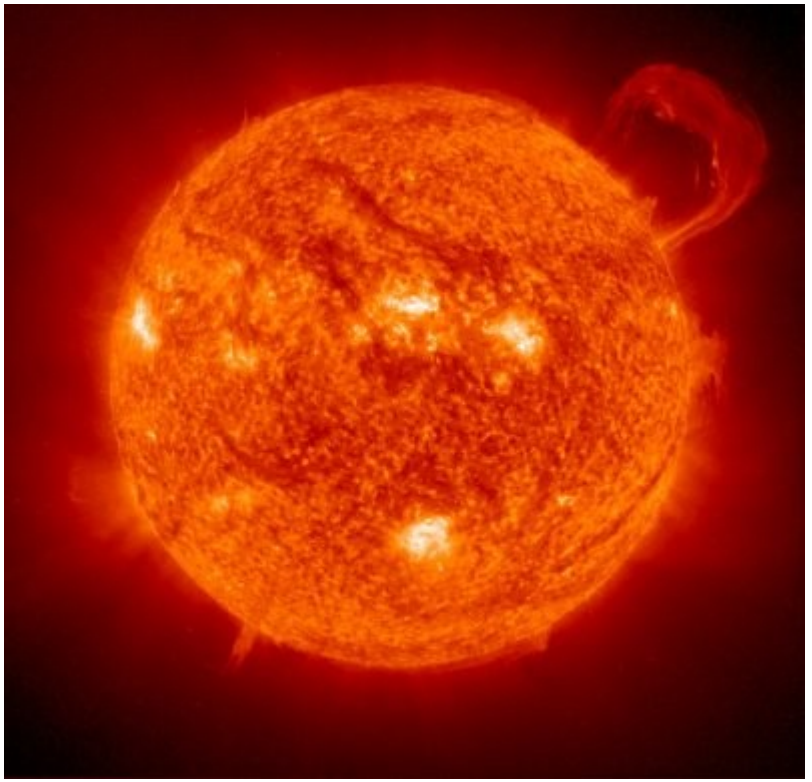
ASTR 2310: Chapter 7, “The Sun”

- Observable Layers of the Sun
  - (Interiors deferred to Ch. 15, ASTR 2320)
- Solar Activity
- Angular Momentum of the Sun



ASTR 2310: Chapter 7, “The Sun”

- Observable Layers of the Sun
- A Really Great Webpage with Basic Info and Images/Animations of the Sun: http://ircamera.as.arizona.edu/NatSci102/lectures/sun.htm
- Also see Wiki*: http://en.wikipedia.org/wiki/Sun*
- *Photosphere*: where the light comes from (optical depth of 1), about the top 400 km, R=696,000km from the center.
- *Absorption Lines* indicate surface layer is cooler. Lines indicate H is 73.4% by mass, Helium 25.0%

ASTR 2310: Chapter 7, “The Sun”

- Atmospheric Opacity
  - Main source is the H^- ion.
  - Hydrogen atom with an extra electron
  - Trace “metals” easily give up some outer electrons, partly ionized, and electrons are captured by neutral hydrogen to make ion
  - First electron ionization potential 13.6 eV, second only a mere 0.75 eV, so easily lost again, absorbs photons with wavlengths on order of 1.7 microns and shorter.
  - Need right range of densities and temperatures for this negative hydrogen ion to be common. Sun has them.

