

**I. The Solar Atmosphere**

- Photosphere
- Chromosphere
- Corona

**II. Magnetic Activity**

- Spots, Plage, Spicules, Flares, CME's
- The Solar Cycle
- Rotation and Differential Rotation
- Impact of Solar Activity on Earth's Climate

**Some Notes About Atmospheric Modeling and Spectrum Synthesis**

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| <p><u>The "Easy" Part</u></p> <ul style="list-style-type: none"> <li>• radiative transfer equation                     <ul style="list-style-type: none"> <li>- plane parallel geometry</li> </ul> </li> <li>• steady-state &amp; LTE</li> <li>• hydrostatic equilibrium</li> <li>• radiative equilibrium</li> </ul> | <p><u>The Hard Part</u></p> <ul style="list-style-type: none"> <li>• <math>\nu</math>-dependent opacity</li> <li>• spherical geometry</li> <li>• not LTE</li> <li>• flows, magnetic fields</li> <li>• abundance anomalies</li> </ul> |
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Atmospheric Models & Synthetic Spectra:  
 ATLAS - Kurucz; Castelli & Kurucz  
 PHOENIX - Hauschildt  
 Synthetic Spectra Only:  
 SYNOPSIS - Hubeny & Lanz  
 SPECTRUM - Gray

**Source Function**

- with  $d\tau_\nu = \alpha_\nu ds$  and  $S_\nu = j_\nu / \alpha_\nu$
- RT Eq ( $dI_\nu/ds = j_\nu - \alpha_\nu I_\nu$ ) can be written as:

$$dI_\nu/d\tau_\nu = -I_\nu + S_\nu$$

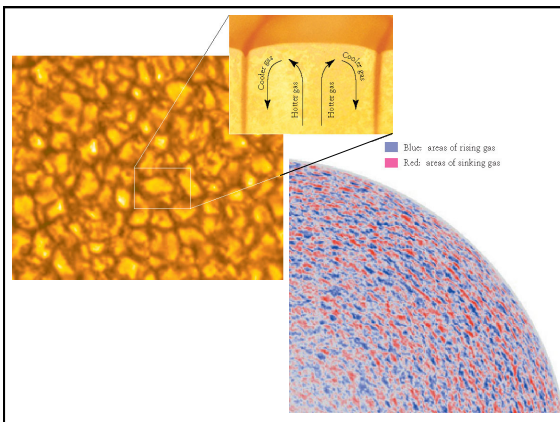
- I approaches S
- S -->  $B_\nu$  ("thermal emission")
- determining S is equivalent to solving RT eq
- but it can involve integrals, differentials
- and lots of physics

