Roger A. Freedman • Robert Geller • William J. Kaufmann III

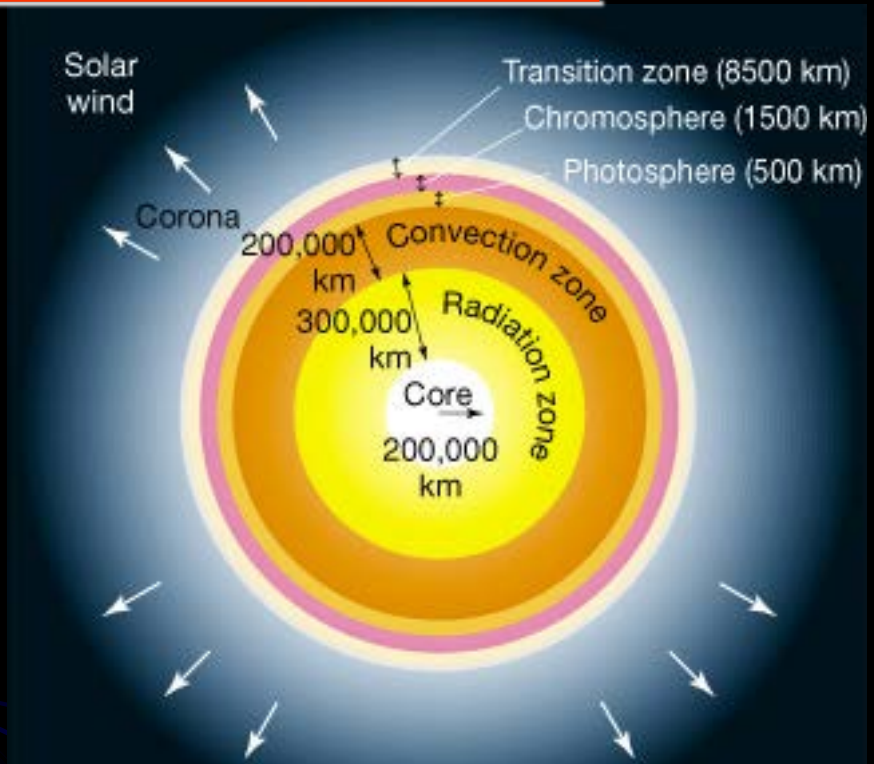
Universe

9th Edition

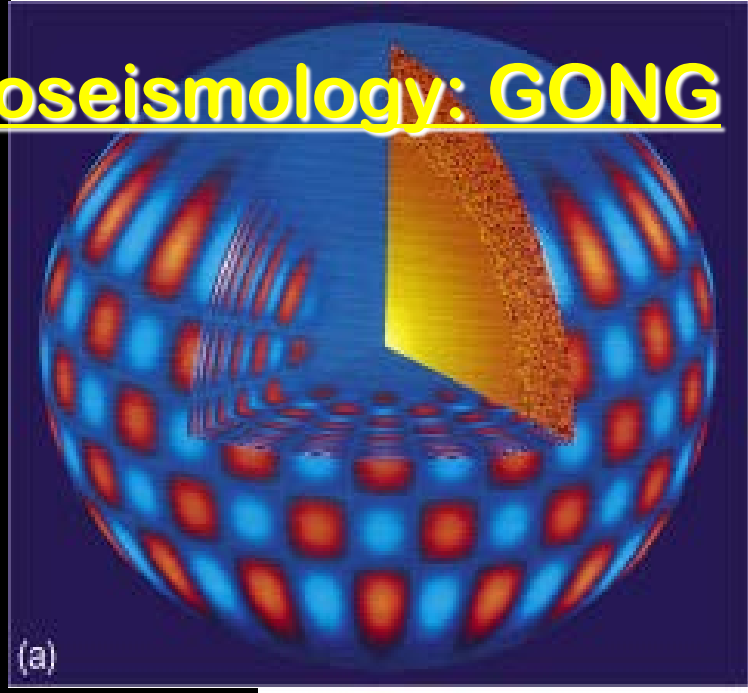
CHAPTER 16

Our Star, the Sun

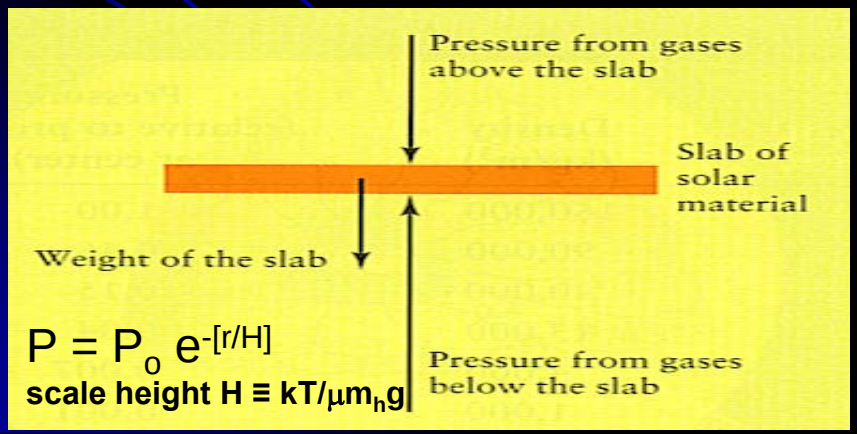
Solar Interior



Helioseismology: GONG

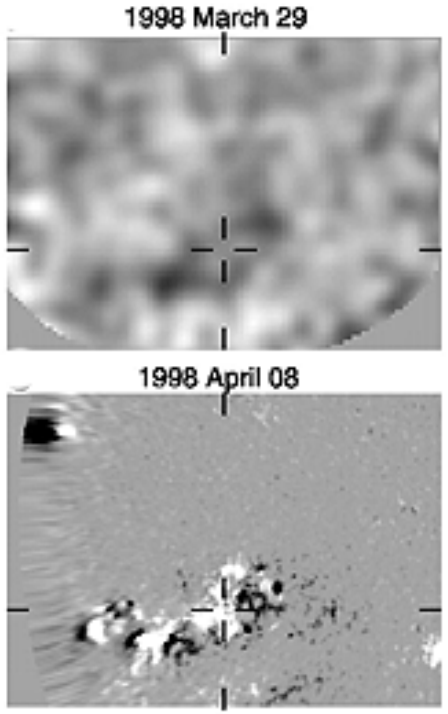


Hydrostatic Equilibrium



Douglas Braun, Solar Physics Research Corp. 2000.

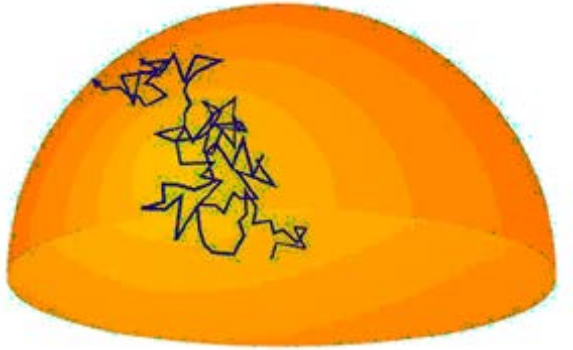
An application of helio-seismology: predicting solar storms

