

ASTR 1120: Stars & Galaxies



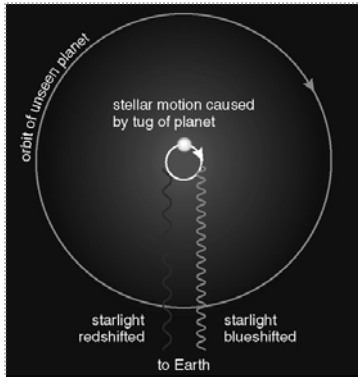
NGC 1232
Spiral Sb

Prof. Juri Toomre TA: Ben Brown
Lecture 32 Fri 1 Apr 05
zeus.colorado.edu/astr1120-toomre

Today's Topics

- Today we look at the challenge of *measuring big distances* to figure out how far away things are in universe – leads to *Hubble's law of expansion*
- Read *20.4 Measuring Cosmic Ages* carefully for Mon lecture
- Class in *Fiske Planetarium* next Wed (April 6) – go there directly: *Dick McCray: "Supernovae"*
- New *Homework Set 9* on Planet Finder handed out today – will discuss in detail – unusual format. Recall that *HW 8* is due in class on Monday

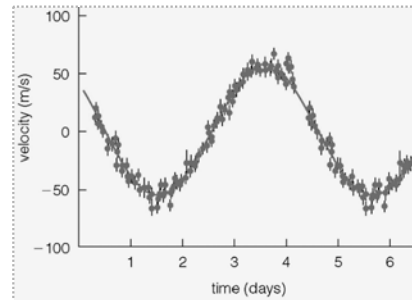
Life Elsewhere: Planet Finder



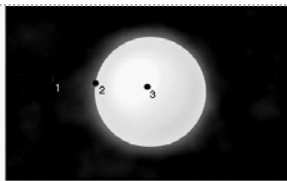
Deduce presence of planet by Doppler wobble of star around center of mass of system

HOT SUBJECT

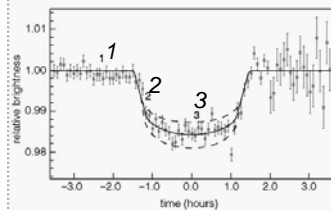
Signature of unseen companion: Doppler wobble of star



Read 9.6 Other Planetary Systems



Another route: observe dimming by planet passing in front of star



Overall about 100 stars with planets found so far, mostly by Doppler wobble

Good Background Reading for Homework 9: Planet Finder

- In textbook, read carefully *Chap 9.6 Other Planetary Systems*
- In *McCray Hypertext link* (from course website), look at 9. *Star Formation*, section 4: Extra-Solar Planets
- Now for a detailed demo by Ben
- Note special *help labs* next week

Clicker -- reading on galaxies

• How might you classify this galaxy?

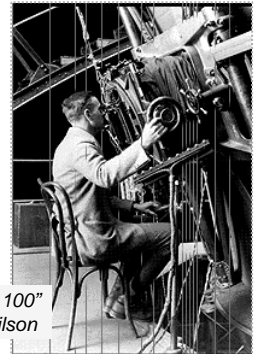
- A. Sa
- B. SBb
- C. E
- D. SO



Hubble: Andromeda is separate galaxy far outside Milky Way

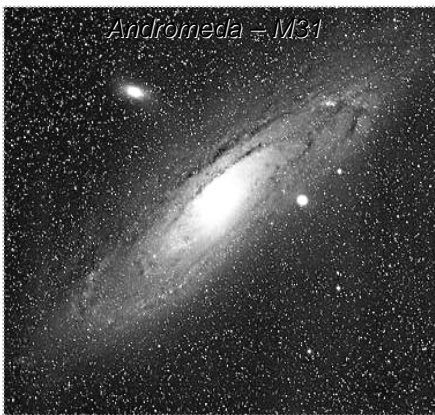
REMINDER

- Edwin Hubble in 1924 identified Cepheids in Andromeda (M33) → showed they were far outside of Milky Way!
- Then got busy with other galaxies.....



Hubble using new 100" telescope at Mt Wilson

Andromeda = M31



Hubble: showed universe appeared to be expanding!

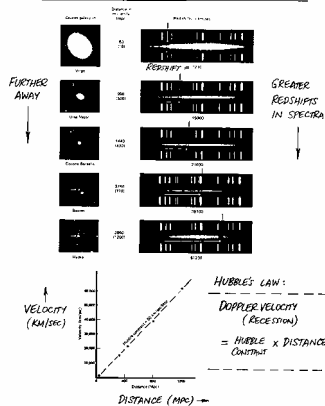
- Vesto Slipher (1912) reported that most galaxies showed Doppler redshifts
- Edwin Hubble, using new 100" telescope, started busily measuring galaxy redshifts
- Hubble (1929) announced that redshifts of galaxies appear to increase with distance from us
- This was startling: suggests an EXPANDING UNIVERSE !

Hubble and recession of galaxies: measured many redshifts

Further away, greater redshift !

Hubble guessed their distances by size and brightness -- underestimated by factor 10!

HUBBLE'S DISCOVERY OF RECESSION OF GALAXIES



"Hubble's Law"

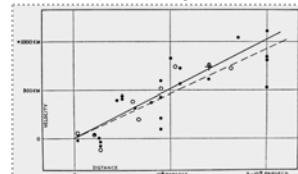
REDSHIFTS OF GALAXIES

HUBBLE VELOCITY - DISTANCE LAW
(FOR AN EXPANDING UNIVERSE)

$$v = H \times d$$

VELOCITY OF RECESSION (DOPPLER SHIFT) = HUBBLE CONSTANT x DISTANCE

Hubble's (1929) original



(km/sec) ~ 50 → 100 (Mpc)
km/sec/Mpc

Scatter here from random velocities of nearby galaxies, unreliable distance estimates

