Light is the only information we get from most astronomical objects. To understand these objects, we need to understand the physics of light and how it is produced.
First result: light is a wave (electromagnetic wave)

Wave characterized by wavelength, amplitude

DEMO
Amazing fact of nature: wide range of wavelengths of electromagnetic waves

EM radiation includes gamma rays, x-rays, ultraviolet, light, infrared, microwave, radio
Concept from physics crucial for astronomy: the spectrum of light

Will do in lab this week (or soon); DEMO
Spectra (plural of spectrum)

The solar spectrum

- A fundamental measurement to extract more information from starlight
- Spread out light according to wavelength
The Solar Spectrum as an astronomer would study it

Fig. 3-1  The spectral distribution of solar irradiance measured above the Earth’s atmosphere, in units of mW/sq.meter/nanometer. Kindly provided by G. Thuillier (see G. Thuillier et al., “Sun Irradiance Spectra” in “Solar Variability and Its Effect on Climate”, J. Pap et al., Eds., AGU Monograph Series (2003).
What do the spectra of the Sun and stars tell us about those objects?

See Figure 16.11 from book

The Physics of Spectrum Formation, Kirchoff’s Laws and Wien’s Law

- Hot opaque solid or liquid produces a continuous spectrum
- Hot, tenuous gas observed against dark background produces emission line spectrum
- Cold, tenuous gas observed against bright background produces absorption spectrum
Kirchoff’s Laws of Radiation

Source: A hot solid, liquid, or dense gas

Thin cloud of cool gas

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Kirchoff’s First Law + Wien’s Law

• Hot, opaque objects produce continuous spectrum
• The hotter the object, the bluer it is
• Wien’s Law $w_{\text{max}} = 2.9\times10^{-3}/T$
• The hotter an object, the brighter it is
• demo
Why does Wien’s Law look like that?

A physicist is bothered when he or she sees an equation like:

\[ w_{max} = \frac{2.90 \times 10^{-3}}{T} \text{ meters} \]

The form which emerges from fundamental equations of physics is:

\[ w_{max} = \frac{0.201hc}{k_B T} \]
Kirchoff’s Third Law: Absorption Spectra