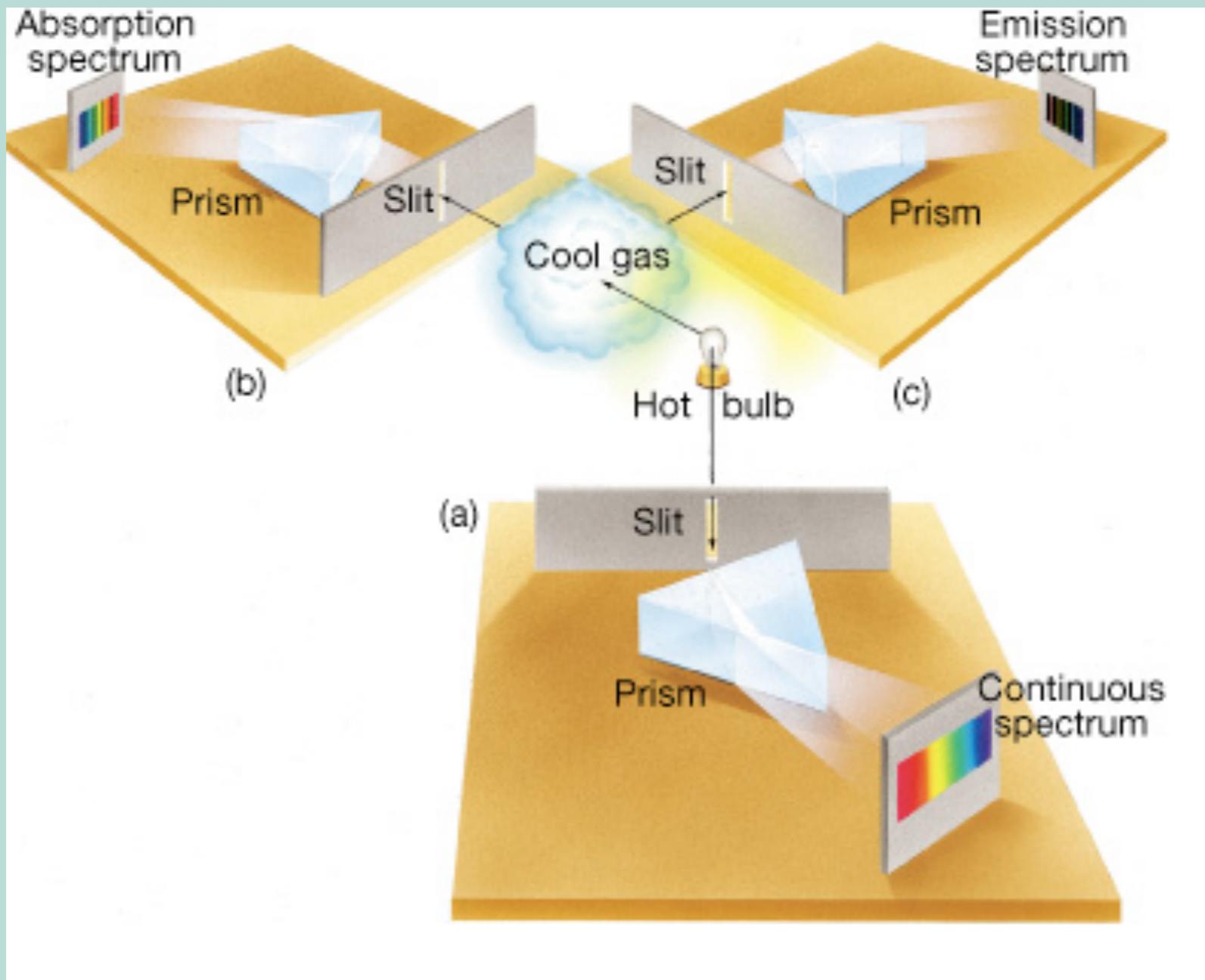
## Gustav Kirchhof



Born in Koenigsberg, Prussia  
1824, 1887

# Spectroscopy: Ch 4

## Kirchoff's Laws



# Spectroscopy: Ch 4

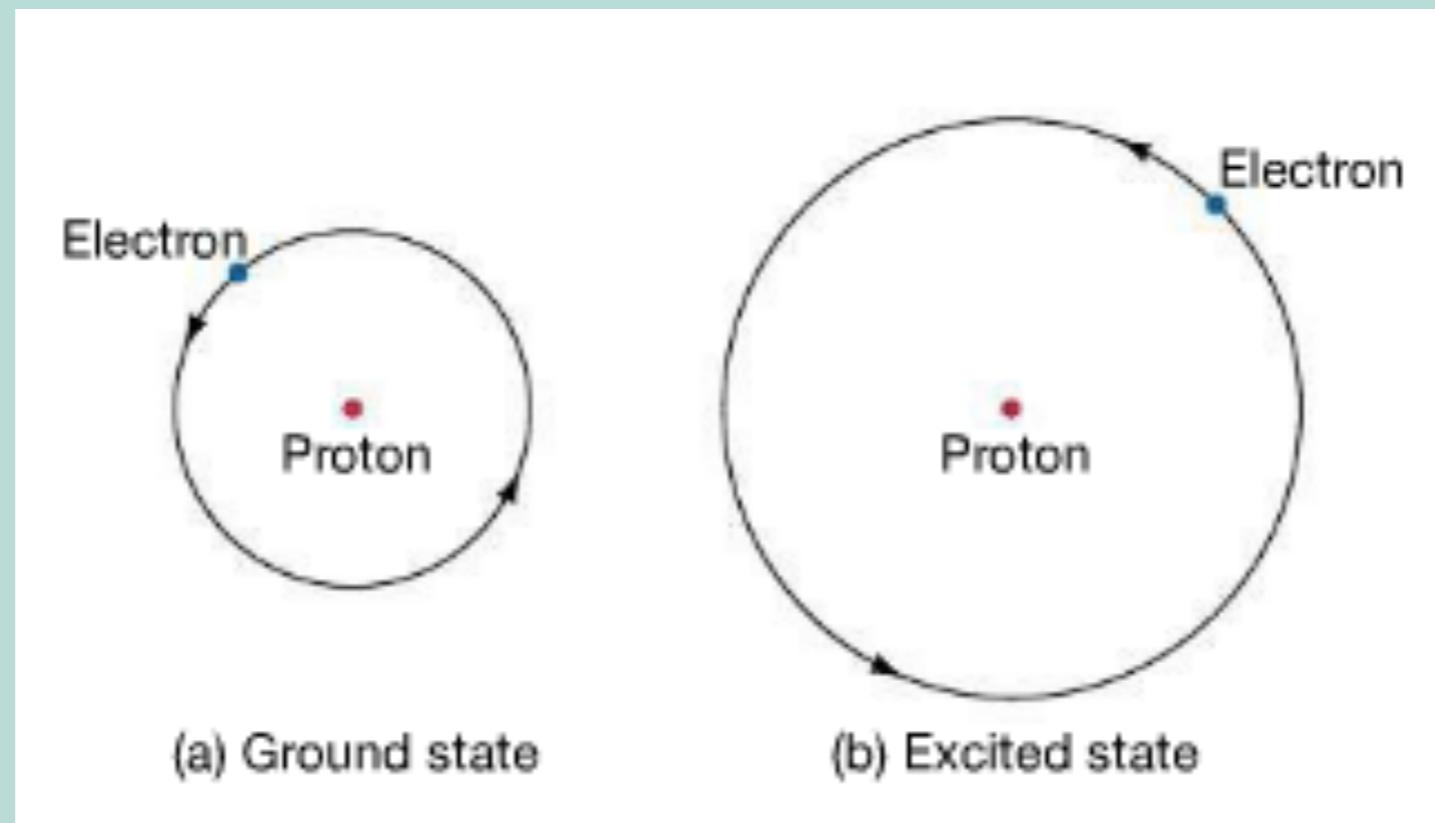