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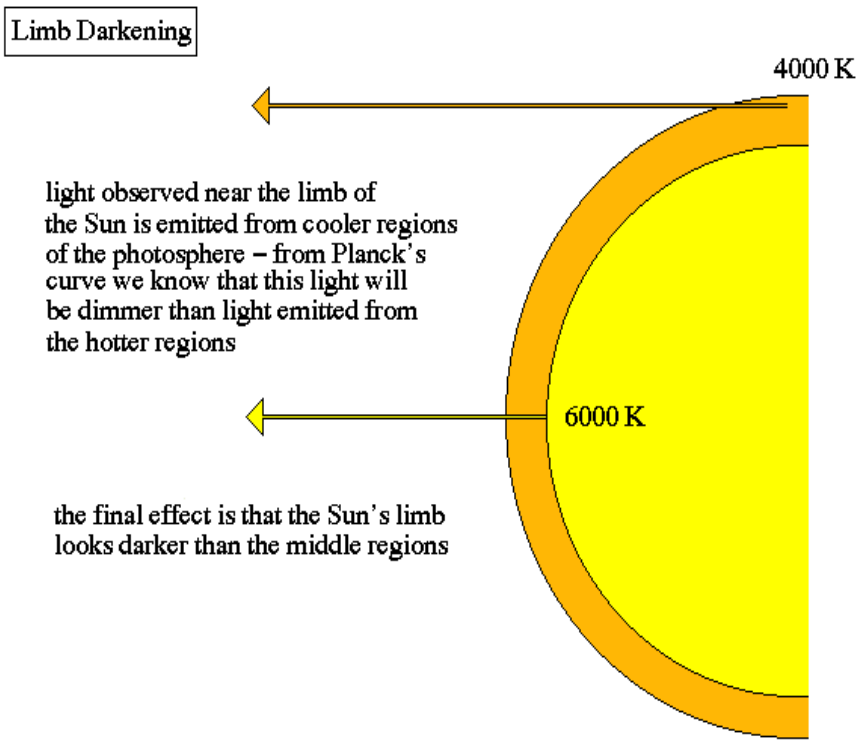
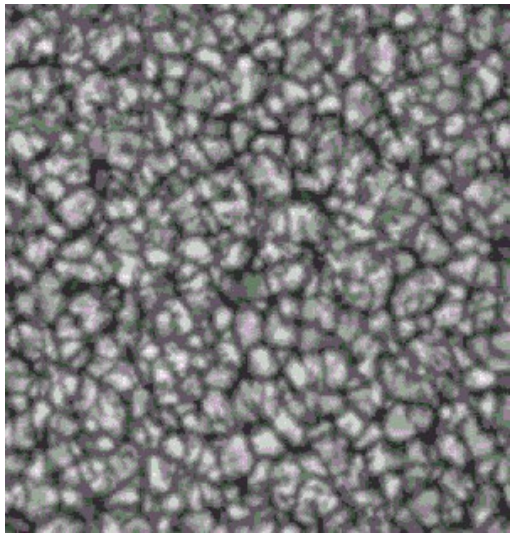
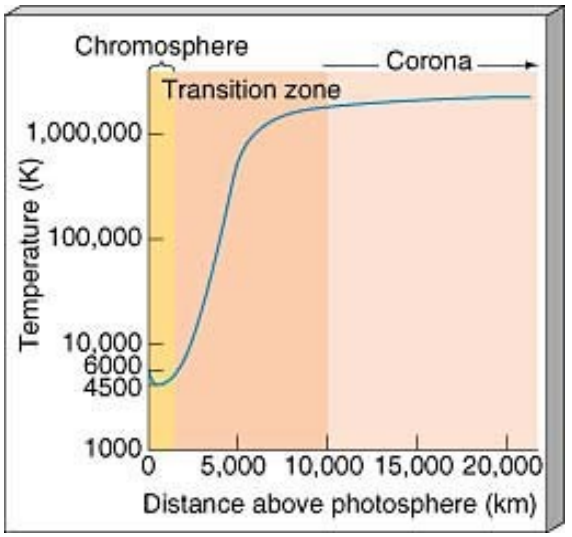
- Atmospheric Opacity
  - Limb Darkening: photons come from tau of 1, the photosphere. At the edge, that is from a shallower depth (and lower temperature) than in the center of the disk (T = 6100 K), for average of T = 5700 K.

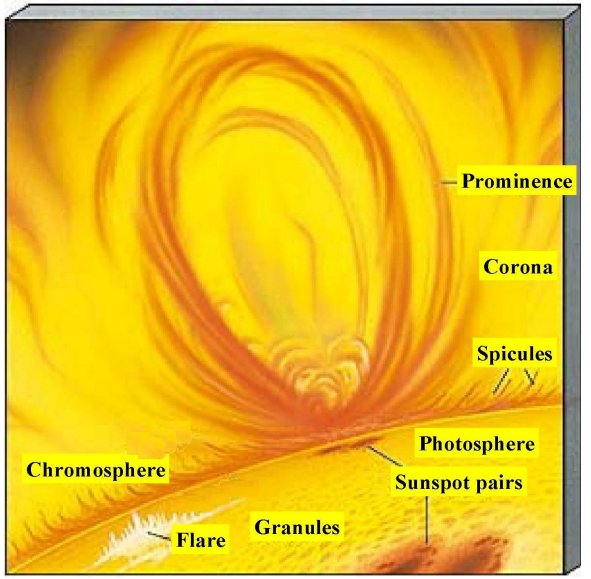


ASTR 2310: Chapter 7, “The Sun”

- Other Atmospheric Phenomena
  - *Granules* that are convection cells (see movie on website on page 2 of the slides)
  - *Chromosphere* – hot, tenuous region above the photosphere with an emission-line spectrum, and temperature increasing with altitude
  - Other features include plages, filaments, prominences, and spicules

