

ASTR 1020: Stars & Galaxies

February 13, 2008

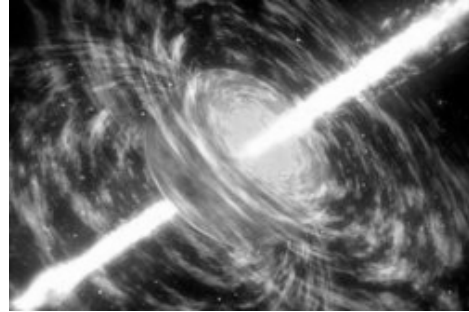
- *MasteringAstronomy* Homework on The Properties of Stars is due Feb. 18th.
- Reading: Chapter 15, section 15.1.
- Meet at Fiske Planetarium for class on Feb. 15th.
- Exam 1 – Wednesday, Feb. 20th; Chapters 1, 4, 5, 14, 15.

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

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Astronomy in the News

Mario Vetanze



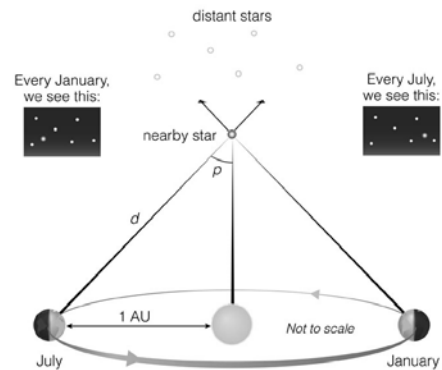
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Today's Class: Stellar Masses

- Quick Review of
 - Parallax (distance)
 - Temperature measurements
- Measuring stellar masses via binary stars.



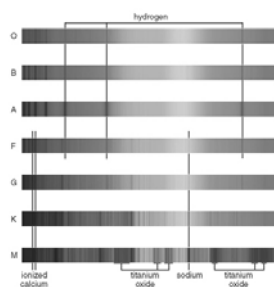
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How do we measure distances to stars?

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How do we measure stellar temperatures?



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

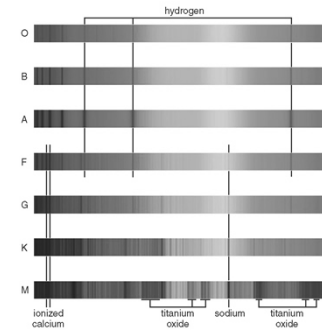
- A. Visible and infrared
- B. Ultraviolet and infrared
- C. Infrared and radio
- D. X-ray and ultraviolet

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Lines in a star's spectrum correspond to a *spectral type* that reveals its temperature

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Clicker Question

Which kind of star is hottest?

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

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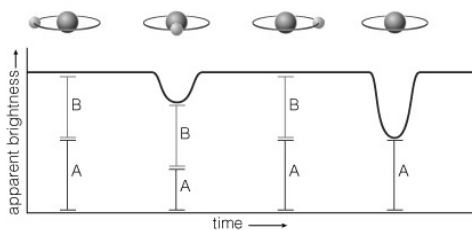
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How do we measure stellar masses?



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The orbit of a binary star system depends on strength of gravity

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Animation of Binary Stars



Albireo: A Bright and Beautiful Double

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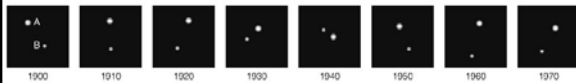
Types of Binary Star Systems

- Visual Binary
- Eclipsing Binary
- Spectroscopic Binary

About half of all stars are in binary systems

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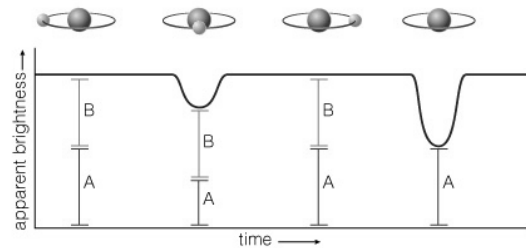
Visual Binary



We can directly observe the orbital motions of these stars

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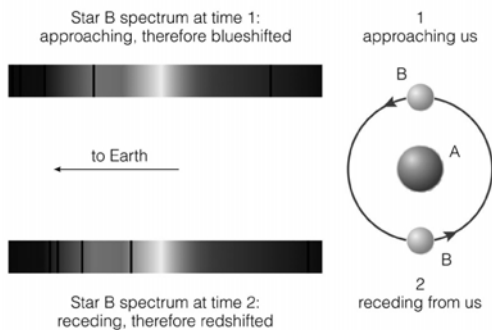
Eclipsing Binary



We can measure periodic eclipses

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Spectroscopic Binary



We determine the orbit by measuring Doppler shifts

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Isaac Newton

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 = period

a = average separation

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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.

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Clicker Question

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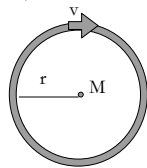
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Need 2 out of 3 observables to measure mass:

- 1) Orbital Period (p)
- 2) Orbital Separation (a or $r =$ radius)
- 3) Orbital Velocity (v)

For circular orbits, $v = 2\pi r / p$



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Most massive stars:

$100 M_{\text{Sun}}$

Least massive stars:

$0.08 M_{\text{Sun}}$

(M_{Sun} is the mass of the Sun)

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)

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