Niels Bohr



Born in Copenhagen, Denmark  
1885 - 1962

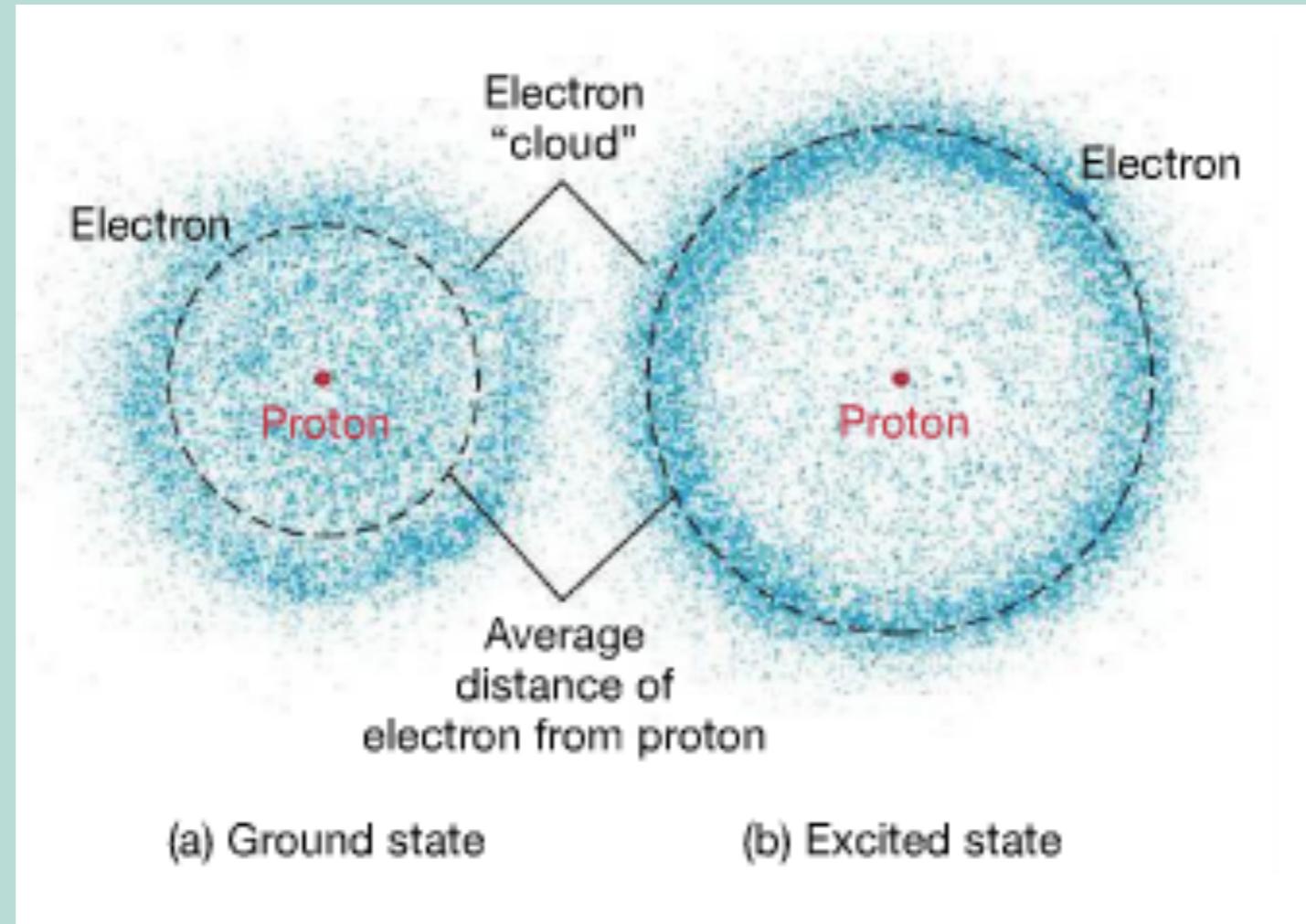
# Spectroscopy: Ch 4

## Simplified Model of the Atom



