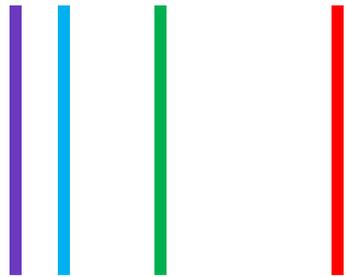
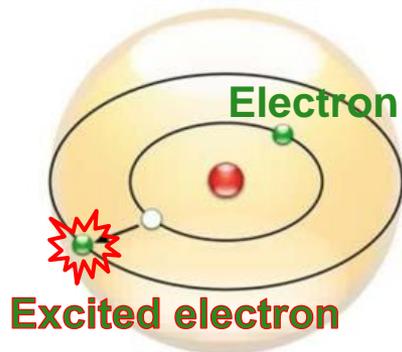


Gases

atoms far apart

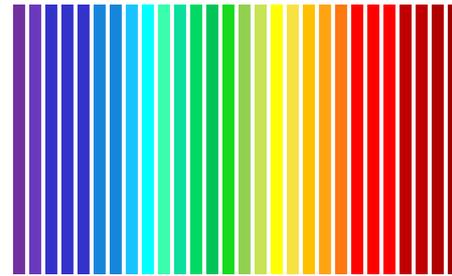


limited set of distinct colors

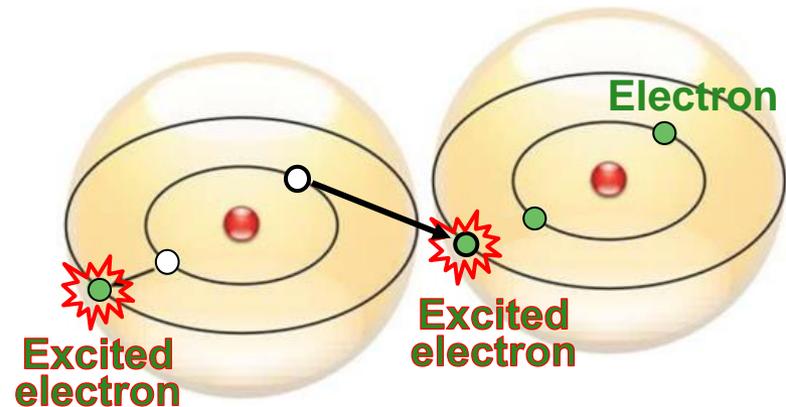


Solids/Liquids

atoms close to each other