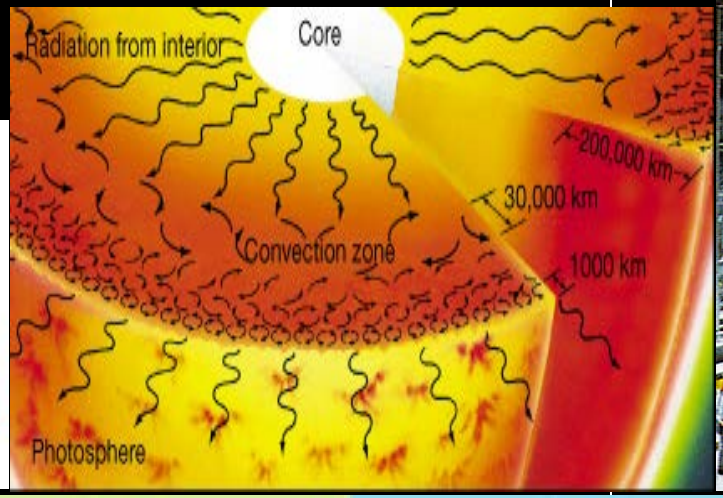


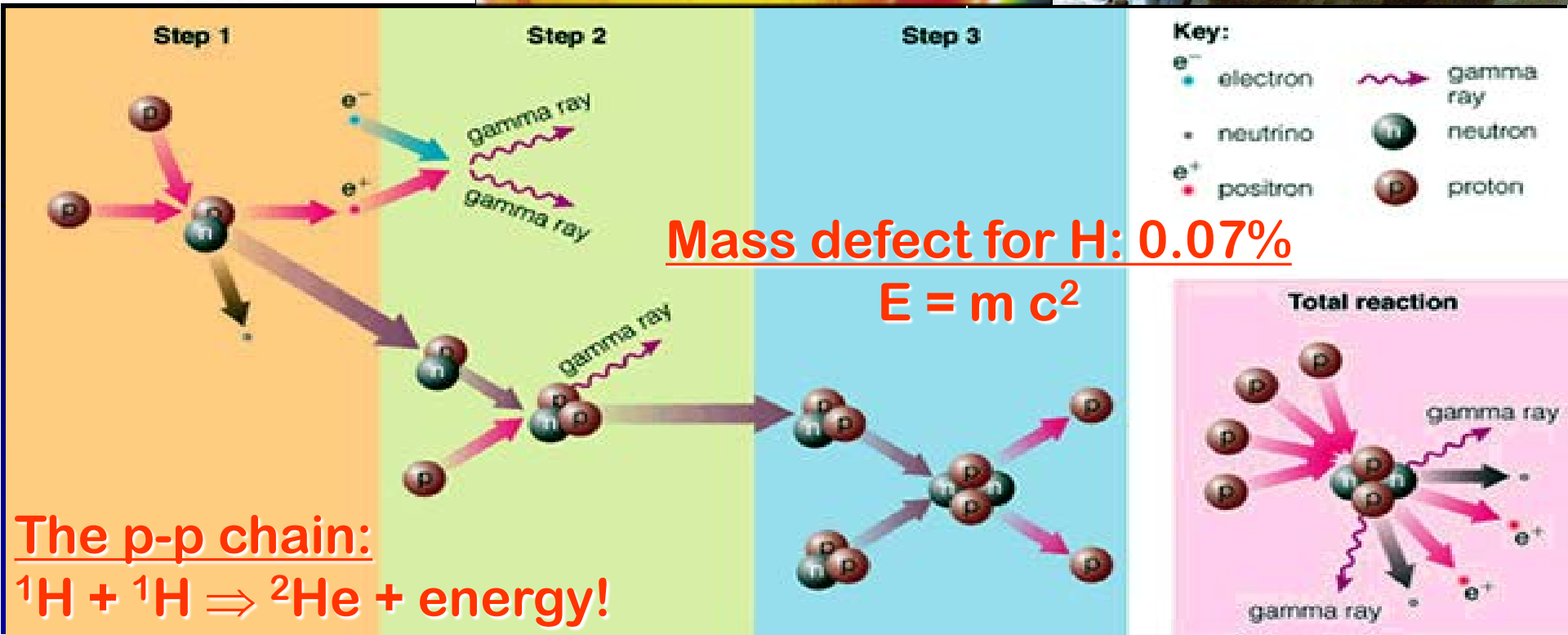
Solar Energy

c. 1998: Neutrino Problem Solved!

Random walk: 10^6 y







Mass defect for H: 0.07%

$E = m c^2$

The p-p chain:

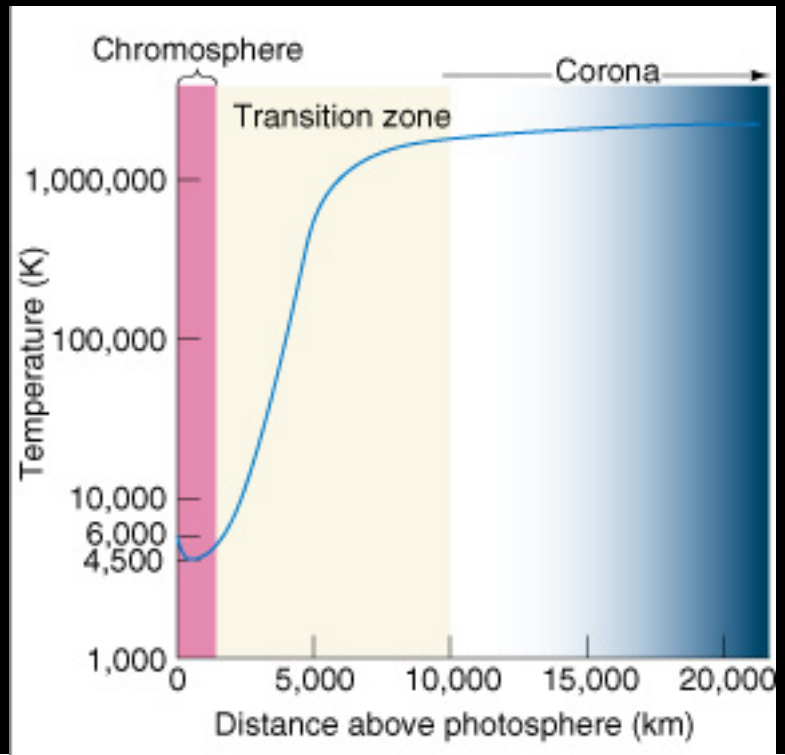
$^1H + {}^1H \Rightarrow {}^2He$ + energy!

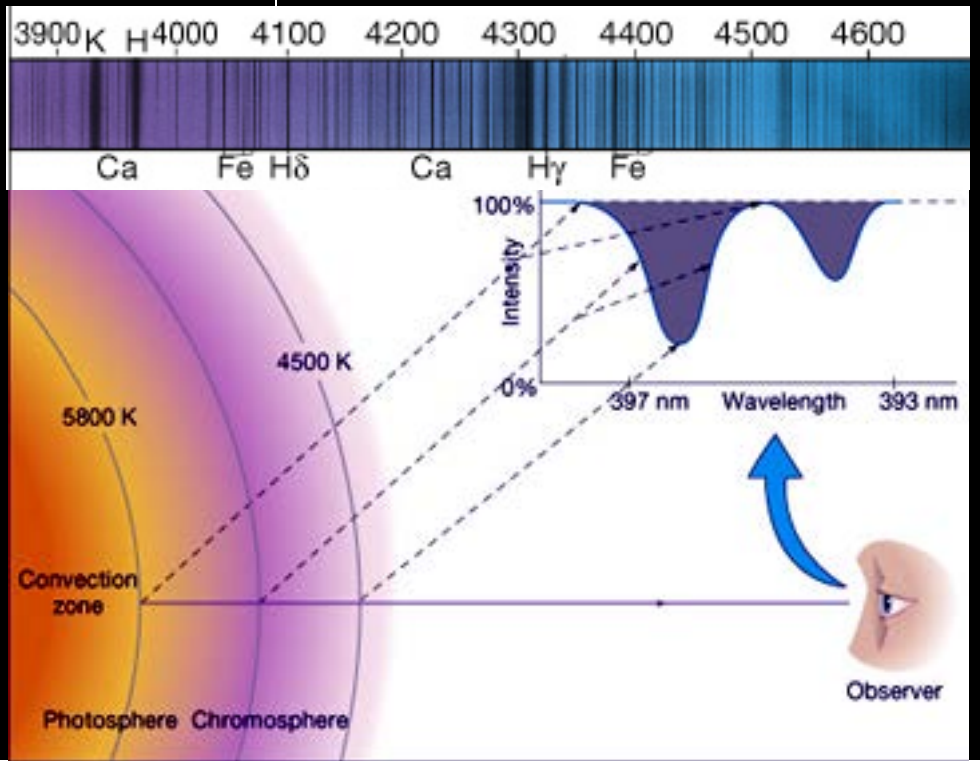
Solar Atmosphere

Photosphere
absorption

Chromosphere
H-α emission

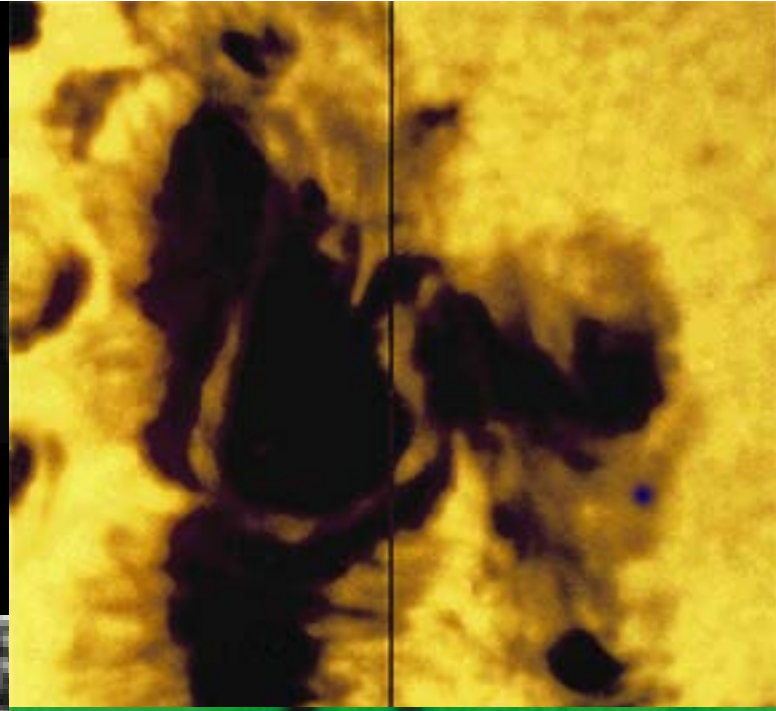
Corona
Fe XIII emission



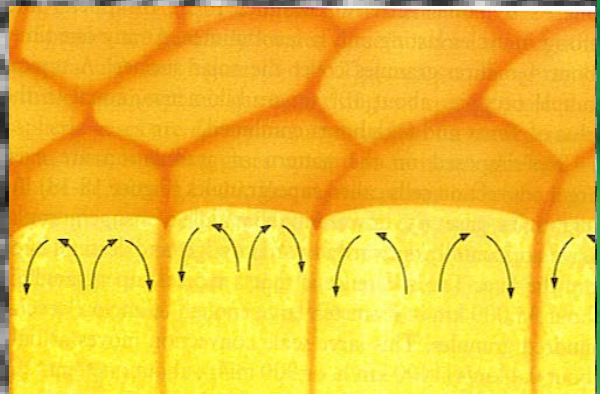


PHOTOSPHERE

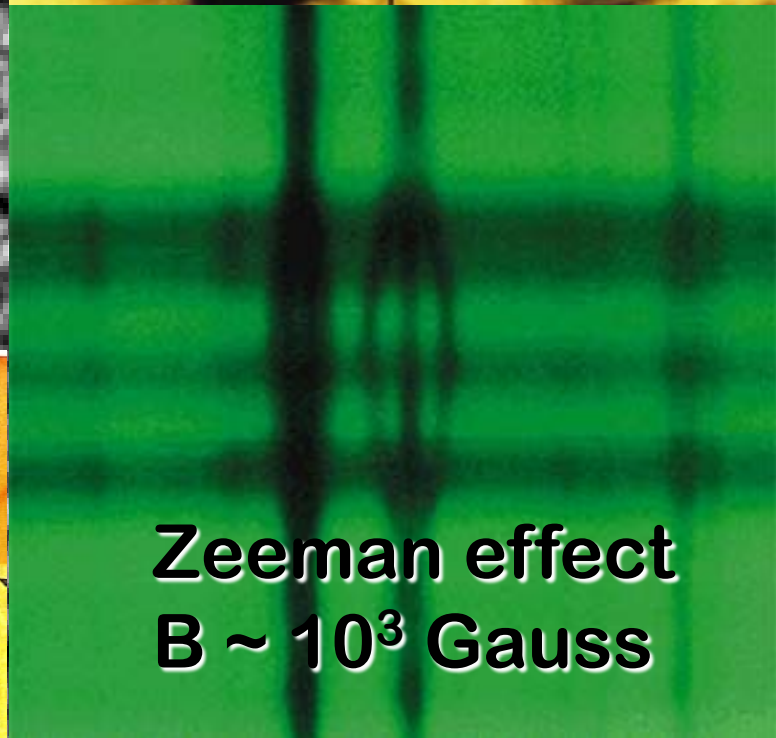
Differential Rotation



~ 400 km thick
Limb darkening
T ~ 5800K
$\rho \sim 1$ gm cm^{-3}
Granulation $\Rightarrow$ convection