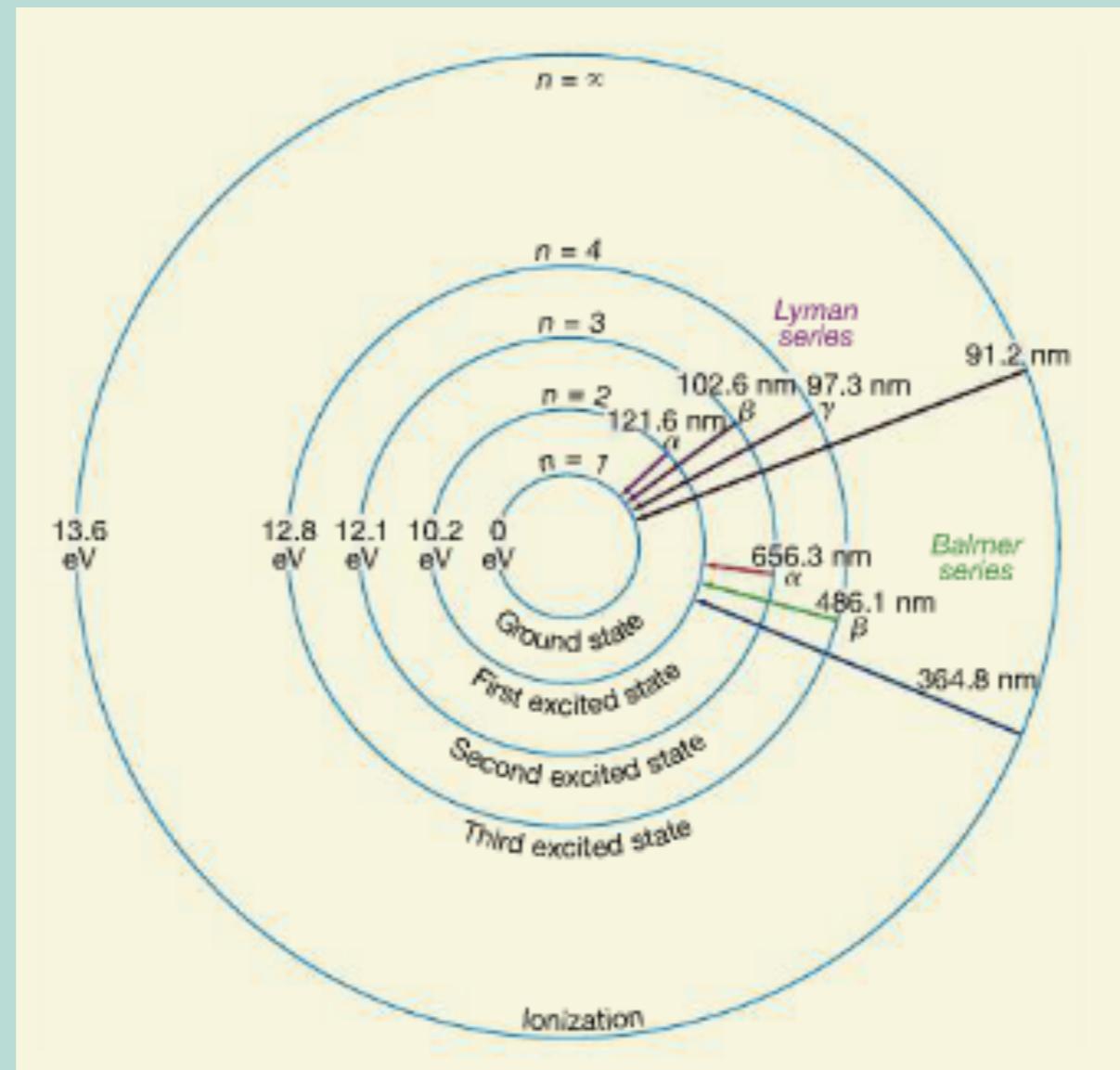
# Spectroscopy: Ch 4

## More Realistic Model of the Atom



# Spectroscopy: Ch 4

## Orbital Transitions



$$E_f - E_i = hf$$

Nobel Prize (1922)

