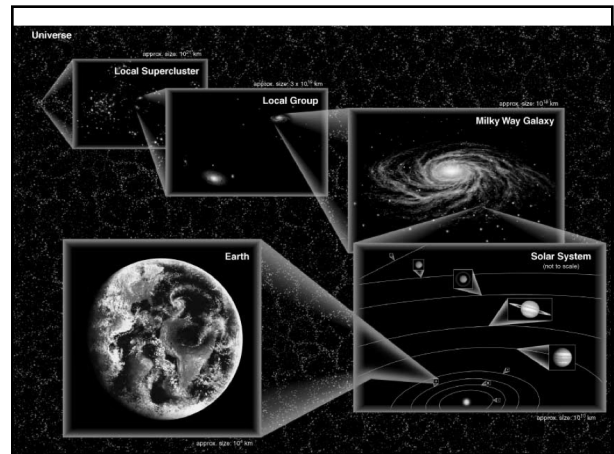
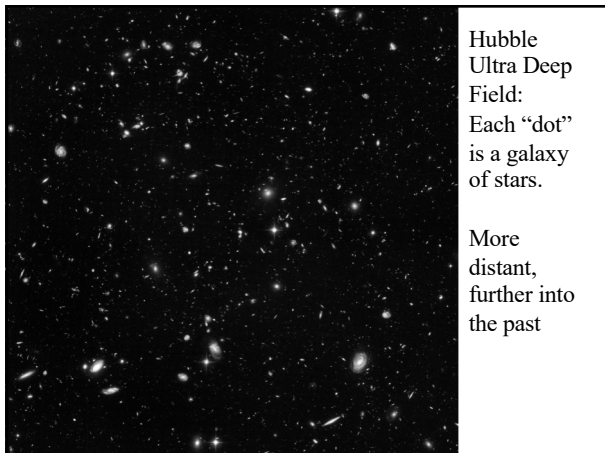


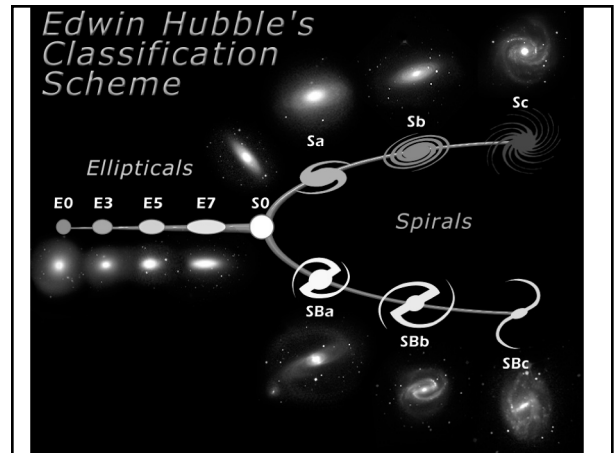
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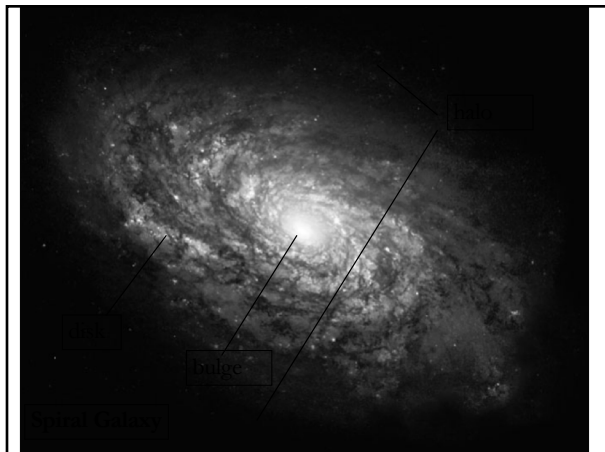
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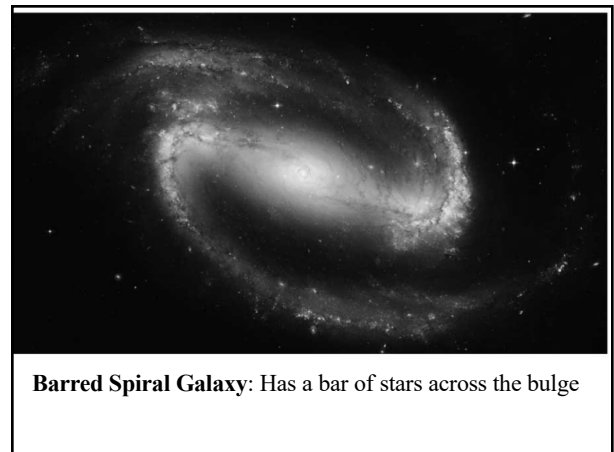
3



4



5

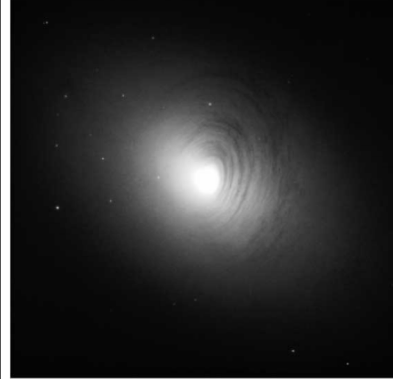


6



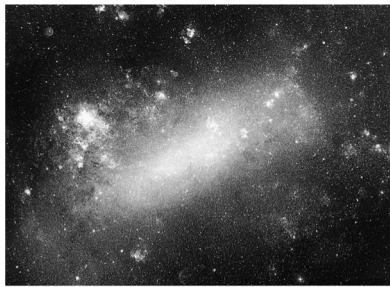
Elliptical Galaxy:
All spheroidal component, virtually no disk component