**I. The Solar Atmosphere**

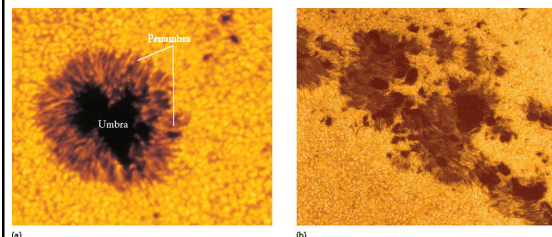


**Photosphere**

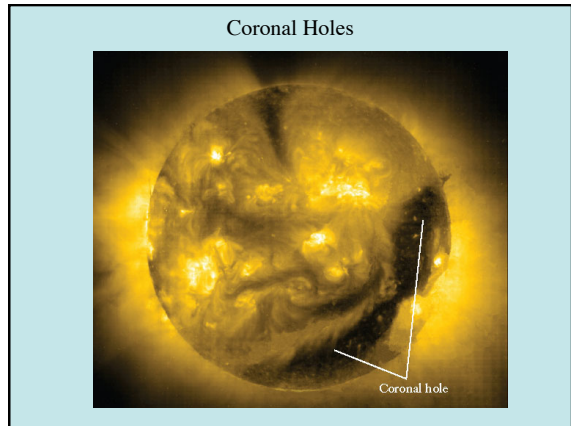
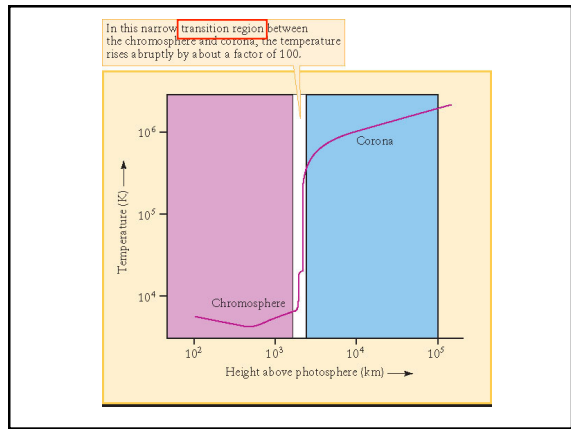
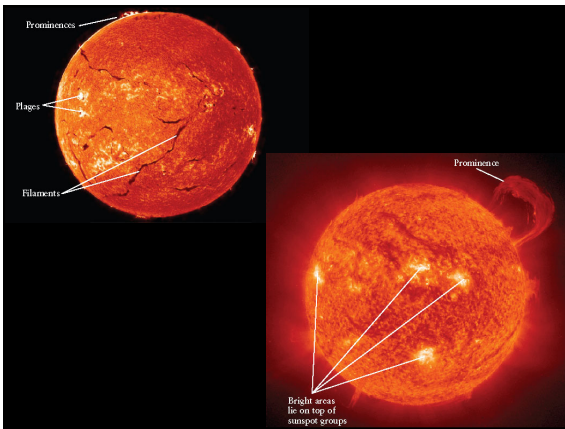
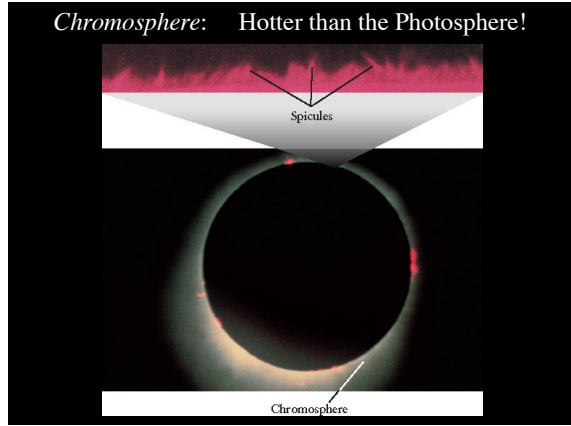
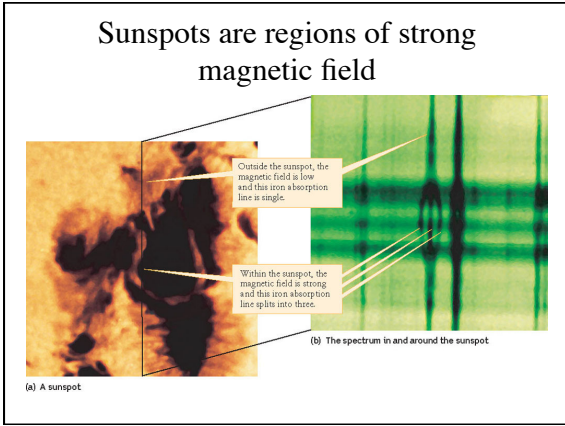
- $\tau = 2/3$
- limb darkening
- emergent spectrum
- visible light
- continuum
- granulation

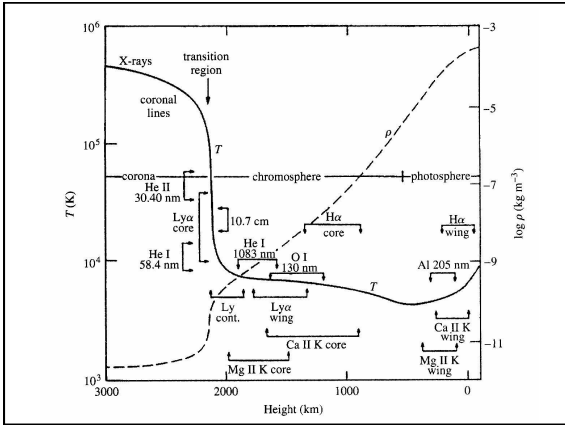


**Sunspots are low-temperature regions in the photosphere**



Videos...