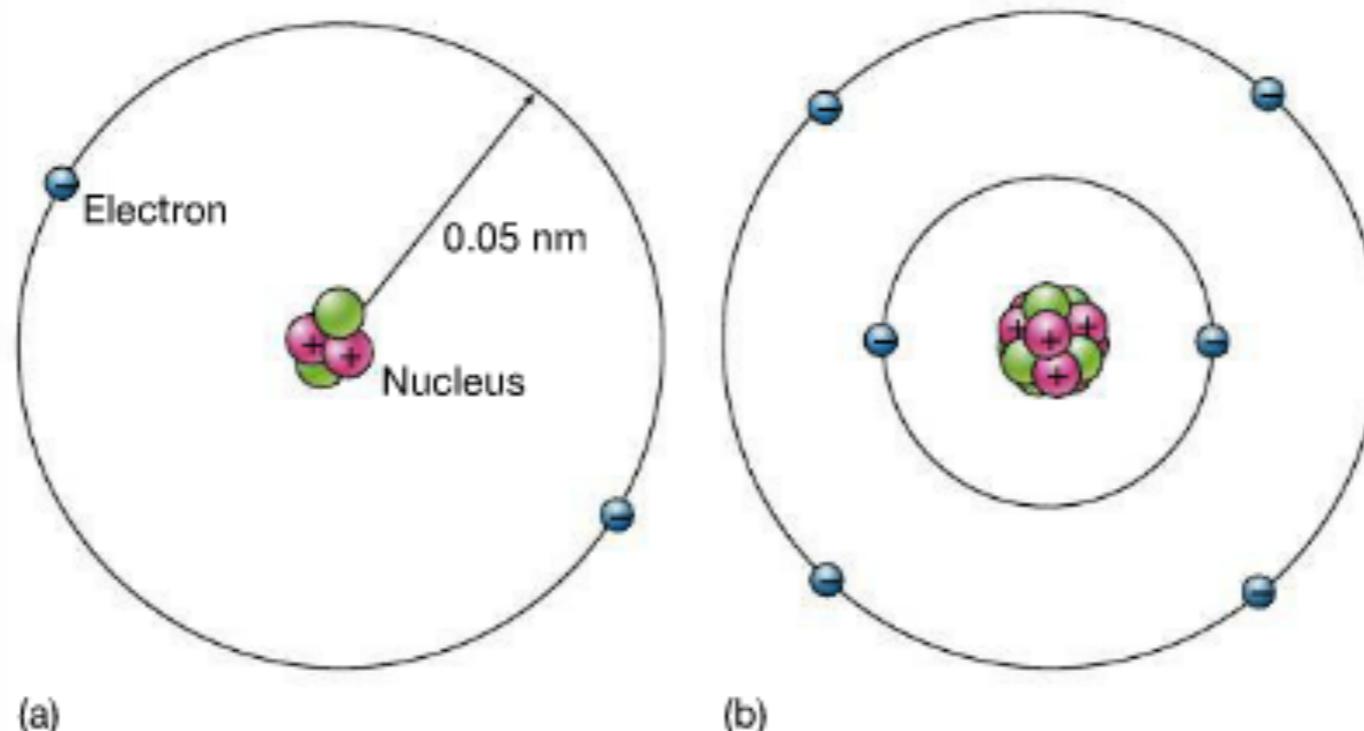
# Spectroscopy: Ch 4



DISCUSSION

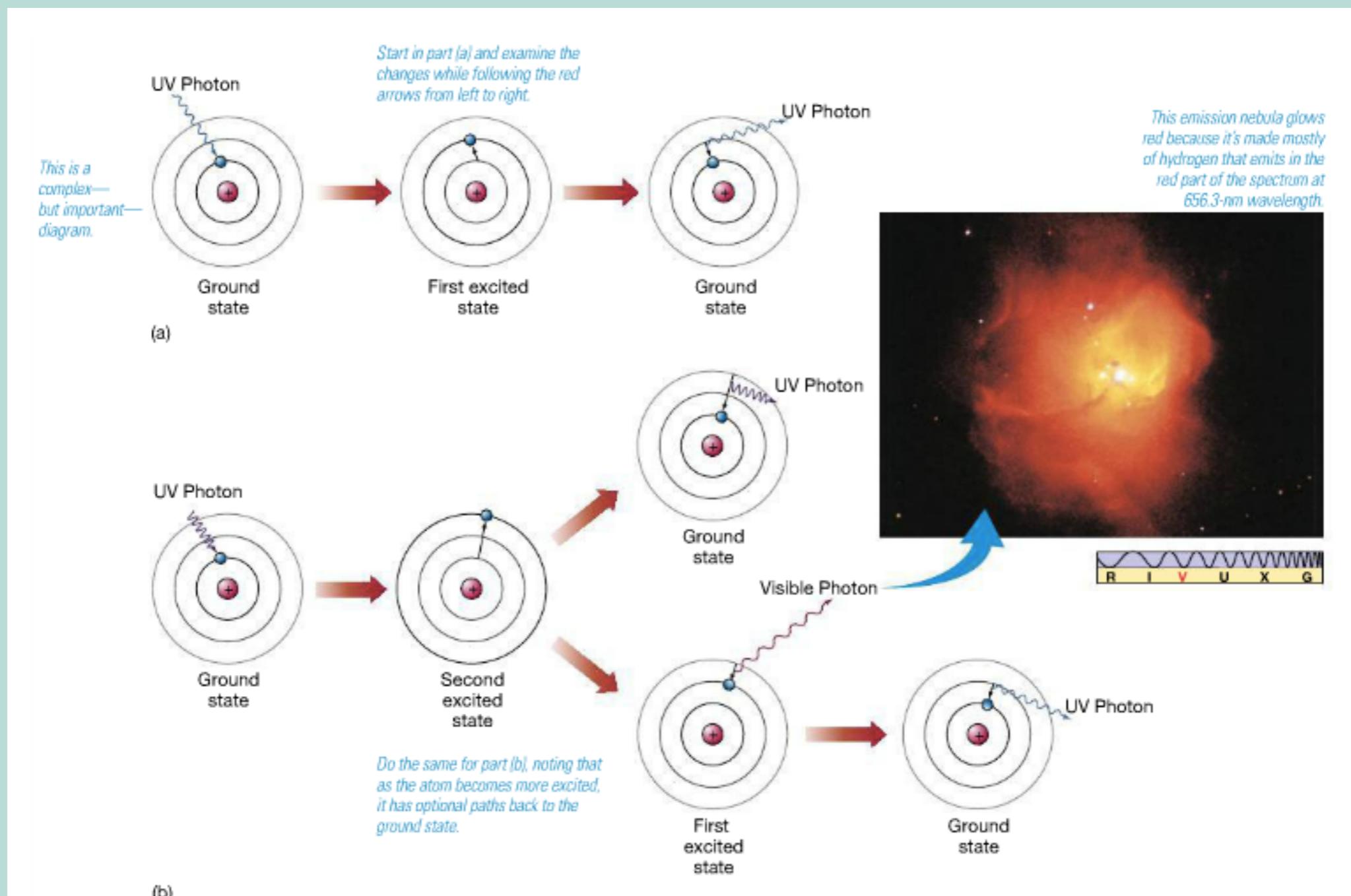
## More Complicated Nuclei

*Remember, the clean orbitals shown here and in other atomic diagrams are really more like fuzzy "clouds" of electron energy levels, as shown in Figure 4.9.*