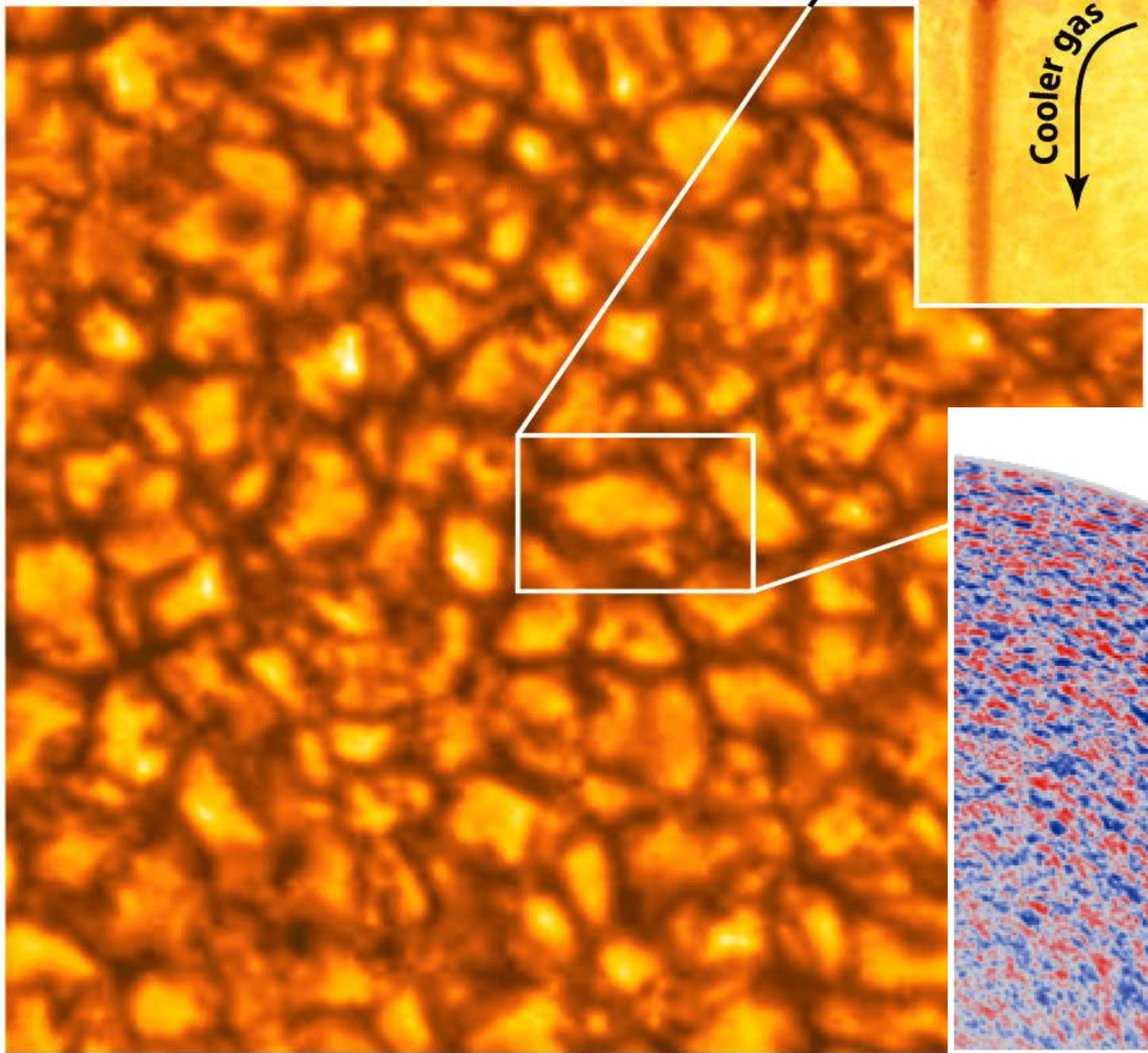


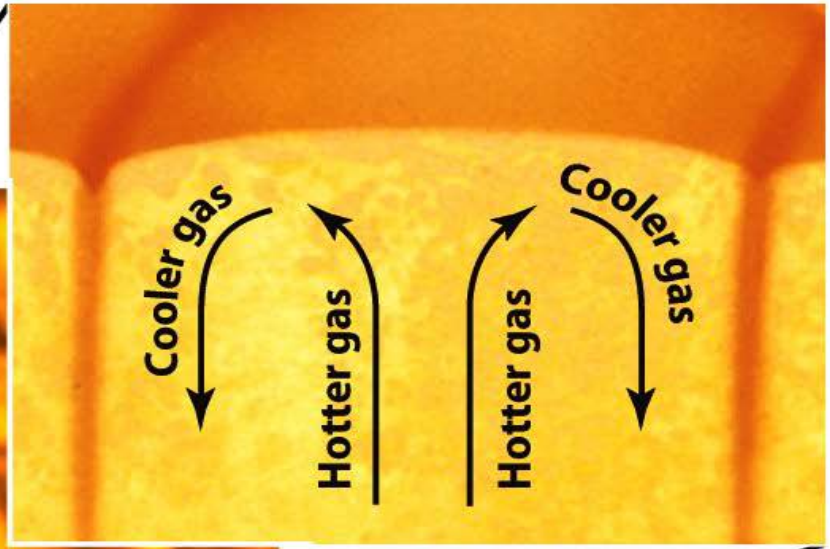
5000 km

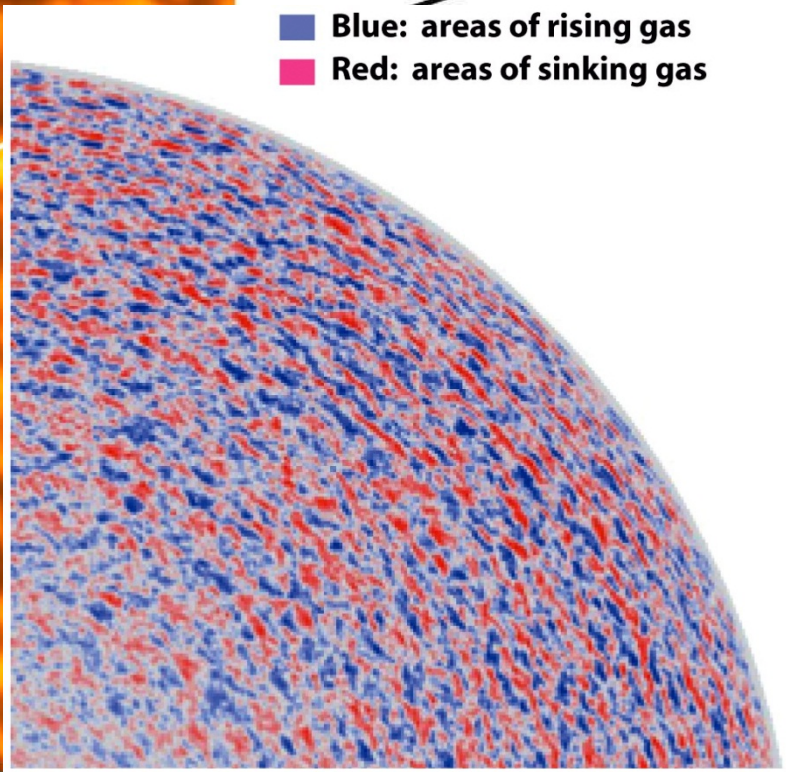


Zeeman effect
B ~ 10^3 Gauss

Granulation in Photosphere: CONVECTION







Limb Darkening