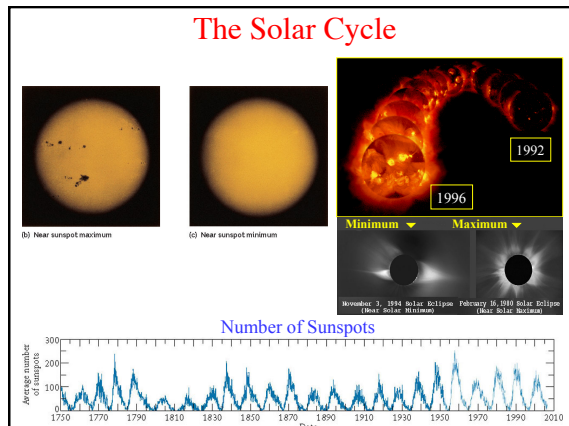
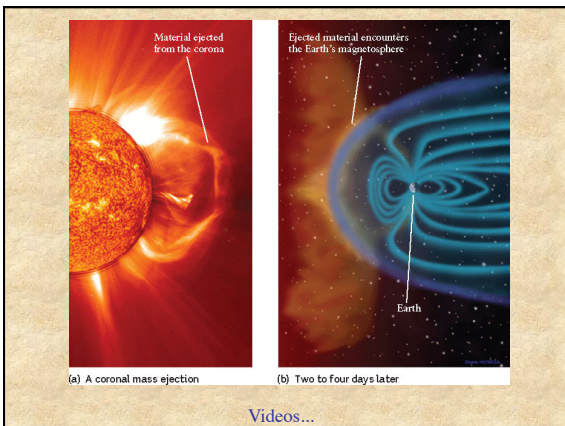
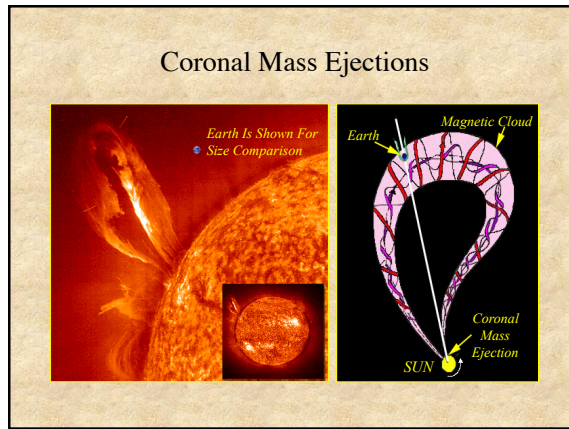
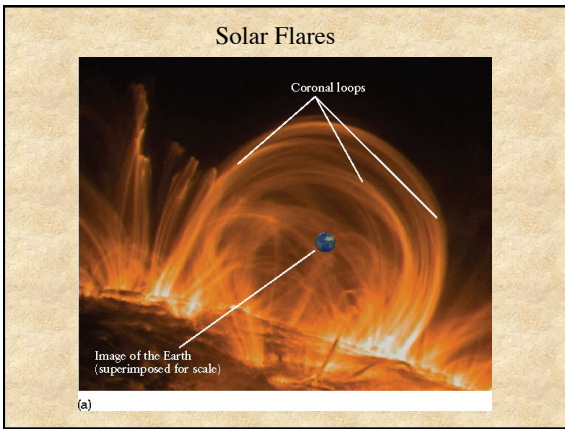


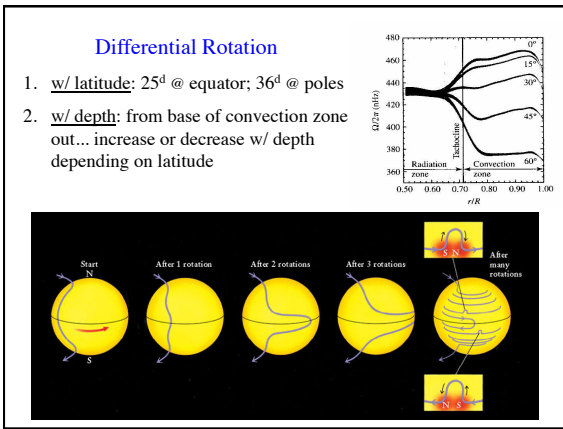
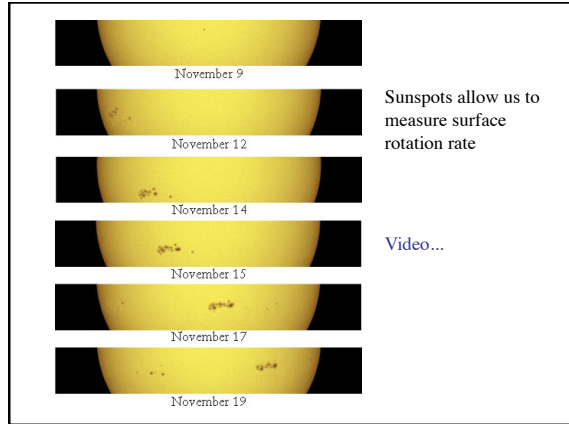
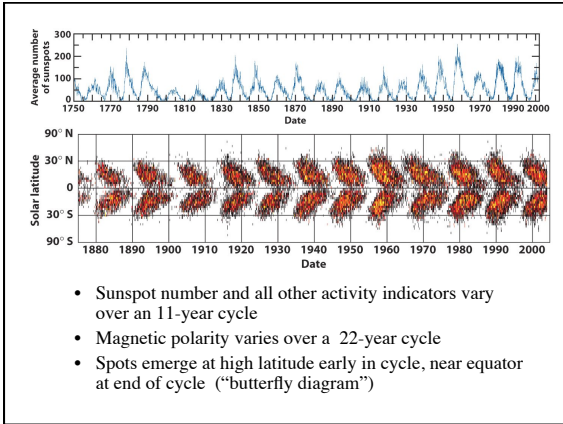


## II. Solar Magnetic Activity

- Photosphere:** visual sunspots
- Chromosphere:** H-alpha & UV plage & spicules
- Corona:** X-ray loops & streamers flares
- Solar Wind:** charged particles coronal mass ejections

A composite image of the Sun showing different layers and solar activity. The central part shows the photosphere with sunspots. The surrounding area shows the chromosphere and corona, with various features like solar flares and coronal mass ejections. A small inset shows a green-tinted image of the Sun's corona.





### Effects of Solar Activity on Earth's Environment

power grids	spacecraft health	aurorae
pipelines	astronaut health	evolution of life
radio communications	airline passenger health	climate???

