Reading: Chapter 14, 15
Exam 1: Thursday, February 8 - in class - review and sample posted
   essay provided in lecture on Tuesday, Feb. 6
Homework: Web reading on the process of science - see course homepage. Due Today!

Last time: What to do with those photons
- instrumentation - squeezing info out of all photons
- getting around (or above) the atmosphere is critical
- astronomy from space provides access to all wavelengths

Today: Our Sun - a star, up close and personal
- our local star, the Sun, is the touchstone for all of stellar astronomy
- what we see at and above the surface of the Sun tells us about how its energy eventually gets out into space
- The Sun is a dynamic powerhouse of light, magnetism, and turbulence.

The Vital Statistics of the Sun

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Distance</td>
<td>$1.5 \times 10^8$ km</td>
</tr>
<tr>
<td>Mass</td>
<td>$2 \times 10^{33}$ grams</td>
</tr>
<tr>
<td>Radius</td>
<td>$7 \times 10^5$ km</td>
</tr>
<tr>
<td>Luminosity</td>
<td>$4 \times 10^{33}$ erg/s</td>
</tr>
<tr>
<td>Temperature</td>
<td>$5800K (10,000^o F)$</td>
</tr>
<tr>
<td>Composition</td>
<td>Spectroscopy</td>
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Hydrogen 73.4% by mass
Helium 24.8%  
Oxygen 0.8%  
Carbon 0.4%  
Everything else 0.6%

i.e. Silver ~ 0.000000066% (still, that’s $5 \times 10^{20}$ tons of silver in the Sun!)

1868: Lockyer & Jansen find spectral lines in Sun never seen on Earth → Helium proposed as a new element
1891: Helium finally discovered on Earth
Visible Light

Extreme UV

The ‘surface’ of the Sun:

**the Photosphere**

- $T \approx 5800K$
- **Granulation**
  - cells of rising gases ($\approx 1000$ km across)
  - give mottled appearance to photosphere
- **Sunspots**
  - relatively cooler than photosphere ($T \approx 4500K$)
  - site of strong magnetic fields

The Chromosphere

- cooler (and hotter) layer above photosphere
- dominated by light of hydrogen emission
- **Prominences**
  - material suspended above photosphere
- **Flares**
  - giant eruptions
SOHO satellite image of a sunspot at and below the solar photosphere (using helioseismology)

The Solar Corona
- rarefied outer solar atmosphere
  - visible during eclipses or from space
- strange emission lines
  - identified as highly ionized heavy elements
  - T ~ 2,000,000K

The Sun this week

Optical image (eclipse)  Extreme UV (space)
The Solar Cycle

- number of spots changes over 11 year cycle
- magnetic polarity (N/S) of spots flips every 11 years
- → whole pattern repeats every 22 years

The Butterfly Diagram

Limb Darkening:

a view below the surface of the Sun