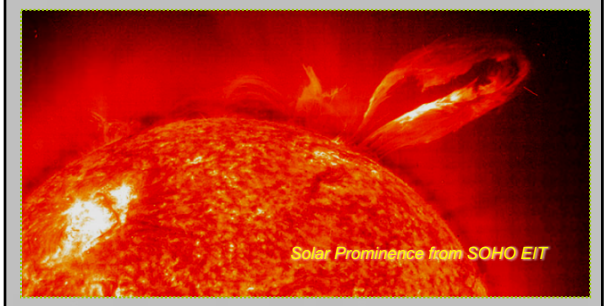
ASTR 1040: Stars & Galaxies



Prof. Juri Toomre TAs: Peri Johnson, Ryan Horton

Lecture 6 Thur 1 Feb 2018

zeus.colorado.edu/astr1040-toomre

Begin this Fiske Planetarium Class Session with

COLORADO SKIES

and the full-dome projection of significant star groupings, including the Pleiades and especially the Orion Nebula in many different wavelength views

Topics for Today and Tues

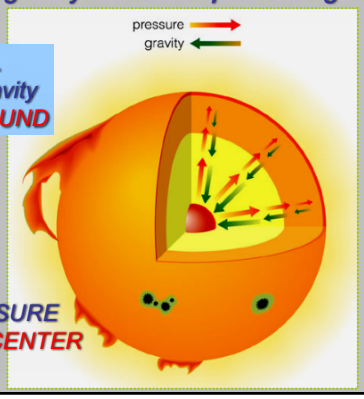
- Start with how Sun is put together
- Why is a star spherical, and does not collapse? (Gravitational equilibration)
- Why does it shine, and must it shine? What is the energy source? (Fusion of H to He)
- Complete detail read Chap 14 (Our Star)
- Read S4.1, S4.2 (quarks, leptons, ..)
- New Homework #3 (The Sun) passed out, HW #2 to be turned in

Next to Our Nearest Star Chap 14

Big Qs about the Sun (and any star)

- Why is a star ROUND ?
- What keeps a star from collapsing inward ?
- What keeps it shining ?
- Why does it rotate and have varying magnetic fields ?

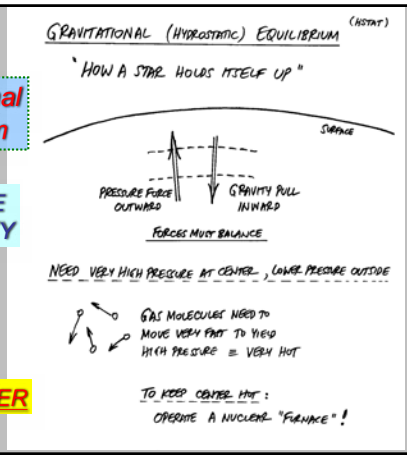
Pull of gravity = Push of pressure gradient



Gravitational equilibrium

PRESSURE vs GRAVITY

HOT CENTER



How to get high central pressure?

In gases, plasmas, "equation of state" is roughly

PRESSURE = DENSITY x TEMPERATURE

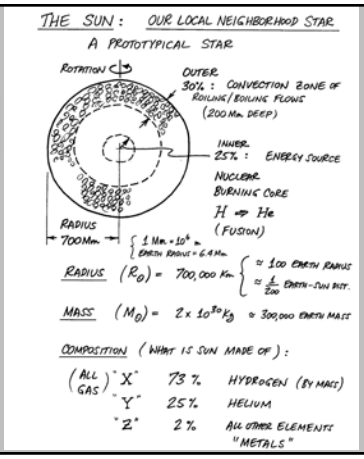
1. *Making the CENTER HOT yields high pressure that keeps star from collapsing*
2. *If really hot, NUCLEAR BURNING can supply the energy that always leaks away from hot places*

Reading Clicker Q D.

- *What is the composition (by mass) of the Sun ?*
- **A.** 100% hydrogen (H) and helium (He)
- **B.** 50% H, 25% He, 25% other elements
- **C.** 70% He, 28% H, 2% other
- **D.** 70% H, 28% He, 2% other
- **E.** 98% H, 2% He and other

OVERVIEW of the Sun

Sun is round, rotates, burns H to He

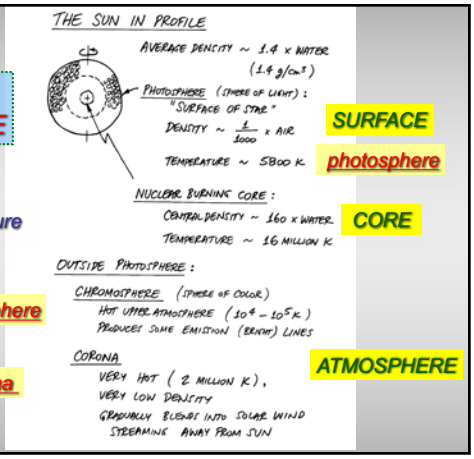


SUN IN PROFILE

Vast range in temperature and density

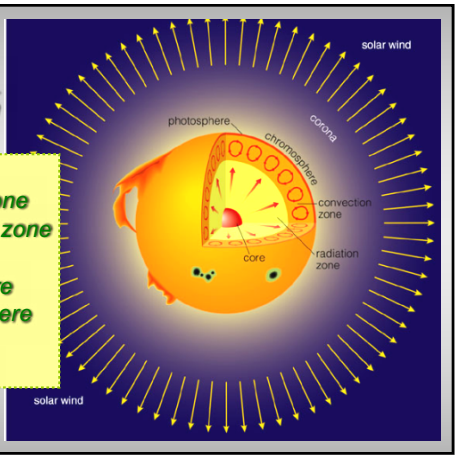
chromosphere

corona



Big System View of Sun

core
radiative zone
convection zone
- - - - -
photosphere
chromosphere
corona
solar wind