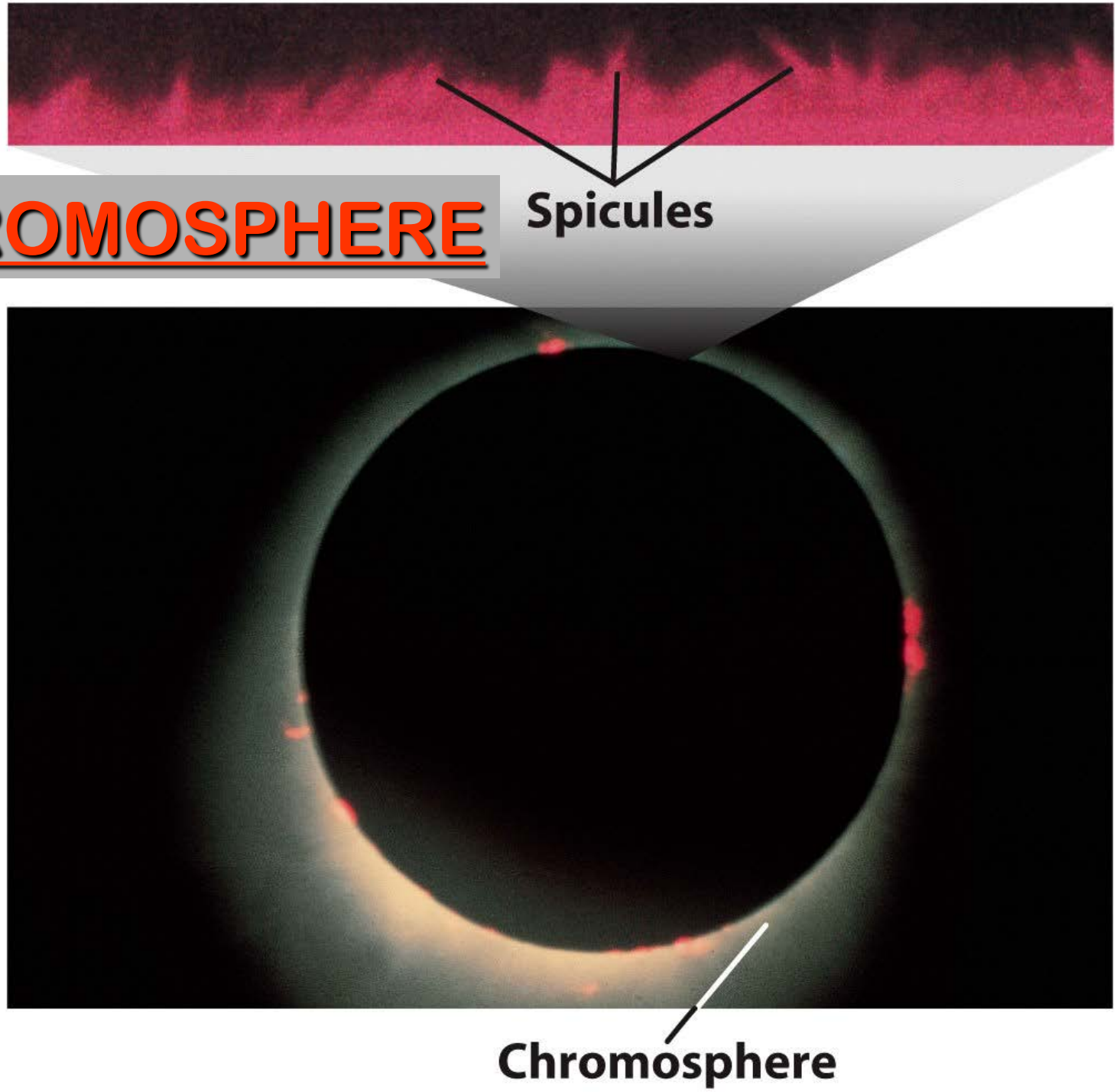
Dimmer light comes from higher, relatively cool layer within the photosphere

Photosphere

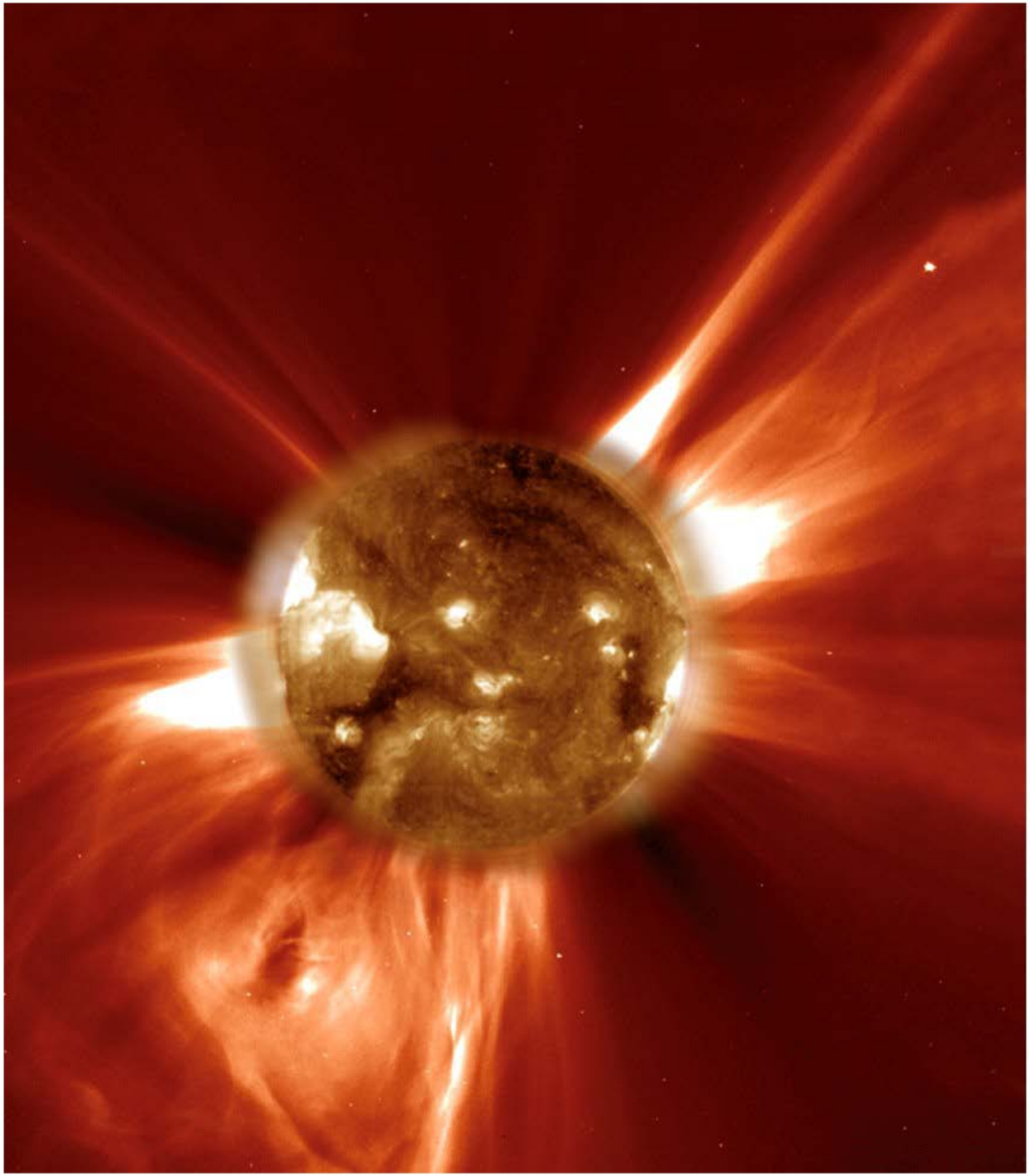
Both light rays travel about the same straight-line distance through the photosphere

