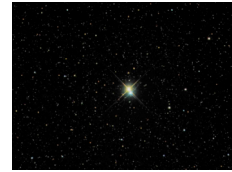


## The Hertzsprung-Russell diagram and the nature of stars

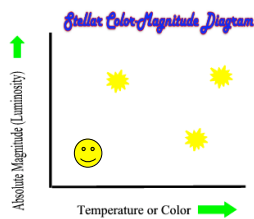


At this point, we have learned a lot about stars: absolute magnitudes (luminosities), distances, temperatures, chemical composition, spectral type...



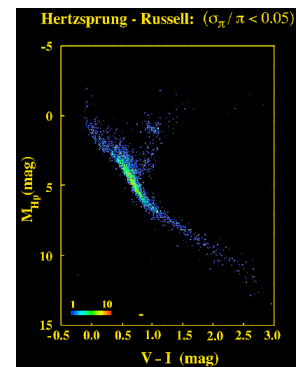
Let's put all the pieces together and learn something really profound about stars

With information provided by spectroscopy, we can search for *correlations* between stellar properties



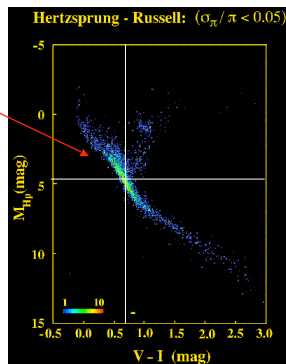
What the data show: the Hertzsprung-Russell Diagram

Highest quality data from the Hipparchus spacecraft

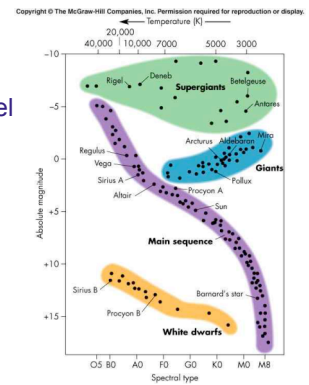


The Sun is here

The Sun is generically related to most other stars. How? Why?



Filling out the Hertzsprung-Russell diagram

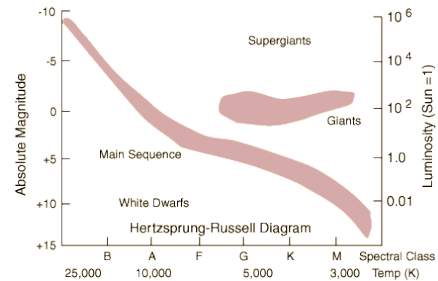


## The Hertzsprung-Russell Diagram and the Types of Stars

- See Figure 16.20
- Types of stars, important terms
- Main Sequence (luminosity class V)
- Giants (luminosity class III)
- Supergiants (luminosity class I)
- White dwarfs

What does it all mean?

## The Hertzsprung-Russell Diagram



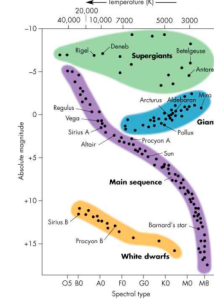
## The scientific classification scheme for the Sun



The Sun is a class G2V star...a main sequence, spectral class G star...the Galaxy probably has a billion of them

## The Hertzsprung-Russell diagram is a plotting board for the nature and evolution of stars

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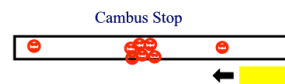


## Understanding the Main Sequence (stars like the Sun)

- A statistical argument (no physics)
- Physical argument 1: what holds stars up?
- Physical argument 2: what powers the stars (where do they get their energy supply?)