much greater number of possible colors

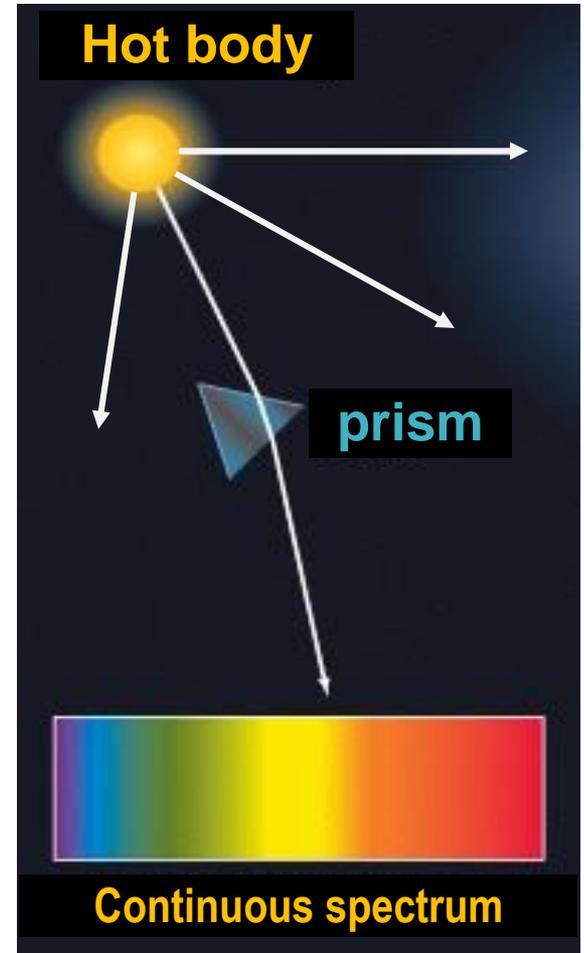


VS

Thermal Radiation

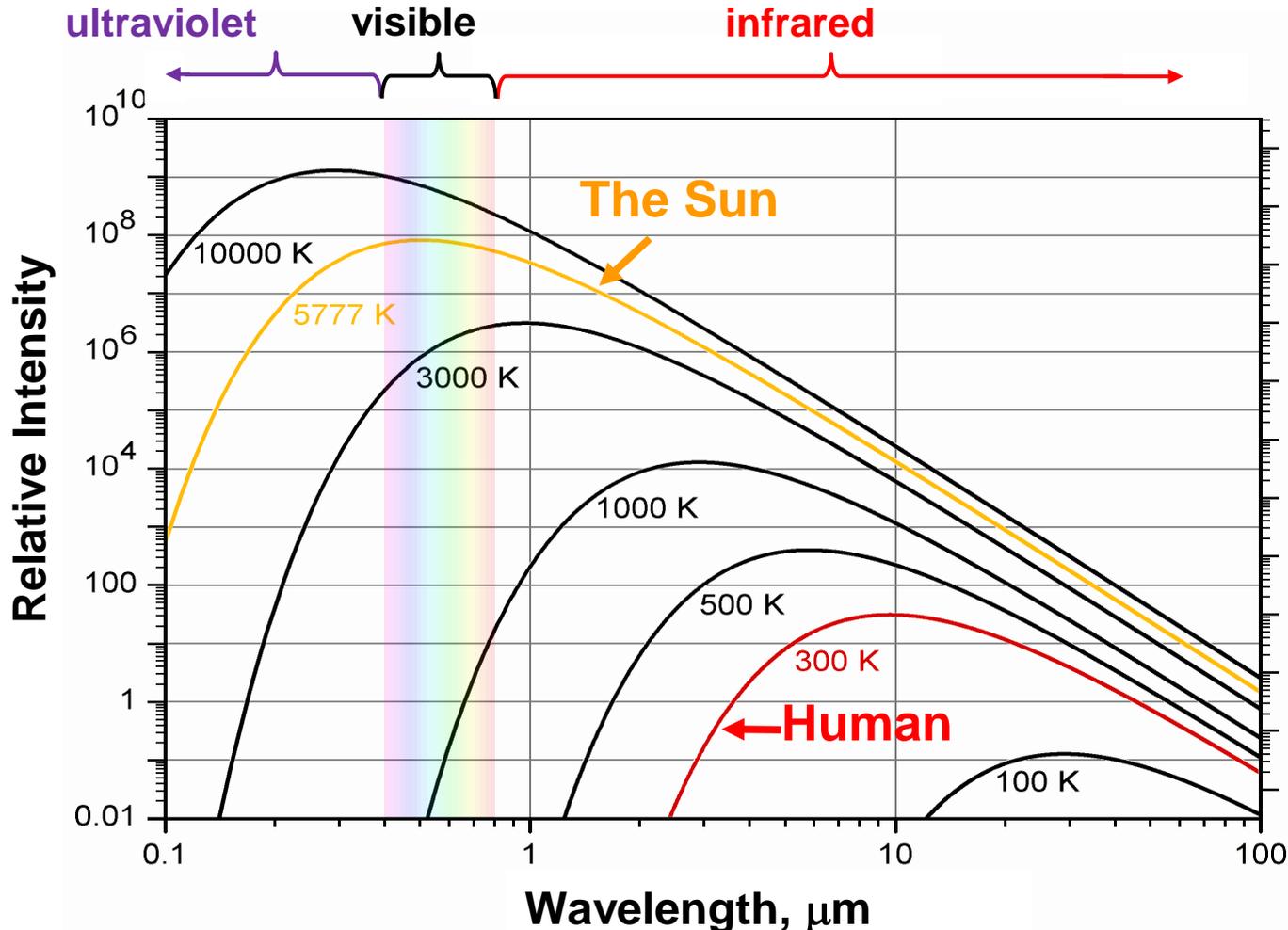
All normal matter emits electromagnetic radiation when it has a temperature above absolute zero.