Bright light comes from low-lying, hot layer within the photosphere

CHROMOSPHERE

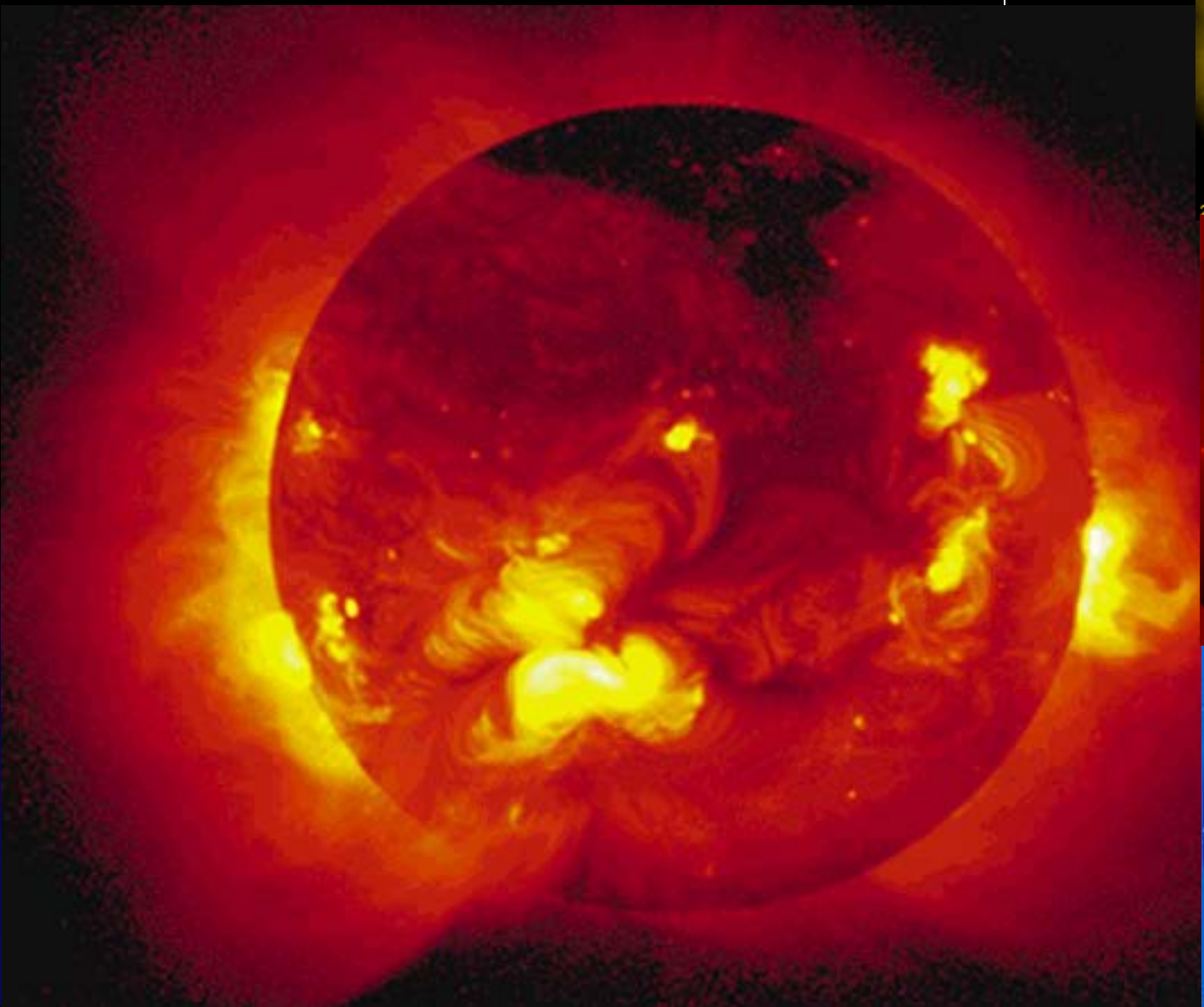


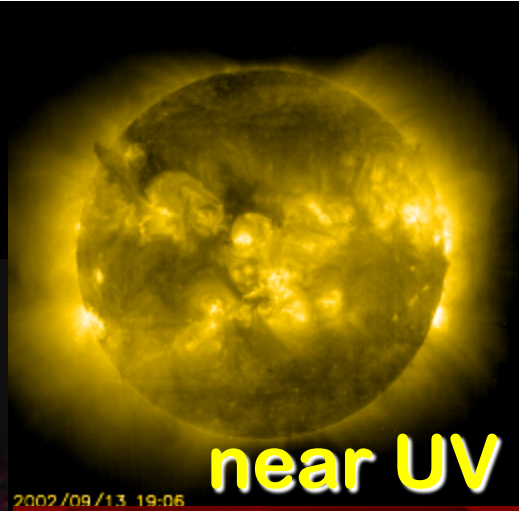
CORONA

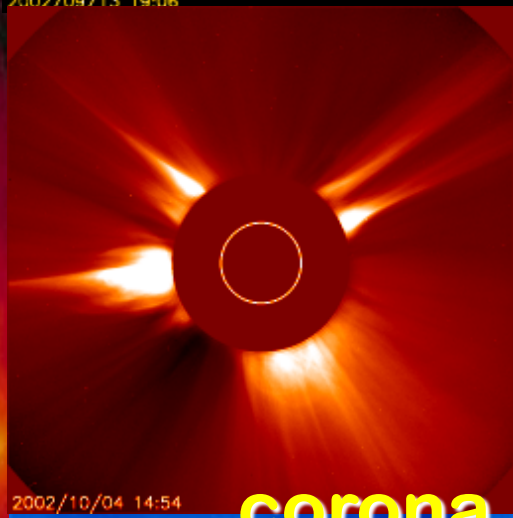


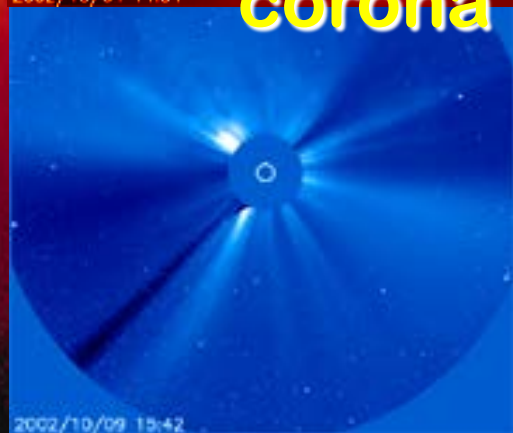
THE ACTIVE SUN

SOHO Spacecraft









November 9

November 12

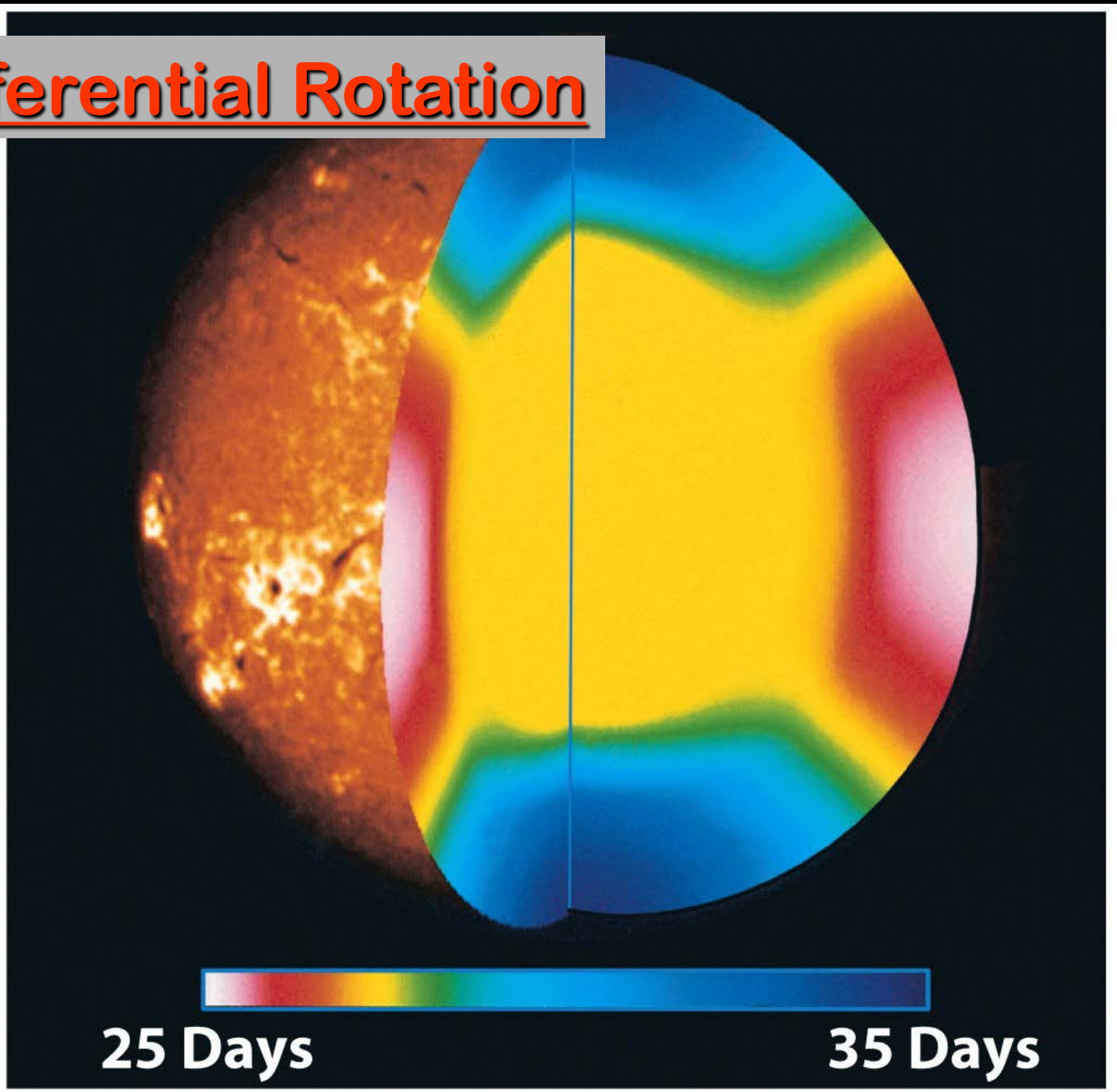
November 14

November 15