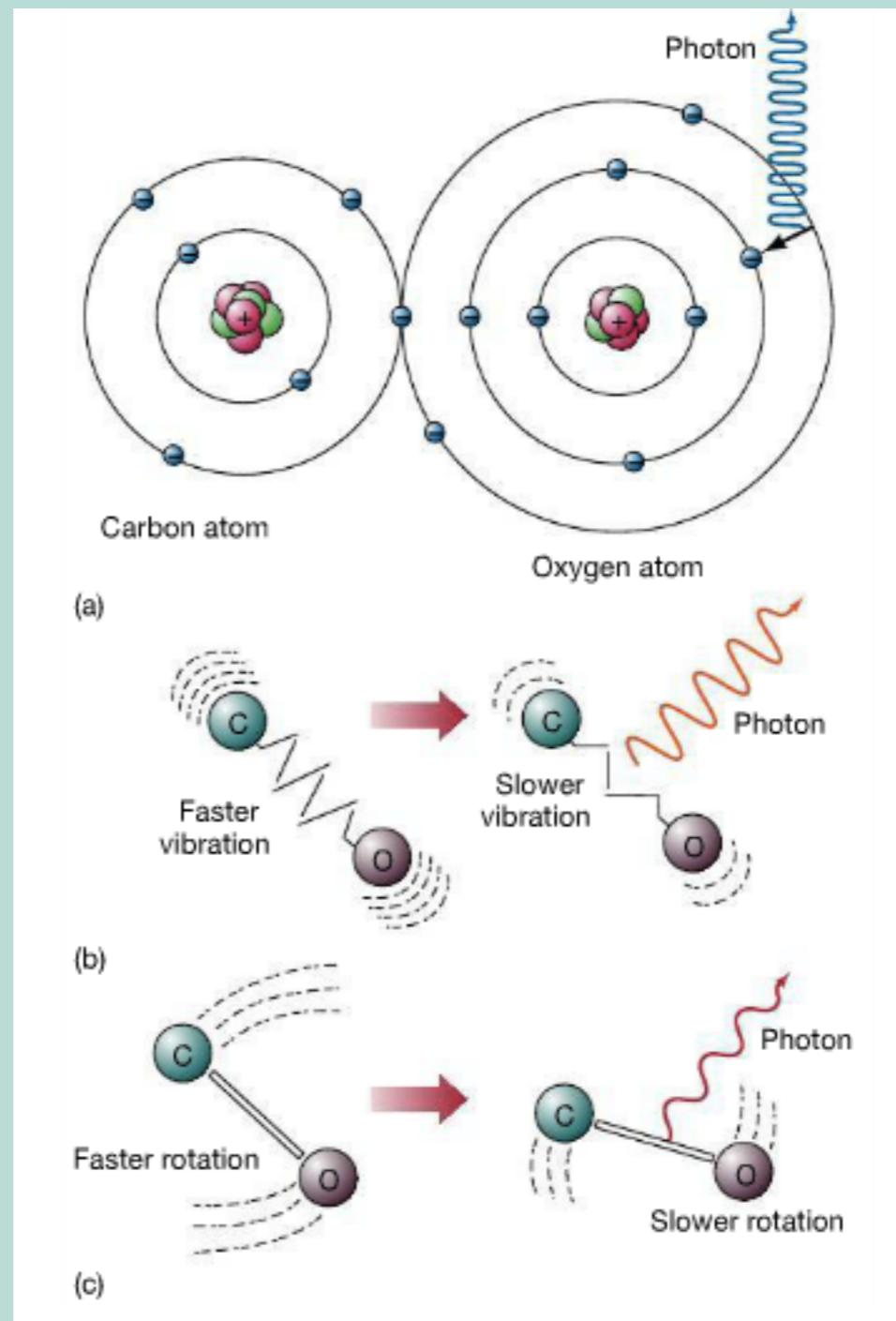
# Spectroscopy: Ch 4

## Cascading Photons



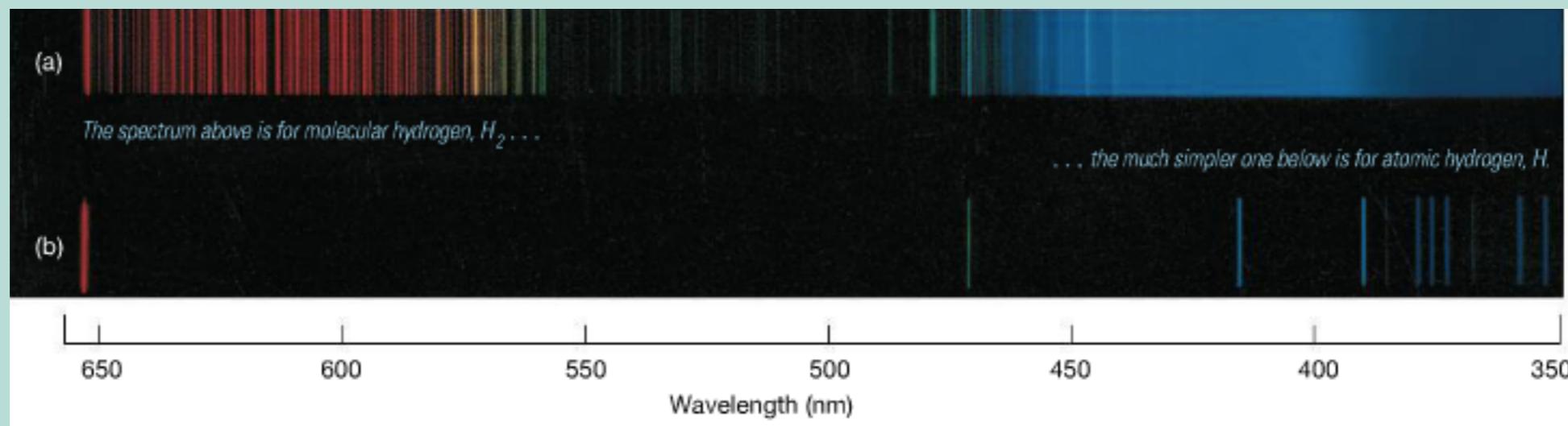
# Spectroscopy: Ch 4

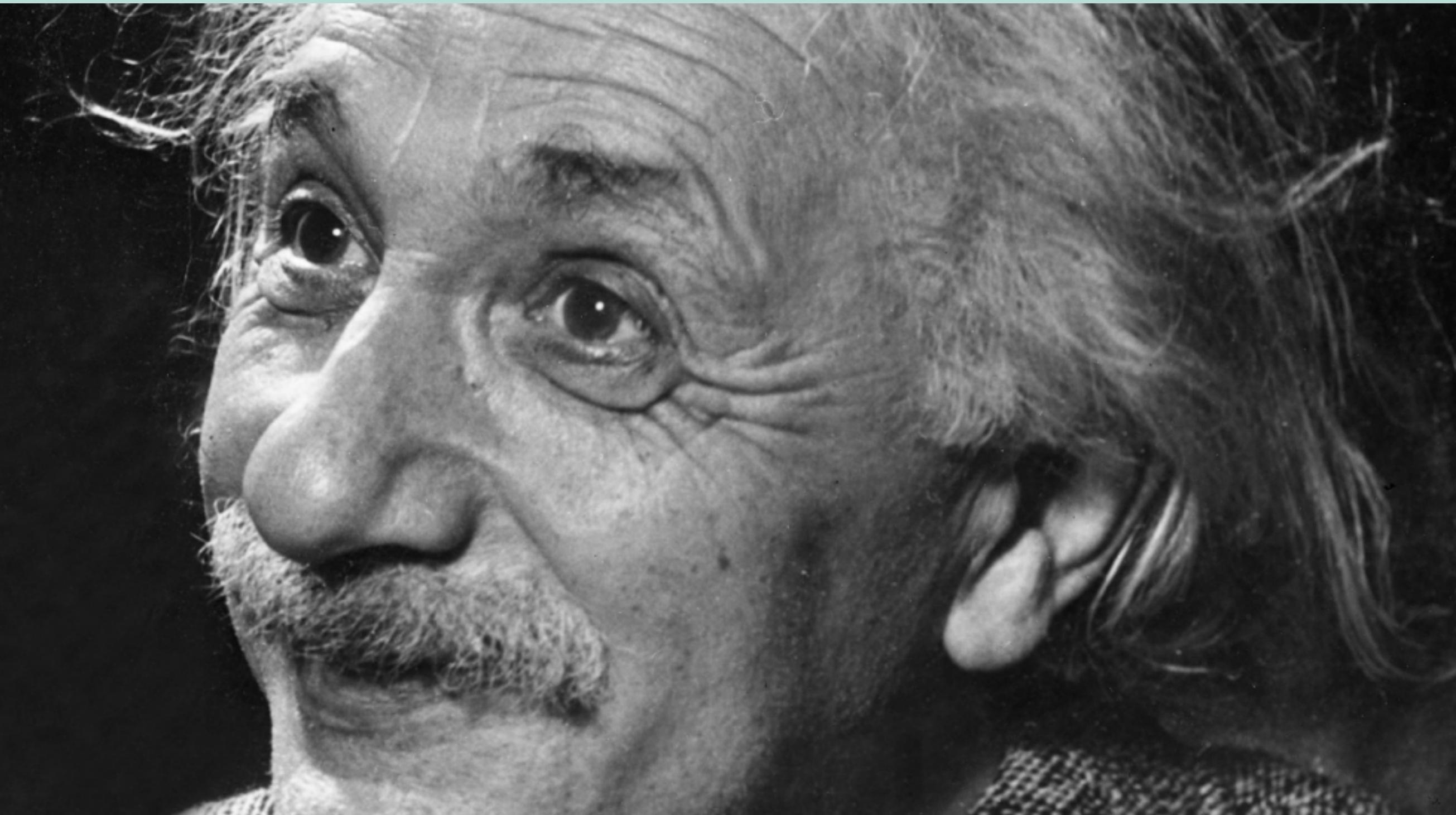
## Molecular Spectra Electric vs Vibrational