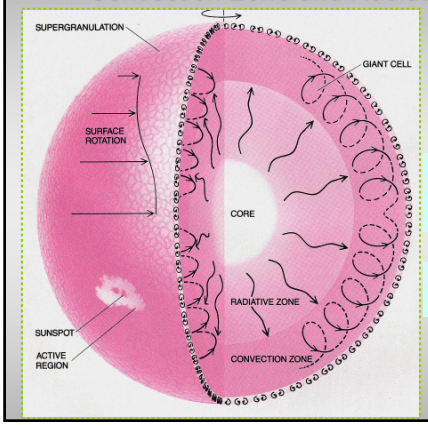


Sun is a big ball of "plasma"

- Hydrogen and helium are ionized by the high temperature throughout most of star
- Such electrically-conducting GAS is called a PLASMA

- Movement of plasma has currents flowing, builds magnetic fields and electric fields

Convection Zone and Radiative Interior

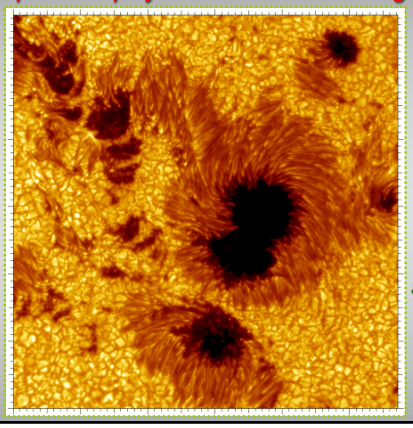


Just below the photosphere:

Deep shell (30%) of very turbulent convection

Drives strong differential rotation

Complex Interplay of Convection and Magnetism

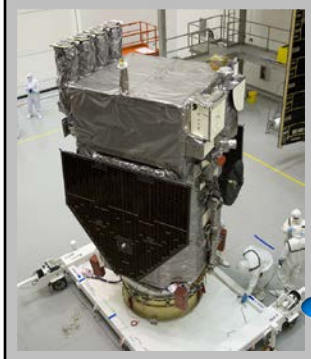


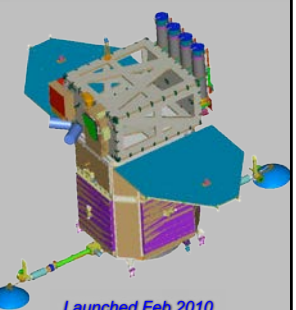
1m Swedish Solar Telescope

1 Mm spacing on ticks

Solar Dynamics Observatory (SDO)

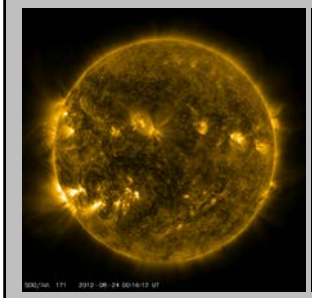
MDI offspring: Helioseismic & Magnetic Imager (HMI)



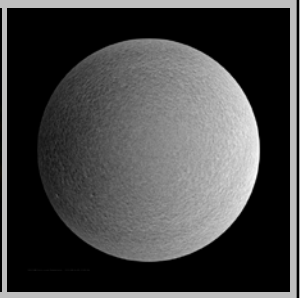


Launched Feb 2010
(4096x4096)

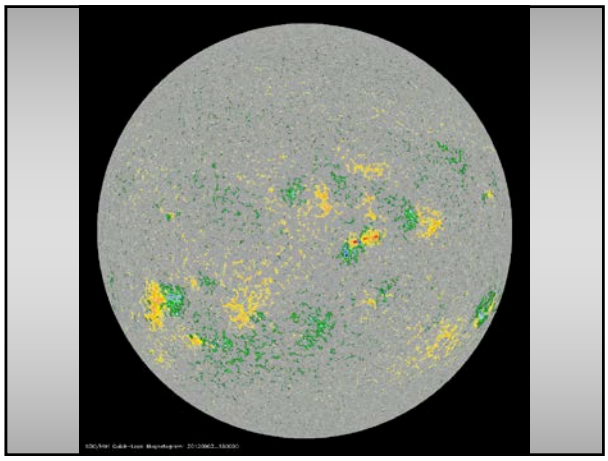
EUV and Visible Images



AIA 171 Å
(Low Corona ~ 6×10^5 K)



HMI Dopplergrams
(Photosphere ~ 5000 K)



The largest optical telescopes are designed to have

- *A.* high magnification, large collecting area, and high angular resolution
- *B.* high magnification, large collecting area, and low angular resolution
- *C.* low magnification, large collecting area, and low angular resolution
- *D.* large collecting area and high angular resolution - the magnification is of secondary importance
- *E.* large collecting area and low angular resolution - the magnification is of secondary importance
- *(high angular resolution = small angle)*

Now let us turn to the full-dome Lucas production

"Solar Superstorms"