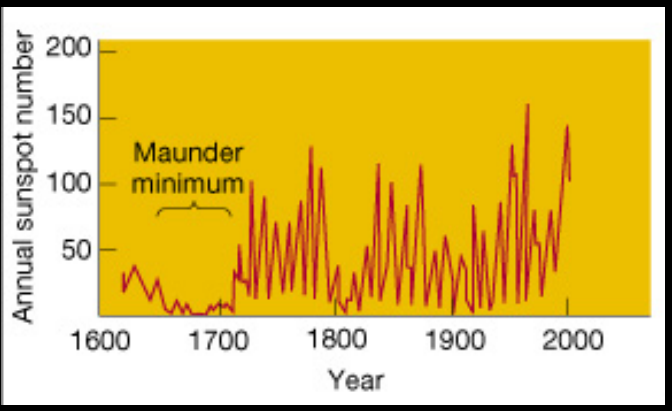
November 17

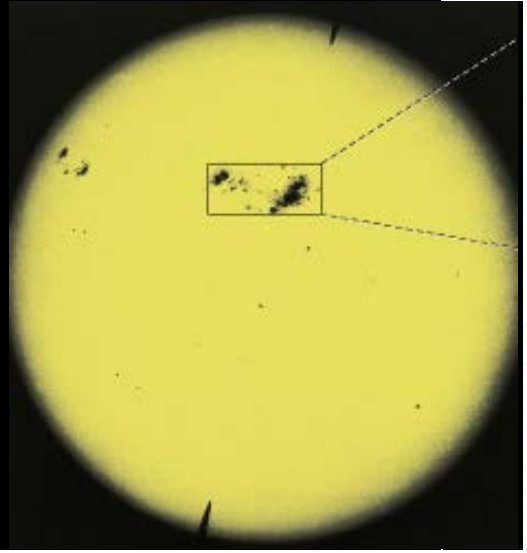
November 19

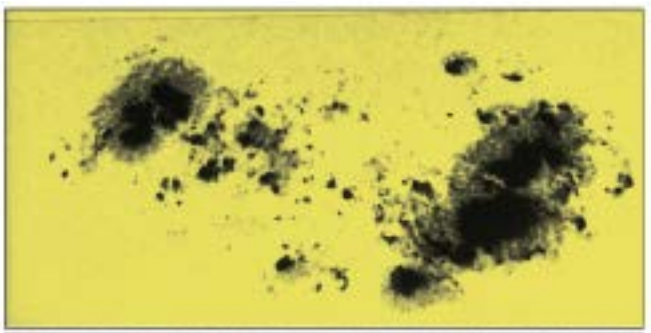
Differential Rotation

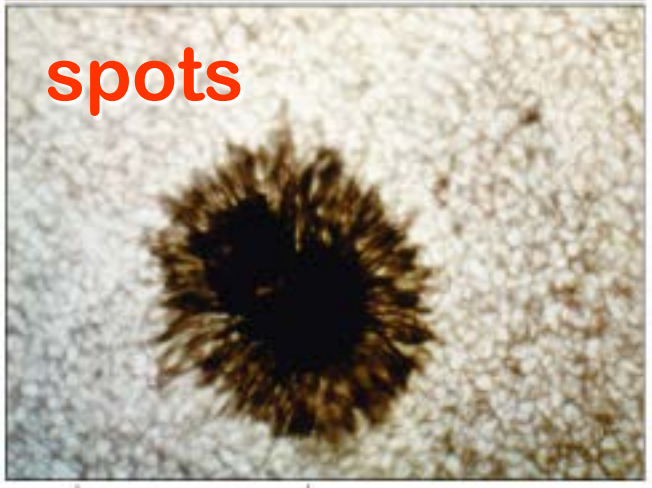


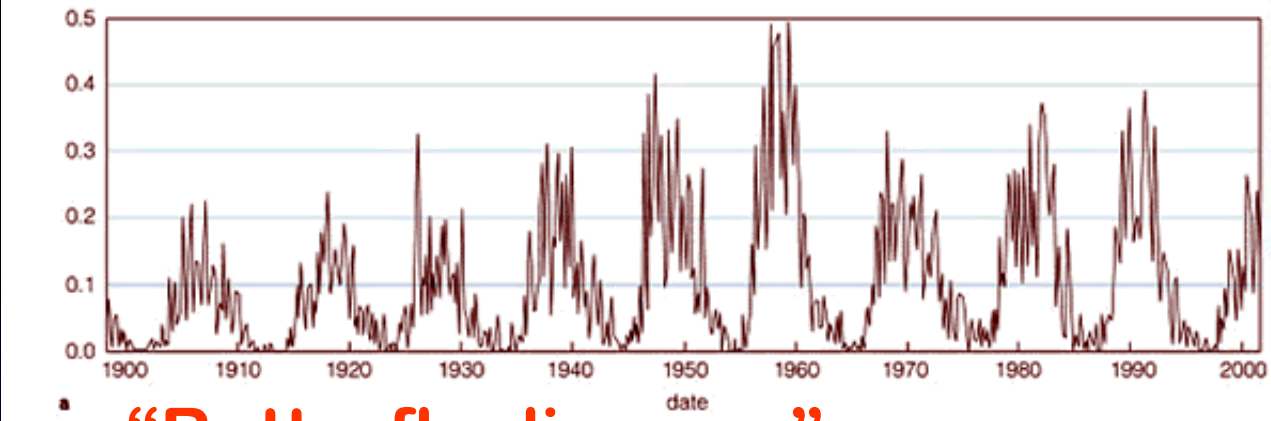
Activity Cycle



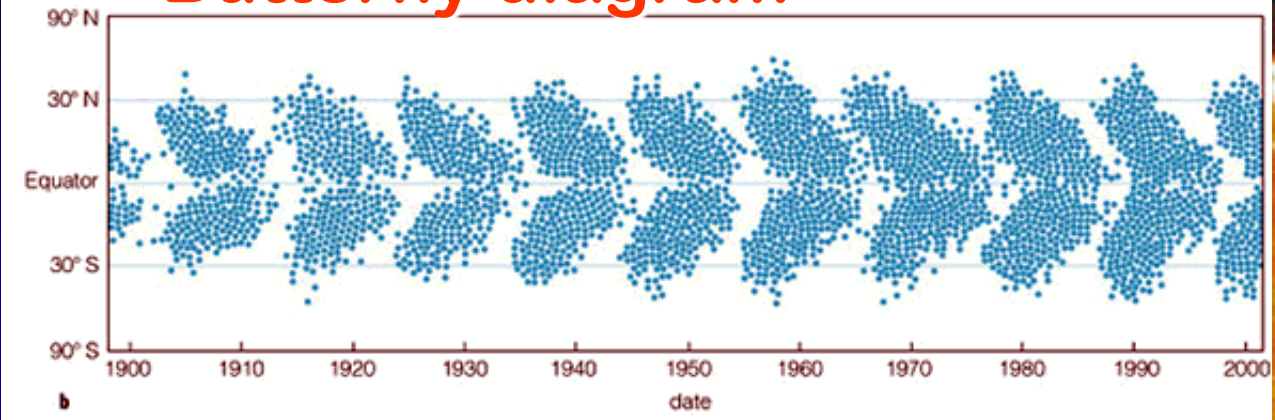


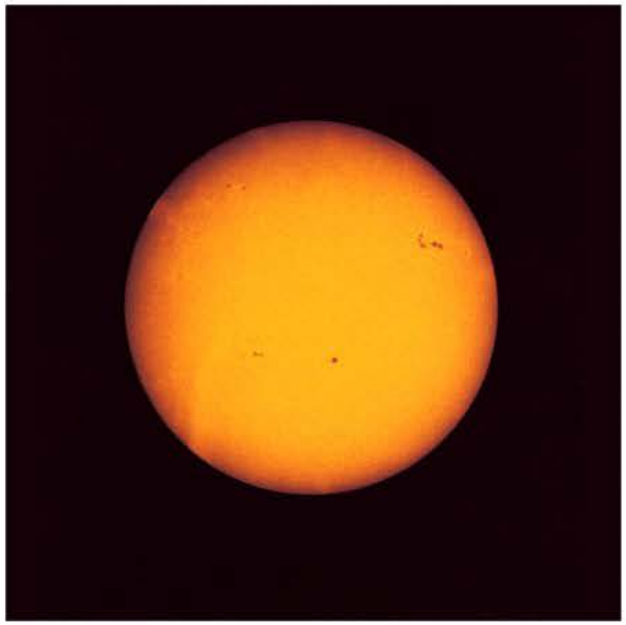




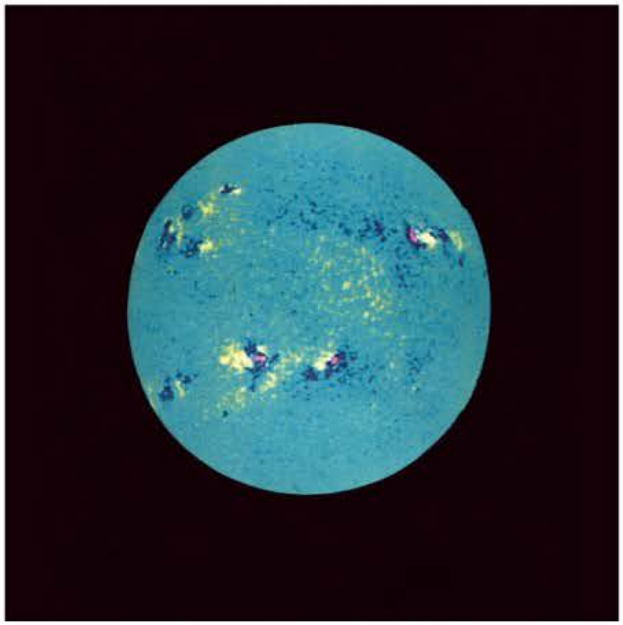


"Butterfly diagram"