vs Rotational Energy



# Spectroscopy: Ch 4

Spectra get complicated for molecules...

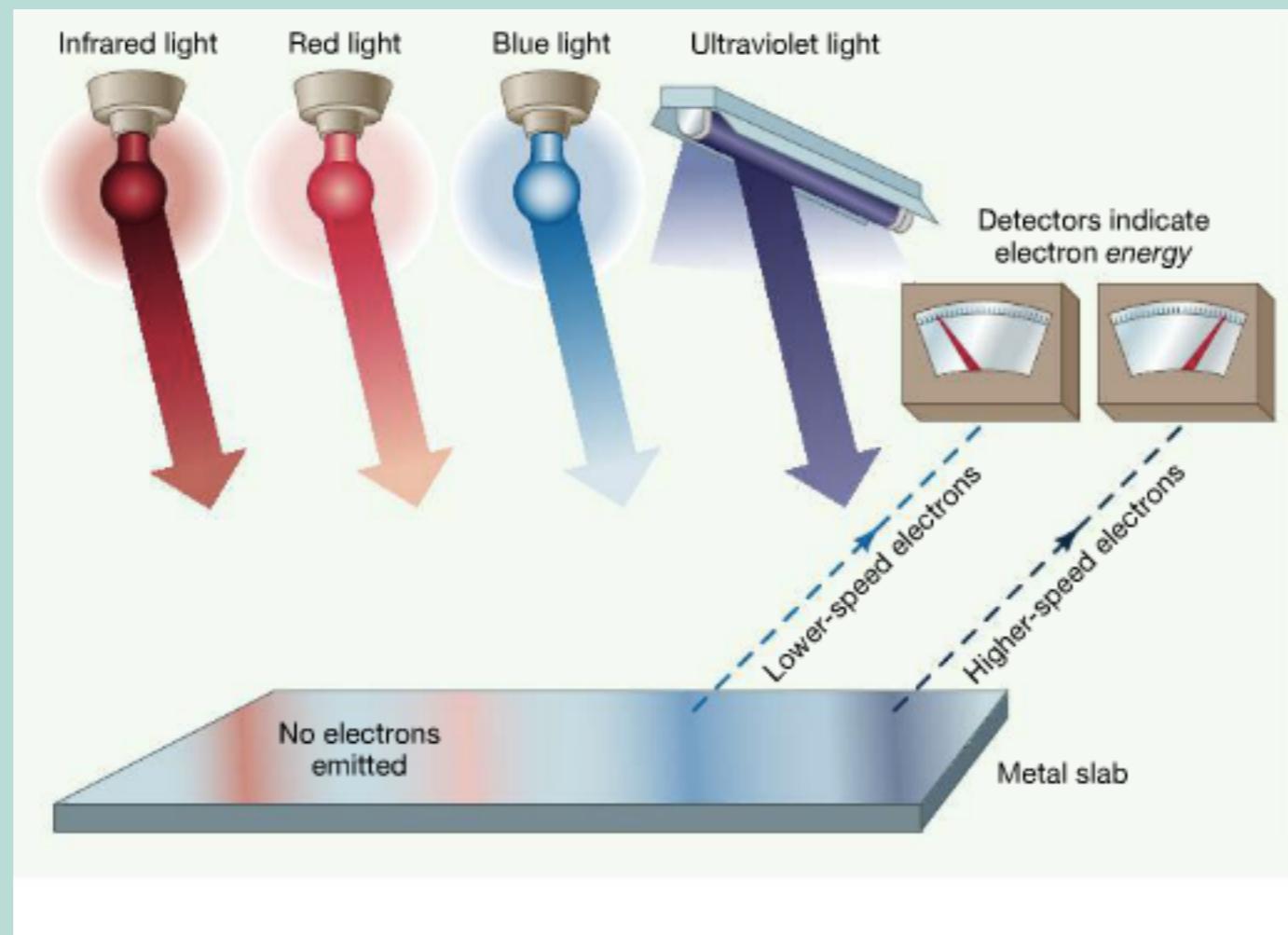




Born in Ulm, Württemberg (Germany)

π, 1879 - 1955

## The Photoelectric Effect



Nobel Prize (1921)