- This radiation represents a conversion of a body's thermal (heat) energy into electromagnetic energy, and is therefore called **thermal radiation**.
- When the atoms are in a condensed state (solid or liquid matter), the “hot” electrons can make transitions not only within the energy levels of their own atom, but also between the levels of neighboring atoms (that can be of same or different kind).
- This results in a **much larger number of possible transitions** with corresponding frequencies of radiant energy, producing a **continuous color spectrum**.



Thermal Radiation Spectrum

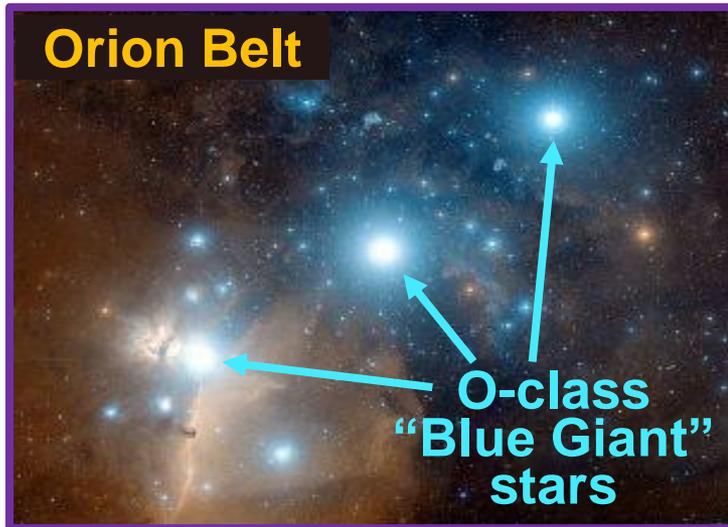
The exact thermal radiation spectrum depends upon **properties of the material** and the **temperature**.



In general, as the temperature increases, the peak of the radiation curve moves to higher intensities and shorter wavelengths.

Everything Glows!

- The temperature at which all solids glow a **dim red** is about **800 K** (over 500°C or 900°F).



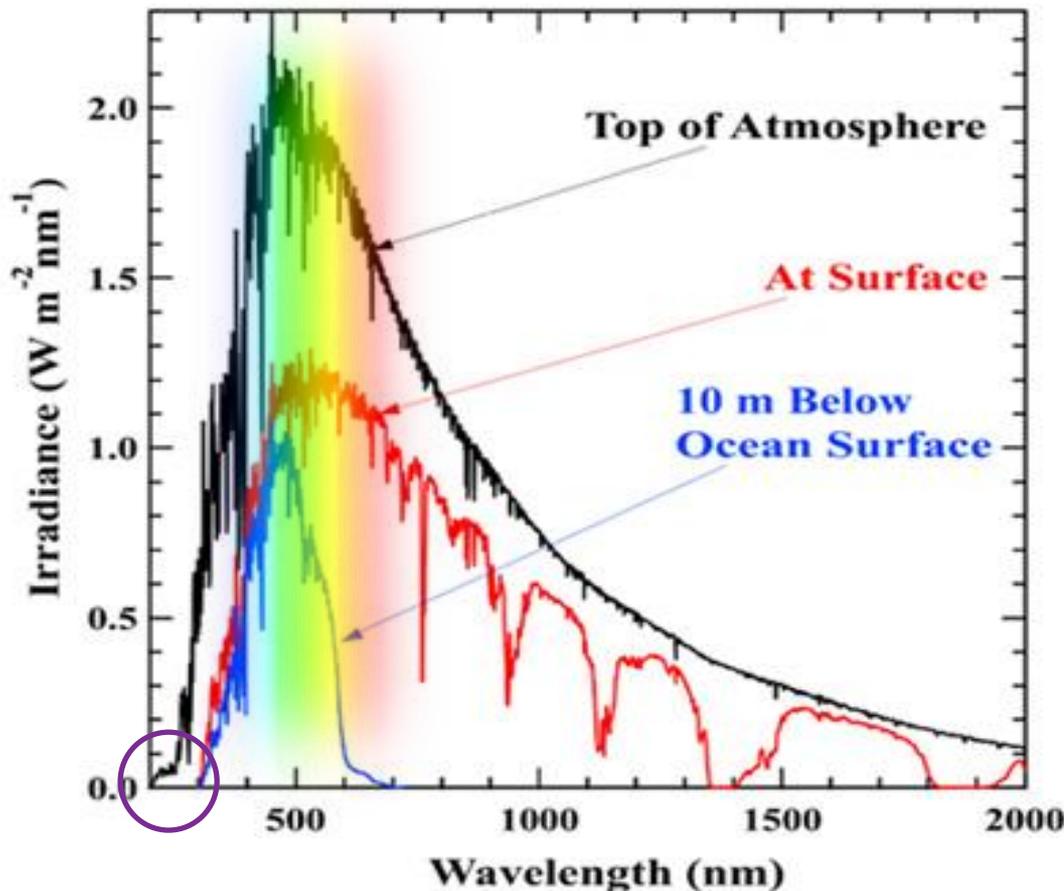
- A very hot object (**10,000 K**) would emit a significant amount of energy in the **ultraviolet and x-ray region** of the spectrum.