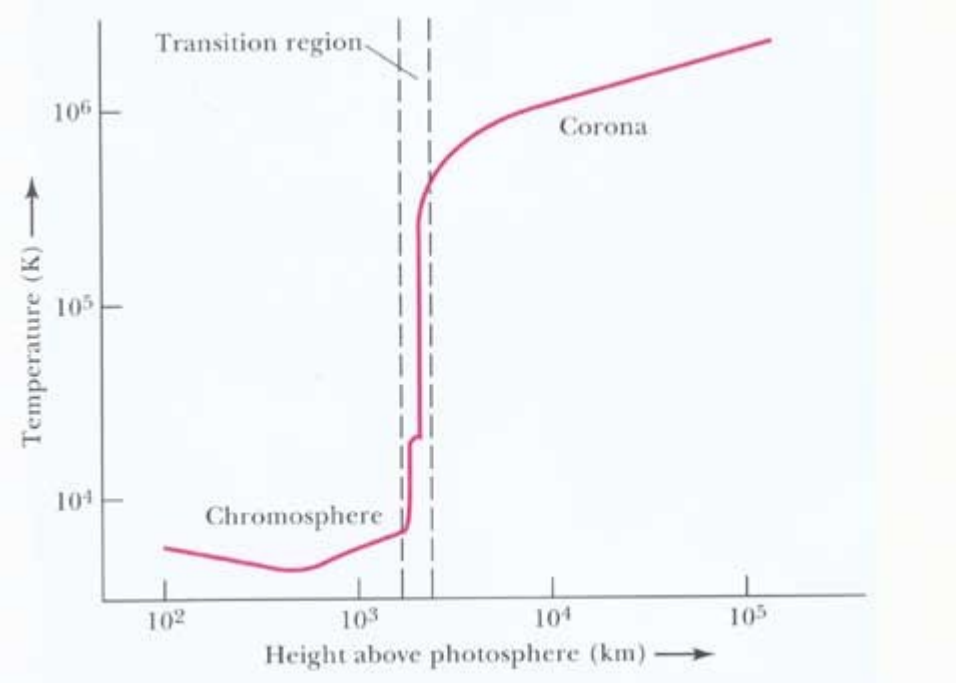






ASTR 2310: Chapter 7, “The Sun”

- Other Atmospheric Phenomena
  - *Corona*
    - Very hot – into the millions of degrees
    - Story of “Coronium” and forbidden Fe XIV
    - Most easily seen in eclipses



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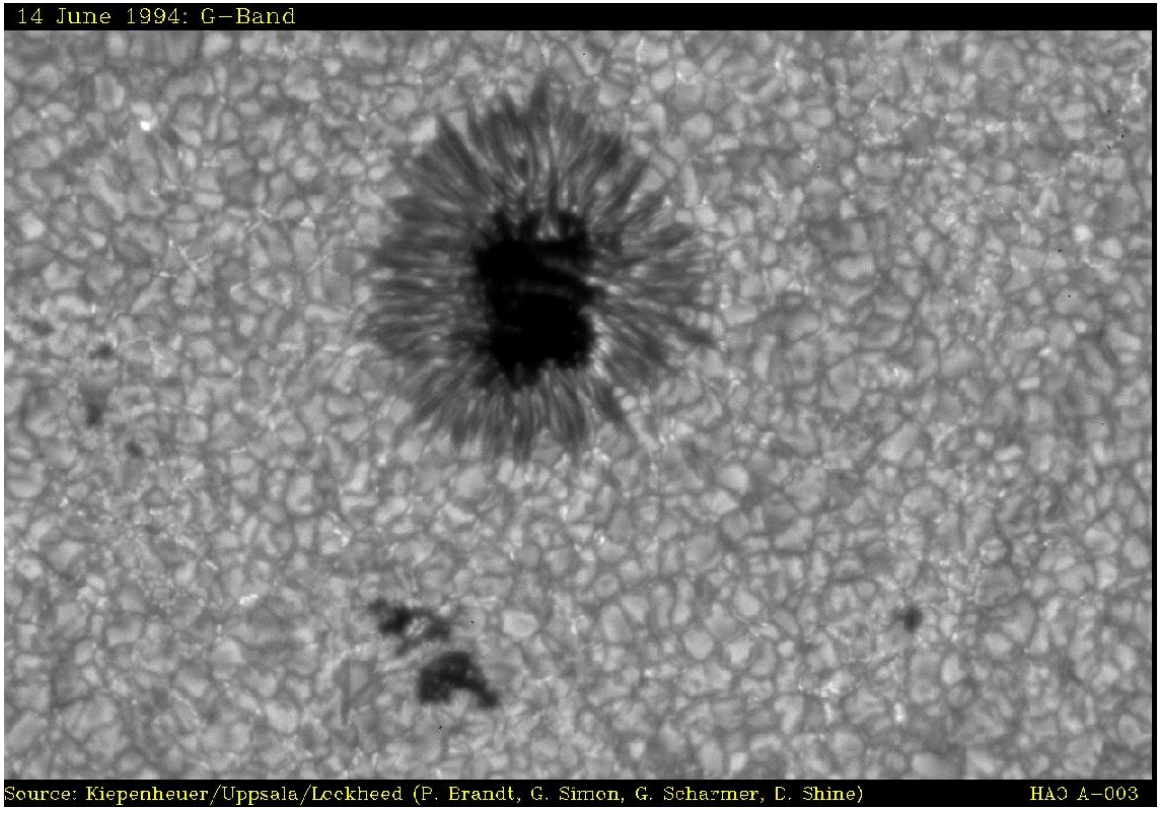
- Other Atmospheric Phenomena
  - *Corona and solar wind*
    - Origin of heating unclear, but acoustic and magnetic effects implicated
    - Rms speed of corona particles ($v_{rms} = (3kT/m)^{1/2}$) is on order a few hundred km/s
    - Escape velocity ($v_{esc}=(2GM/r)^{1/2}$) is a bit larger, but...
    - The outer, hotter part of the corona has an increasing fraction of gas particles being lost
  - “Solar Wind” -- can make estimates on the whiteboard (from pages 178-180 of the text)