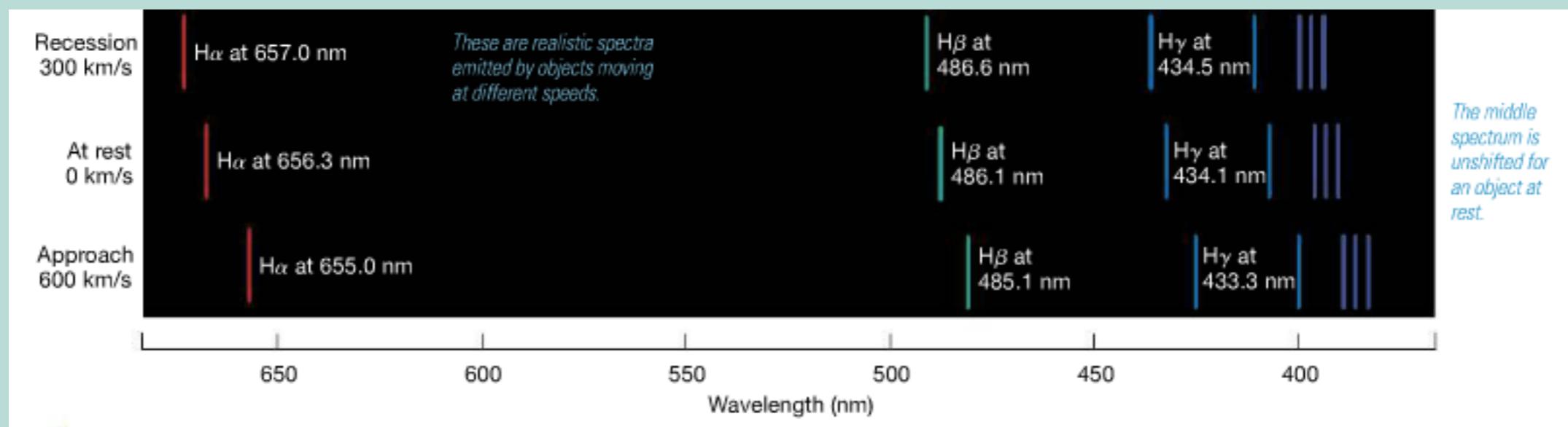
## Wave Particle Duality

Many people find it confusing that light can behave in two such different ways. To be truthful, modern physicists don't yet fully understand *why* nature displays this wave-particle duality. Nevertheless, there is irrefutable experimental evidence for both of these aspects of radiation. Environmental



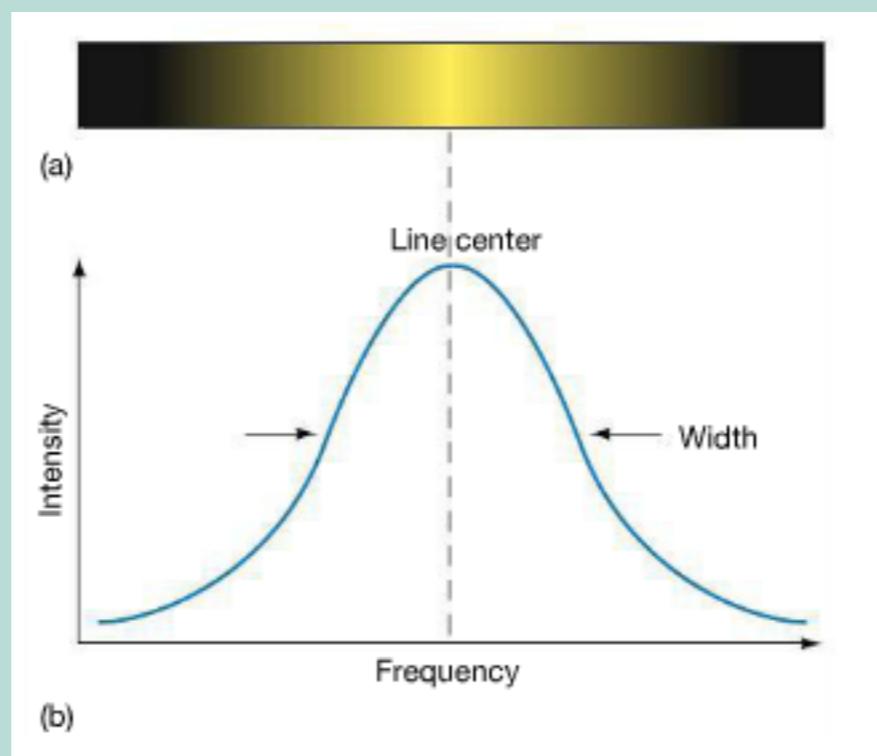
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## Doppler Effect (revisited)