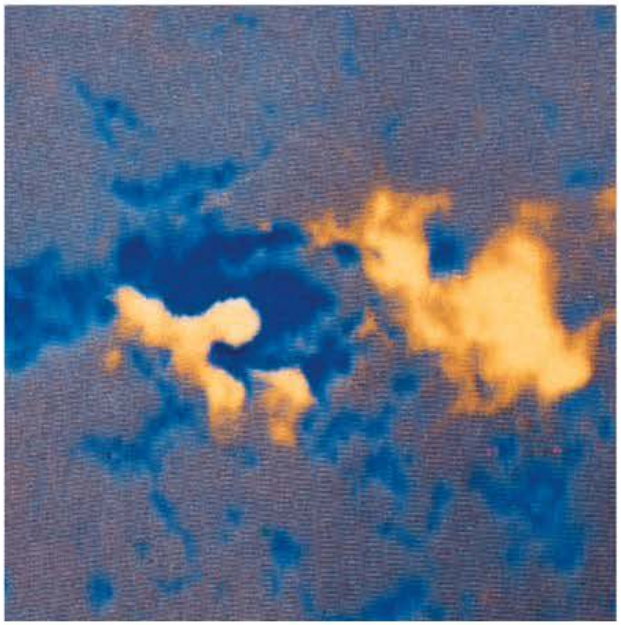




(a) Visible-light image

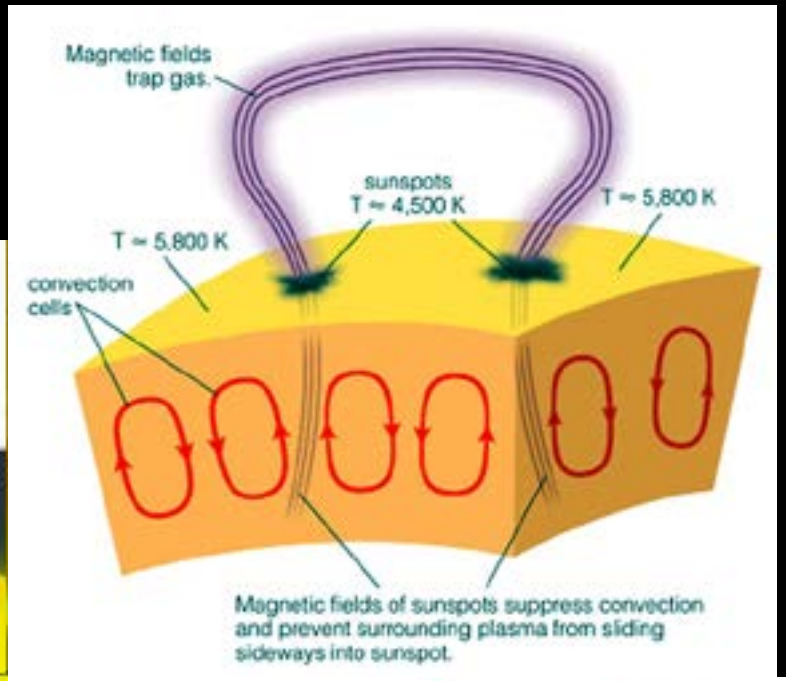


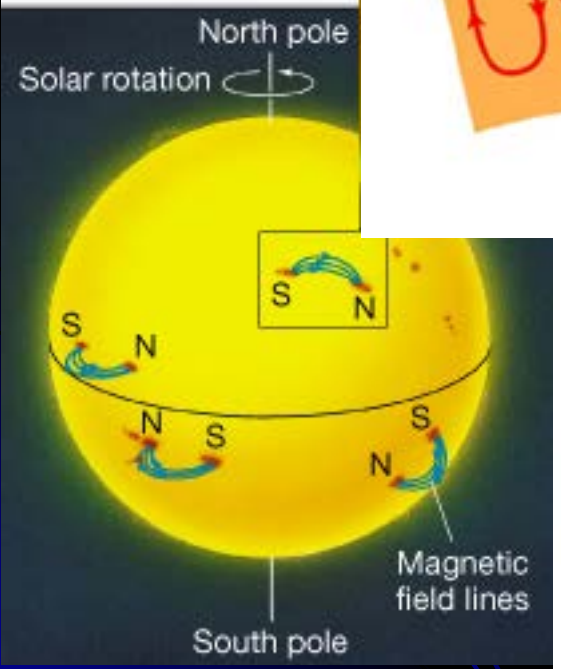
(b) Magnetogram

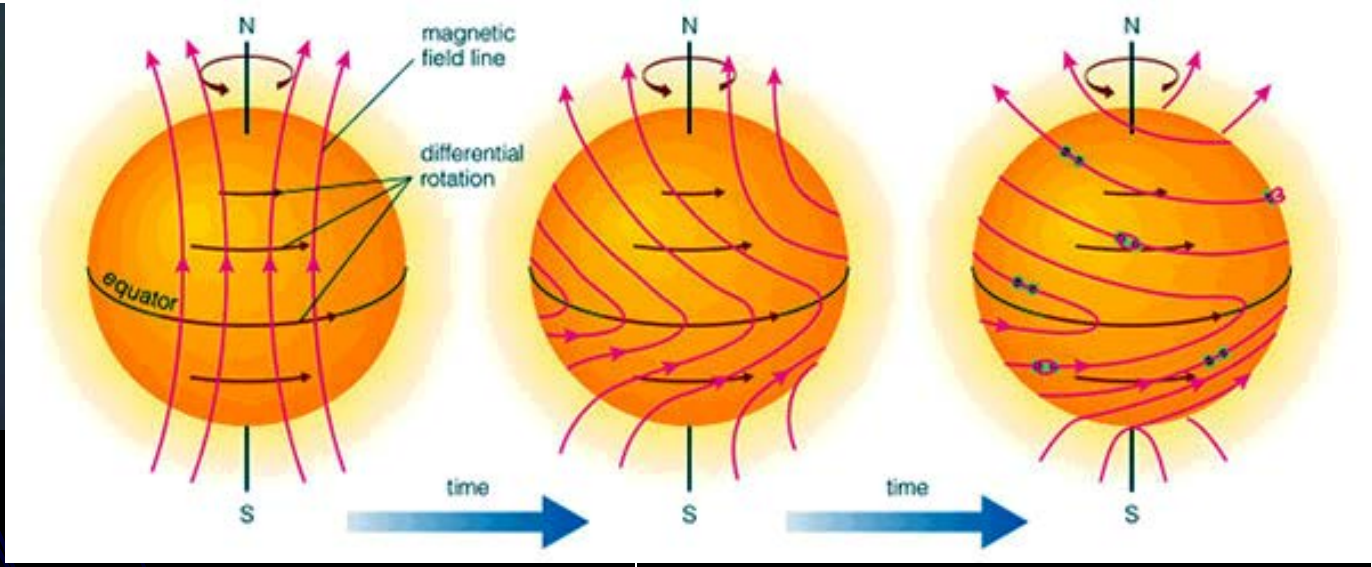


(c) Magnetogram of a sunspot group

Activity Cycle: Babcock Dynamo Model

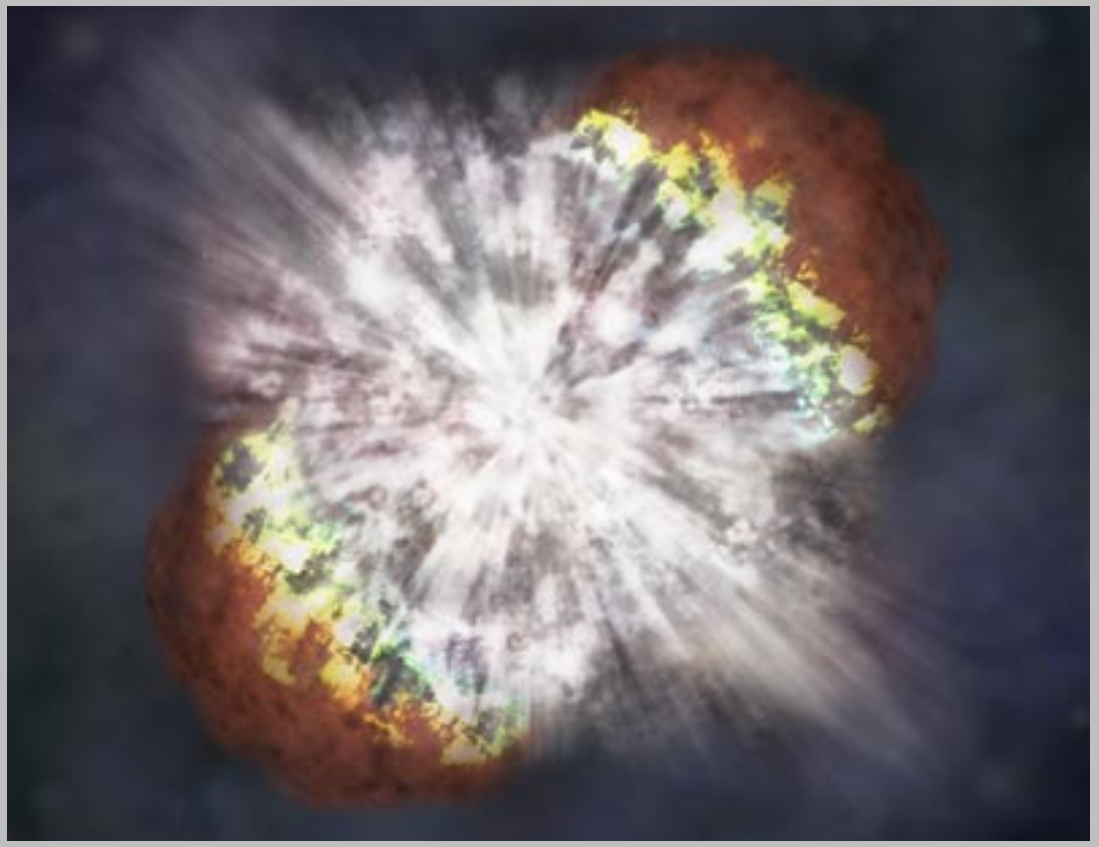






Physics and Space Sciences Department Colloquium:

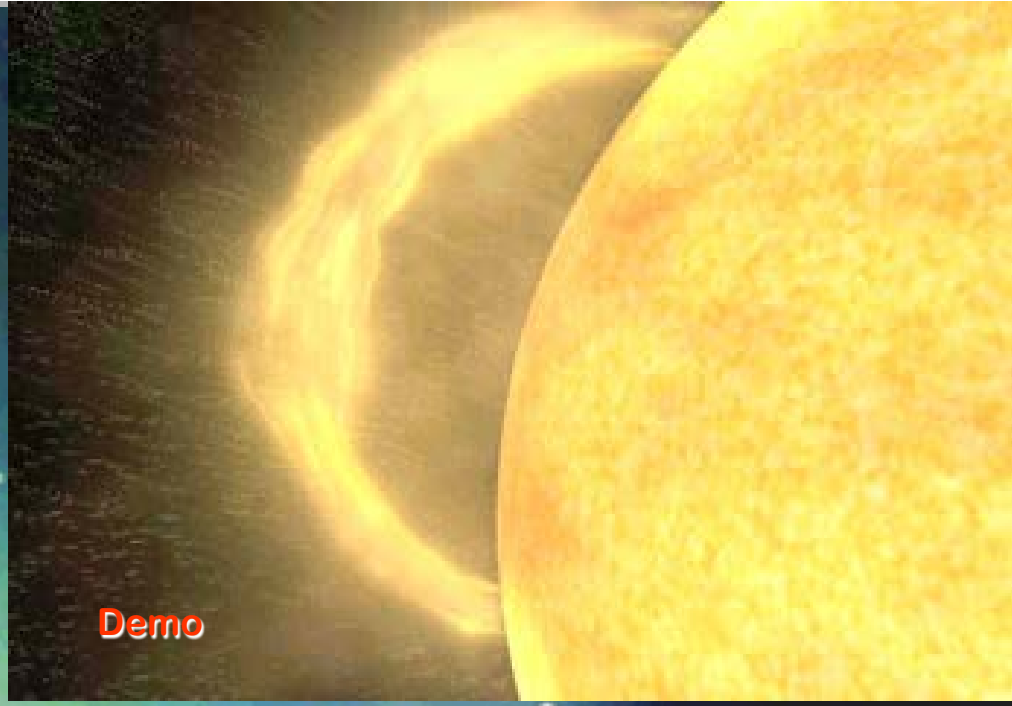
Seed Magnetic Field Generation in the Cosmos