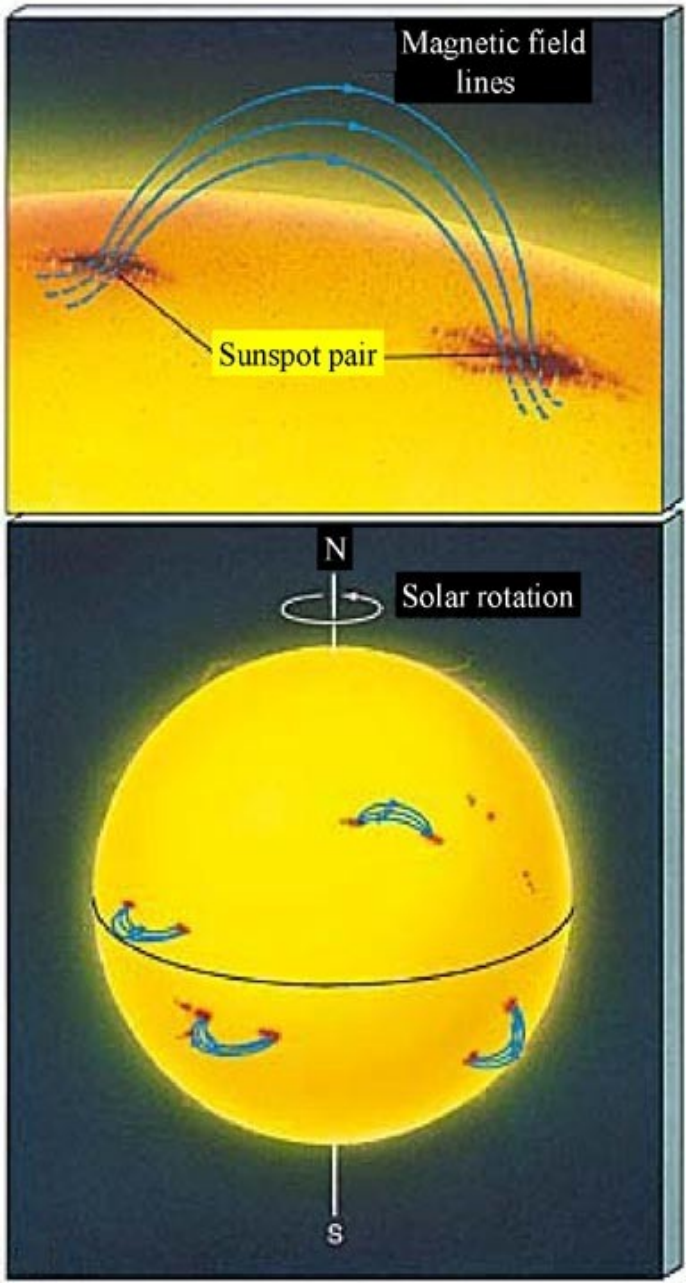
ASTR 2310: Chapter 7, “The Sun”