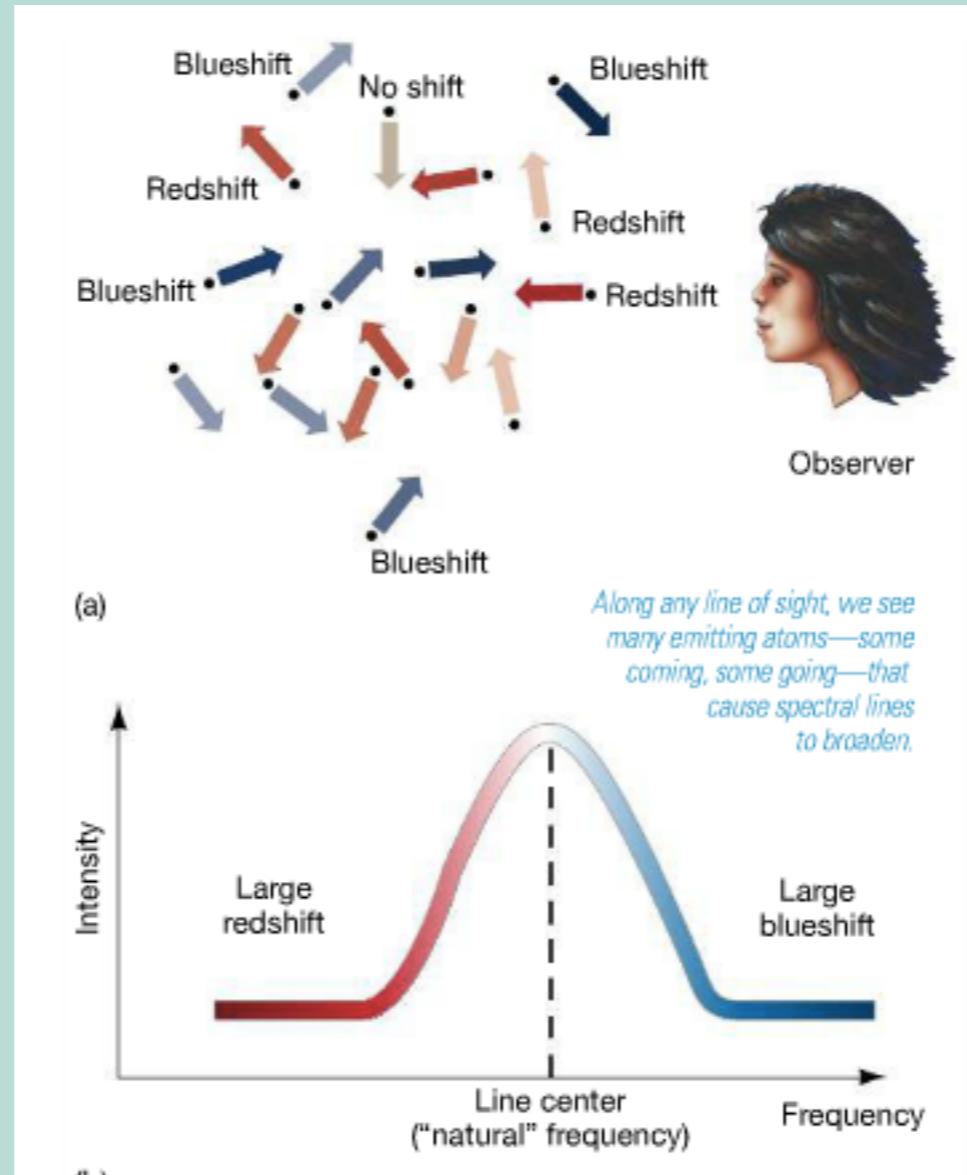
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## Line Broadening



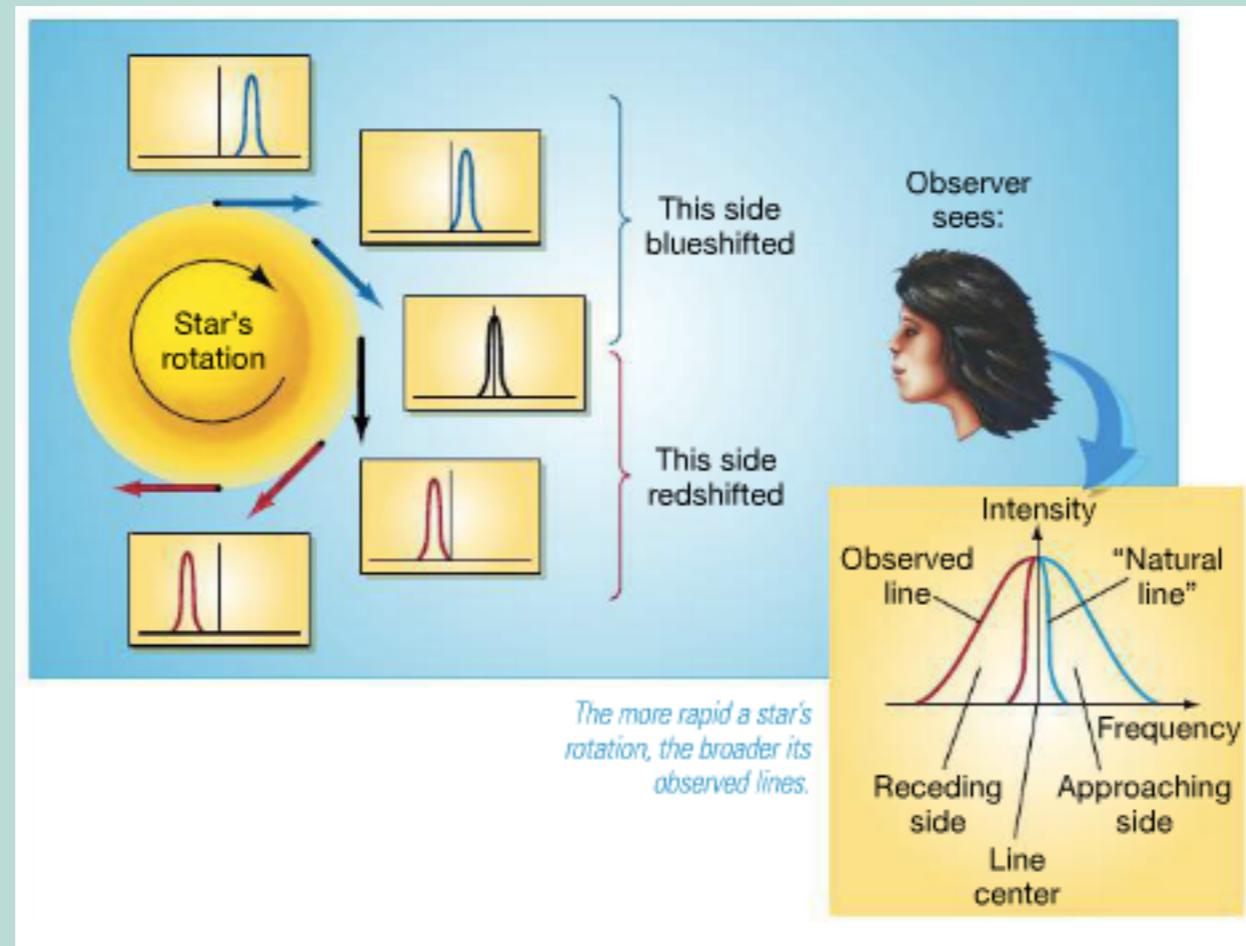
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## Velocity Dispersion



# Spectroscopy: Ch 4

## Rotational Velocity Measurements



# Spectroscopy: Ch 4

Observed Spectral Characteristic	Information Provided
Peak frequency or wavelength (continuous spectra only)	Temperature (Wien's law)
Lines present	Composition, temperature
Line intensities	Composition, temperature
Line width	Temperature, turbulence, rotation speed, density, magnetic field
Doppler shift	Line-of-sight velocity

# Spectroscopy: Ch 4

## 1927 Slovay Conference

