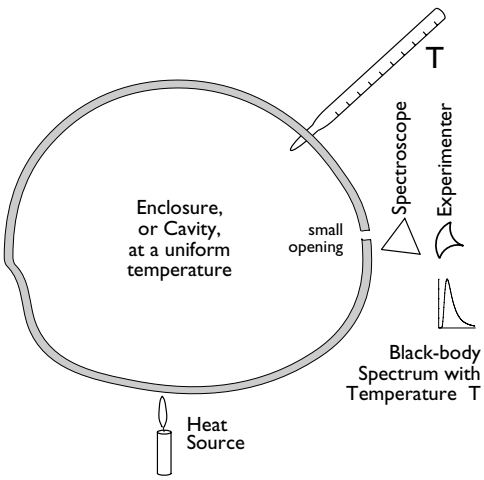


A "black body" is block of, say, firebrick, containing a cavity inside; the cavity is connected to the outside world with a small opening. There is some way of heating up the cavity — represented in this figure by the candle — and a way of measuring the temperature of the block. The idea of having a large block of material is that the cavity walls will be quite uniform in temperature.

If the cavity were completely sealed, then the radiation inside the cavity would come into *thermal equilibrium* with the walls of the cavity — i.e., if the radiation were hotter than the walls, the radiation would heat up the walls, and conversely, if the walls were hotter, they would put more radiation into the cavity.

A small opening allows some of the radiation to "leak out". Therefore the state of thermal equilibrium will not be perfect. However, if the hole is very small in comparison with the cavity, the deviation from thermal equilibrium is very small.

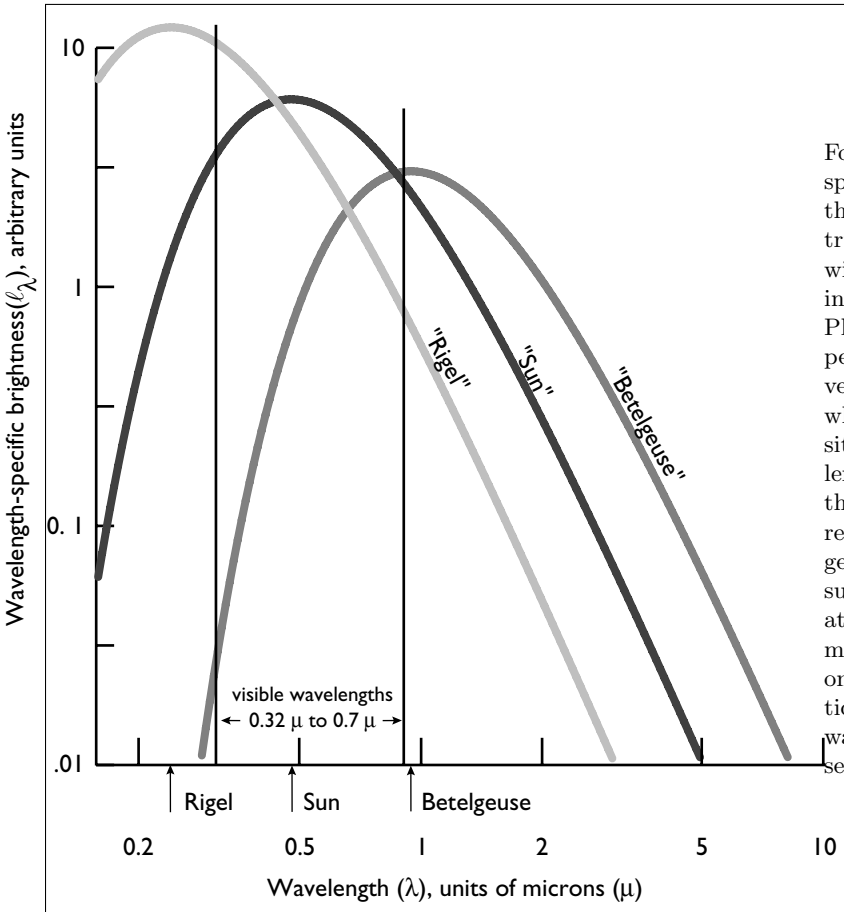
Figure 1: A black body

MOUNT HOLYOKE COLLEGE

Fall 2000 I-121, Unity of Science

QotW: The Colors of the Heavenly Bodies

1. Looking at figure 1 and `http://www.mtholyoke.edu/courses/tdennis/astro101/UnitySlides.htm`:
   - What is the significance of the iconography:
     - What is suggested by the odd shape container and small opening?
     - What does the candle underneath it represent?
     - Why is there a thermometer sticking through the wall?
     - What do the prism, eyeball and funny little iconic graph represent?
   - What does the formula Max Planck wrote down in 1900 (web page) have to do with it?
   - What does it have to do with the photoelectric effect?
2. Looking at figure 2
   - What is the connection between this figure and figure 1?
   - What is on the X-axis (what does the label mean)?
   - What is on the Y-axis?
   - What do the vertical lines at 0.32 μ and 0.7 μ represent?
   - What do T and K mean?
3. Explain why Betelgeuse is red, the sun is yellow, and Rigel is blue.
4. Define these color terms:
   - hue
   - intensity
   - saturation
5. Look at the same figure, recall what you know about color vision (particularly the terms in item 4), and explain why Betelgeuse is redder than Rigel is blue.
6. Thinking again about vision, explain why the colors of bright stars tend to be more noticeable than colors of faint stars.



For the hottest stars, the black-body spectrum peaks in the ultraviolet; throughout the visible part of the spectrum the intensity therefore decreases with wavelength. Such a star ("Rigel" in this illustration, calculated from Planck's formula for $T = 3000°\mathrm{K}$) appears blue to the human eye. Conversely, the coolest stars have spectra which peak in the infrared, the intensity of their light increases with wavelength throughout the visible part of the spectrum, and we perceive them as red in color. The curve labeled "Betelgeuse", calculated for $T = 3000°\mathrm{K}$, is such a star. For stars of intermediate temperatures, all wavelengths are more or less uniformly represented, and only relatively subtle colors are noticed. The curve labeled "Sun", which was calculated for $T = 6000°\mathrm{K}$, represents this case.

Figure 2: Star Colors