- Solar Activity
  - *Magnetic Fields and Lorentz Force*
    - Important for all solar activity
    - Especially sunspots
    - Some basic physics first (whiteboard)

ASTR 2310: Chapter 7, “The Sun”

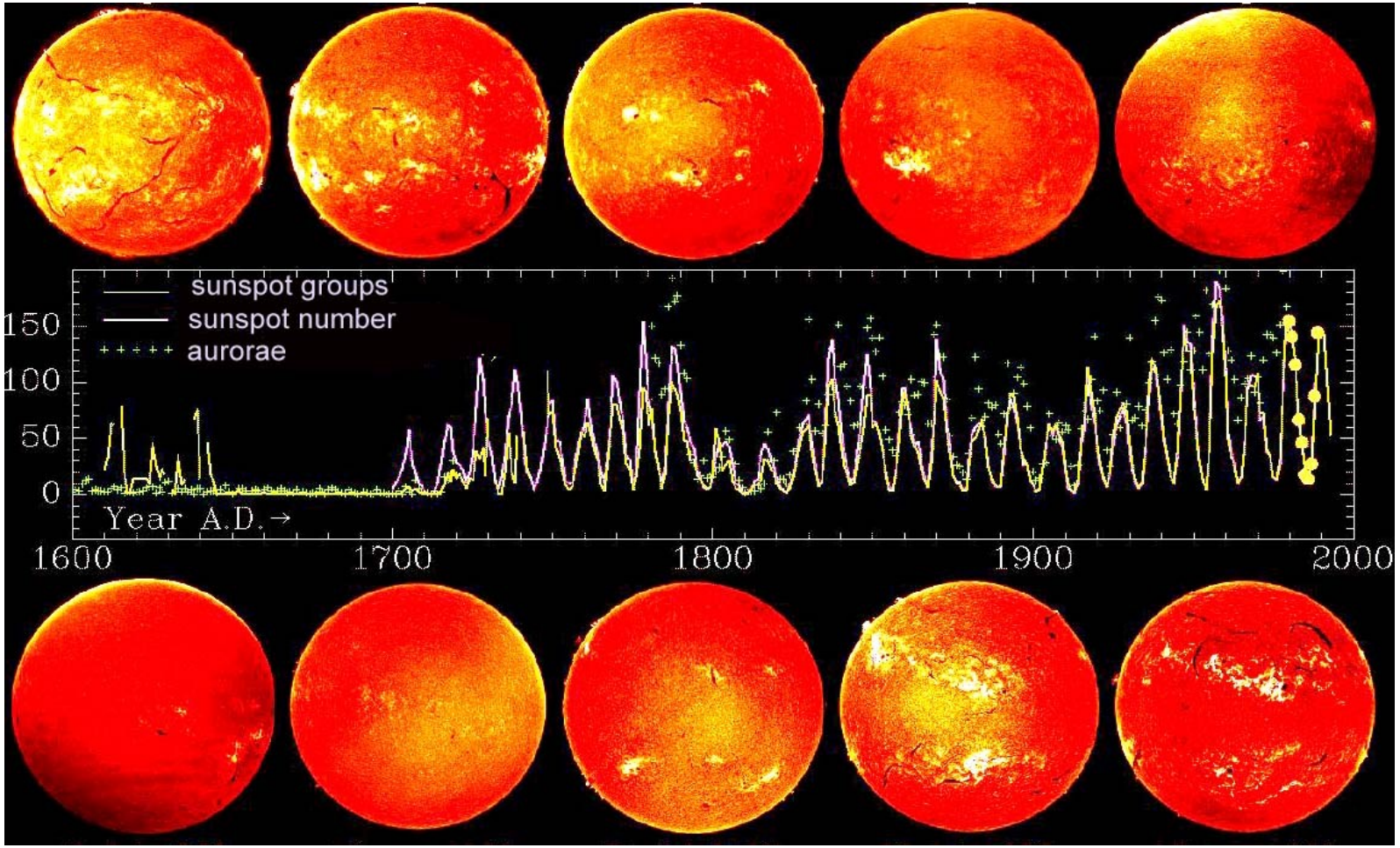
- Solar Activity
  - *Sunspots*





ASTR 2310: Chapter 7, “The Sun”

- Solar Activity
  - *Sunspots*



ASTR 2310: Chapter 7, “The Sun”

- Solar Activity
  - *Coronal Mass Ejections and Solar Flares, Auroras*