- People are emitters of light in the **infrared region** (peak $\sim 9.5\mu\text{m}$).



Sunlight

The Sun emits EM radiation across most of the electromagnetic spectrum. On Earth, solar radiation is obvious as **daylight** when the Sun is above the horizon.



Sunlight composition at top of atmosphere:

- ~9% ultraviolet radiation
- ~40% visible light
- ~51% infrared radiation
- a very small amount of extreme ultraviolet and X-ray radiation from solar corona

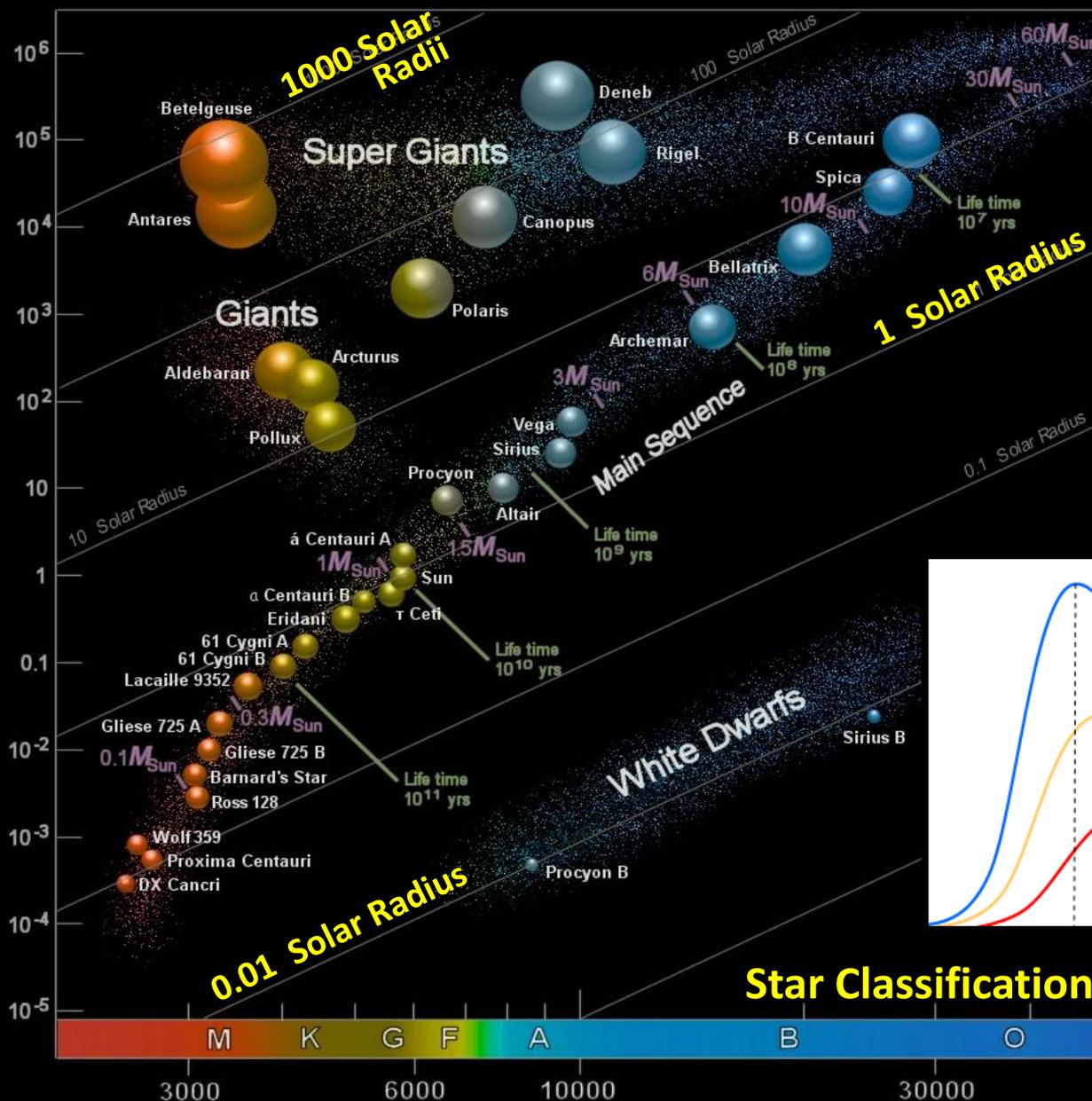
Filtered Sunlight at Earth's surface:

