ASTR 1020: Stars & Galaxies
February 13, 2008

- MasteringAstronomy Homework on The Properties of Stars is due Feb. 18th.
- Reading: Chapter 15, section 15.1.
- Meet at Fiske Planetarium for class on Feb. 15th.
- Exam 1 – Wednesday, Feb. 20th; Chapters 1, 4, 5, 14, 15.

Fiske Planetarium Show: Science of the Signs, Thursday, Feb. 14th at 8:00 pm.

Today’s Class: Stellar Masses

- Quick Review of
  - Parallax (distance)
  - Temperature measurements

- Measuring stellar masses via binary stars.

Astronomy in the News

Mario Vetanze

Clicker Question: What kind of telescopes would be especially useful for studying the hottest and coolest stars, respectively?

A. Visible and infrared
B. Ultraviolet and infrared
C. Infrared and radio
D. X-ray and ultraviolet
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Clicker Question: Which kind of star is hottest?

A. M star  
B. F star  
C. A star  
D. K star  

How do we measure stellar masses?

The orbit of a binary star system depends on strength of gravity.
Animation of Binary Stars

Albireo: A Bright and Beautiful Double

Types of Binary Star Systems

- Visual Binary
- Eclipsing Binary
- Spectroscopic Binary

About half of all stars are in binary systems

Visual Binary

We can directly observe the orbital motions of these stars

Eclipsing Binary

We can measure periodic eclipses

Spectroscopic Binary

We determine the orbit by measuring Doppler shifts

We measure mass using gravity

Direct mass measurements are possible only for stars in binary star systems

\[ p^2 = \frac{4\pi^2}{G(M_1 + M_2)} a^3 \]

\[ p = \text{period} \]
\[ a = \text{average separation} \]
Clicker Question
What 2 pieces of information do you need to measure the mass of stars in an *eclipsing binary system*?

a) Time between eclipses & distance between stars.
b) Period of binary system & its distance to the Earth.
c) Velocities of the stars & the Doppler shifts of absorption lines.

Need 2 out of 3 observables to measure mass:

1) Orbital Period ($p$)
2) Orbital Separation ($a$ or $r = \text{radius}$)
3) Orbital Velocity ($v$)

For circular orbits, $v = \frac{2\pi r}{p}$

What have we learned?
• How do we measure stellar masses?
  – Newton’s version of Kepler’s third law tells us the total mass of a binary system, if we can measure the orbital period ($p$) and average orbital separation of the system ($a$)

Most massive stars: $100 M_{\odot}$
Least massive stars: $0.08 M_{\odot}$
($M_{\odot}$ is the mass of the Sun)