## The nature of the Main Sequence #1: the MS as a Cambus Stop

*Density of Students on Dubuque Street*



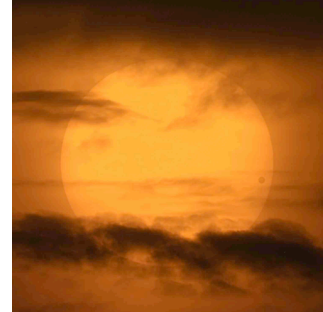
Many more people seen on the sidewalk near a Cambus stop than a random point

The Main Sequence is a long-lived phase of stellar evolution. Stars spend a much longer time here than in other parts of the HR diagram



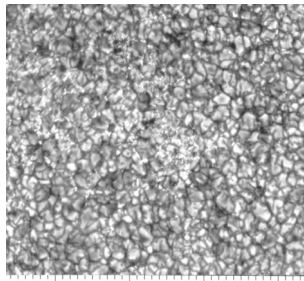
### Back to the Sun: its interior structure

The Sun is a key to understanding the stars because we can get such detailed information about it



### First hint: solar granulation as evidence of convection

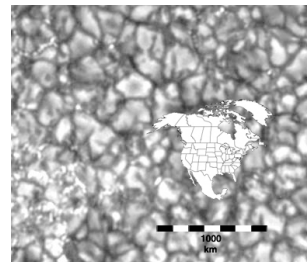
Convection=boiling  
Motion of hot fluid in A gravitational field



Photospheric granulation, G. Scharmer  
Swedish Vacuum Solar Telescope,  
10 July 1997

30 40 50 60  
Distance in units of 1000 kilometers

### The scale of solar granulation



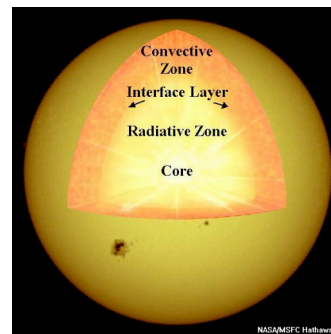
Photospheric granulation, G. Scharmer  
Swedish Vacuum Solar Telescope  
10 July 1997

### How can we know the structure of the Sun below the photosphere?

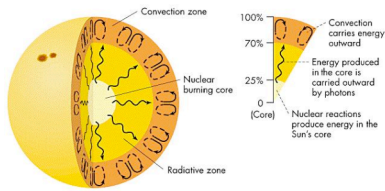
- Application of the laws of physics (equations of stellar structure), find solution consistent with mass and radius of Sun
- Measure "eigenmodes" of the Sun (see how fast it jiggles)
- Results for how the sun is put together



### Our knowledge of the solar interior



### Stellar interior slides from textbook (17.1)



Gravity tends to squeeze a star into ever-smaller object. What resists this tendency?

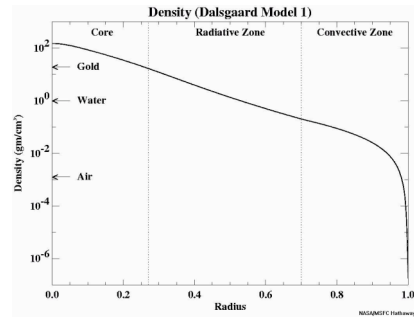
### Physical properties 1: density

- Units: mass/volume  
Grams/cc
- (1) water... 1 grams/cc
  - (2) rock... about 3 grams/cc
  - (3) Lead... 11.3 grams/cc

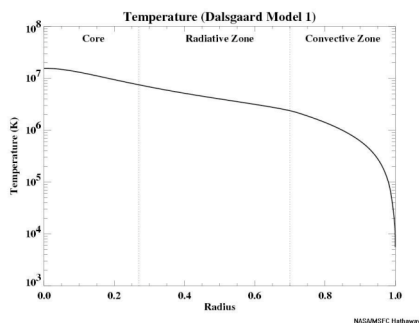
### Physical properties 2: temperature

- Units: degrees centigrade
- Temperature Kelvin: degrees C above absolute zero
- Temperature of this room: 295K
- Boiling point of water: 373 K
- Surface temperature of Sun 5800K

### Distribution of density inside the Sun



### Distribution of temperature inside the Sun



### The interior of the Sun is a region of extreme physical conditions