- ~5% ultraviolet radiation
- ~43% visible light
- ~52% infrared radiation

Colors of the Stars

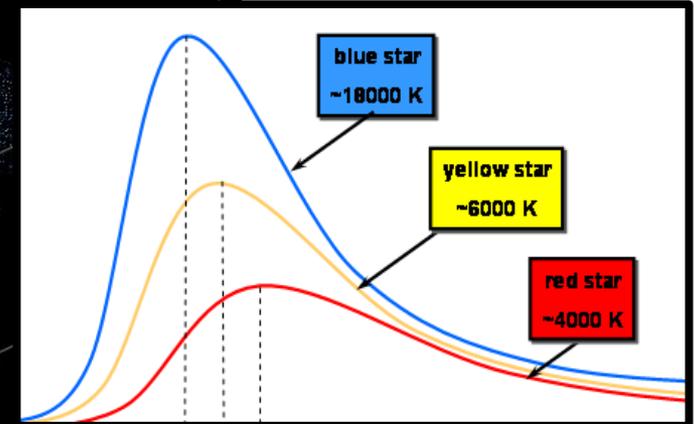
are defined by how hot their *surfaces* are

Star Brightness (Solar Units)



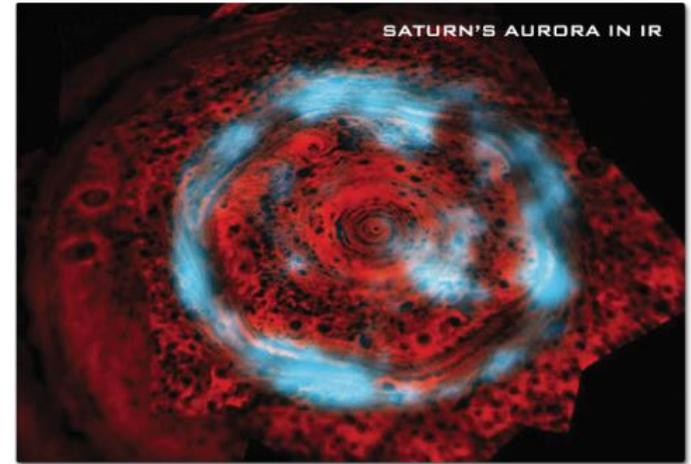
Star Classification

(←lower) Star Surface Temperature (Kelvin) (higher→)



The Sun surface is about 5700 K

“Seeing” the Invisible with Infrared



From
elusive
leopards...

...to hiding
young
stars!