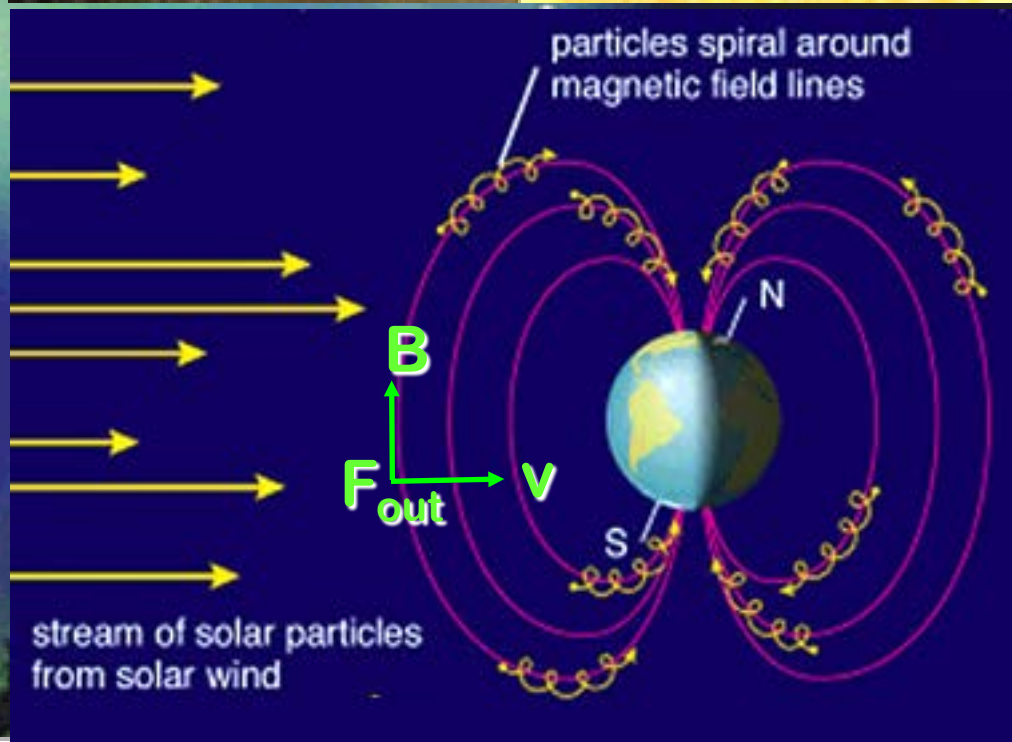
Friday, March 15, 2013
4:00-5:00 P.M.
Olin Physical Sciences
Room 140

Dr. Reinhard Schlickeiser
Ruhr-Universitat Bochum

Solar-Terrestrial Interactions

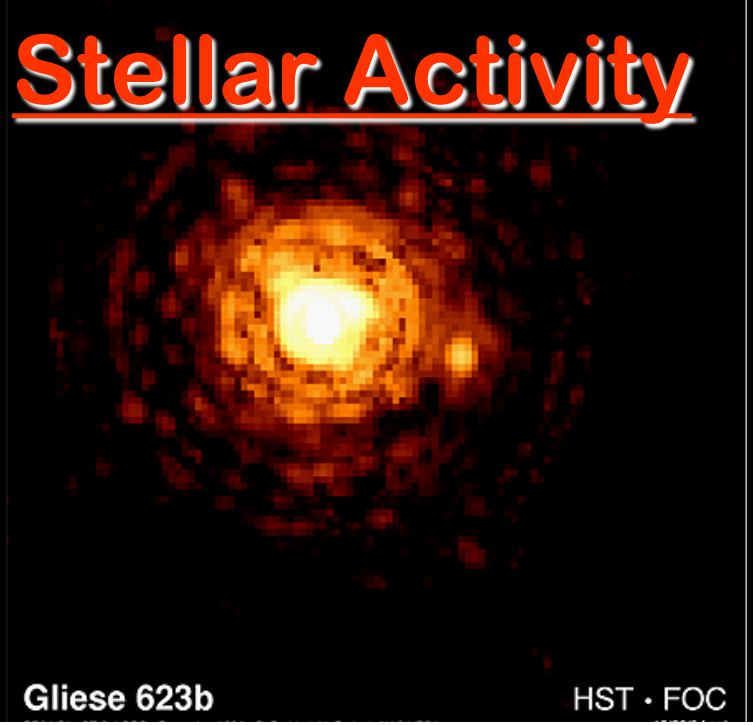


- Aurorae
- Geomagnetic storms
- Power outages
- Satellite damage
- Astronaut hazard
- Climate changes?

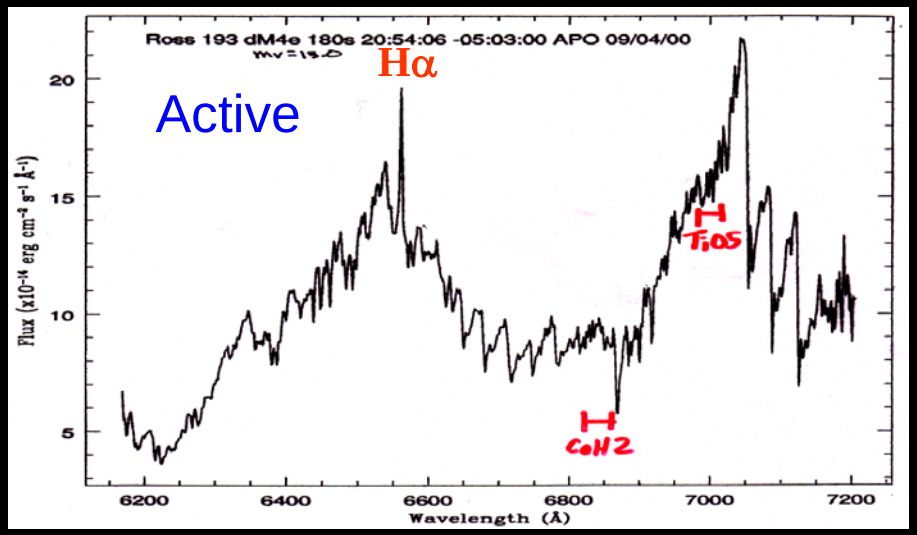


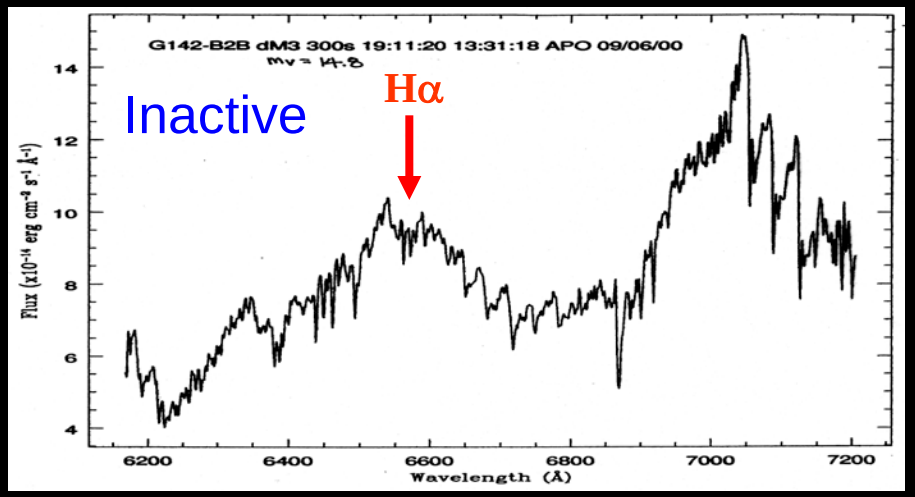
Lorenz Law:
Magnetic Force $\vec{F} = q(\vec{v} \times \vec{B})$

Stellar Activity



Stars get less active as they age- just like people!





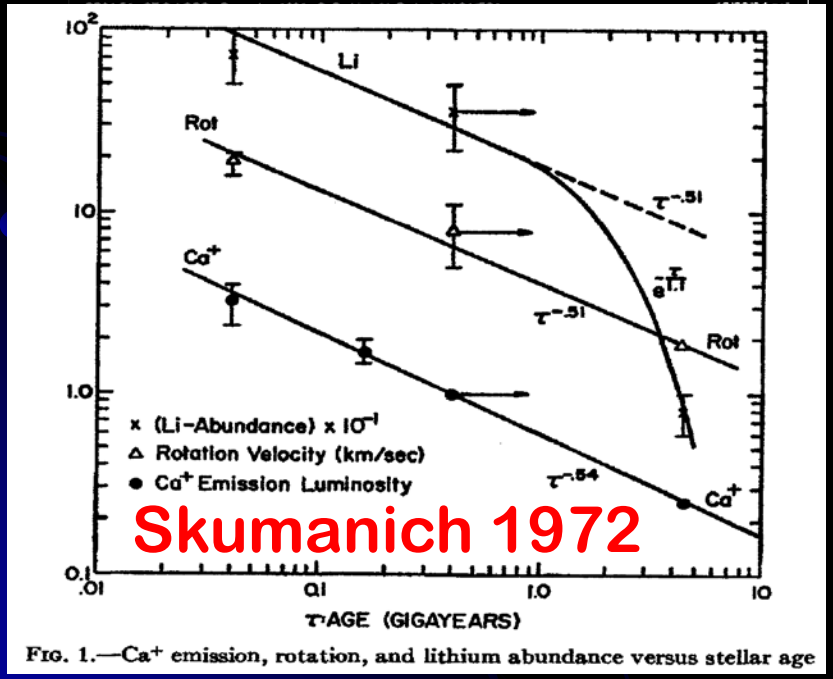


FIG. 1.—Ca+ emission, rotation, and lithium abundance versus stellar age

Stellar Ages