7



Lenticular Galaxy:
Has a disk like a spiral galaxy but much less dusty gas (intermediate between spiral and elliptical)

8

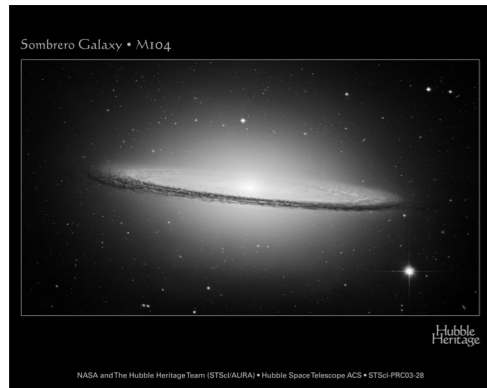


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Irregular Galaxy

9

What type? 1) M104



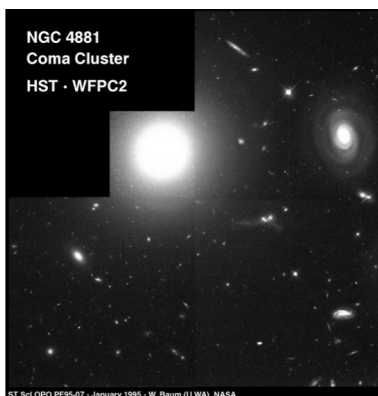
Sombrero Galaxy • M104

Hubble Heritage

NASA and The Hubble Heritage Team (STScI/AURA) • Hubble Space Telescope ACS • STScI-PRC03-28

10

2) NGC4881



NGC 4881
Coma Cluster
HST • WFPC2

ST ScI OPO PF95-07 - January 1995 - W. Baum (UWA), NASA

11

3) NGC3370



Spiral Galaxy NGC 3370

Hubble Heritage

NASA, The Hubble Heritage Team and A. Riess (STScI) • Hubble Space Telescope ACS • STScI-PRC03-24

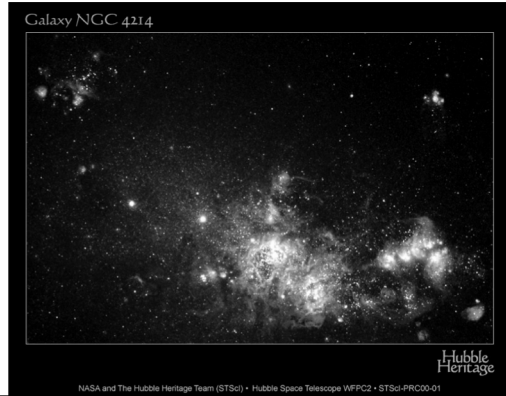
12

4) NGC1365



13

5) NGC4214



14

Quiz Answers

1. M104 Spiral
2. NGC4881 Elliptical
3. NGC3370 Spiral
4. NGC1365 Barred Spiral
5. NGC4214 Irregular

Good at this?

www.galaxyzoo.org

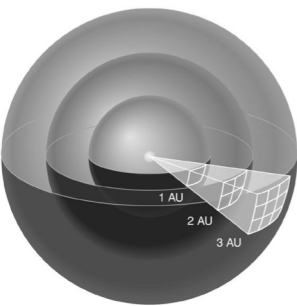
15

Milky Way is a barred spiral galaxy



16

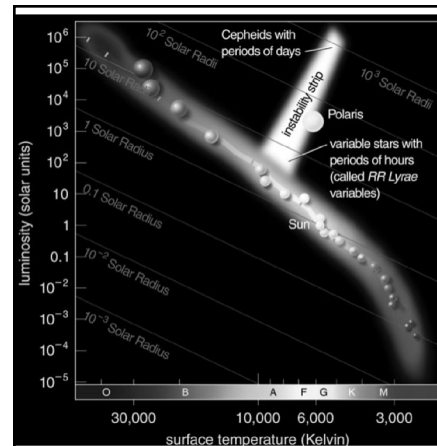
Distances to Galaxies



Luminosity is spread over larger area
 $4\pi (\text{radius})^2$
 with distance.
 If you know luminosity and brightness, you can estimate distance.

A **standard candle** is an object whose luminosity is known; helpful if it is very luminous, seen to great distance.

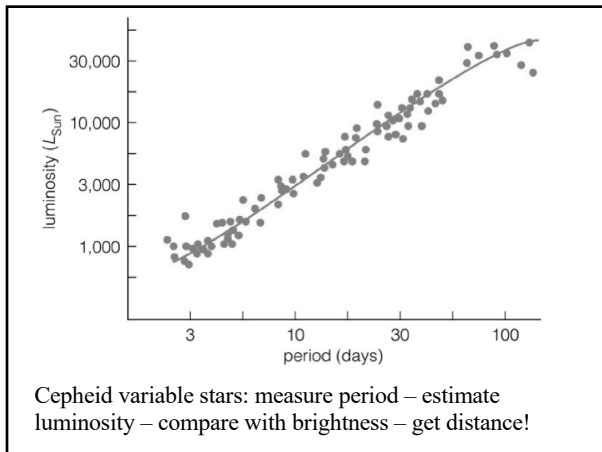
17



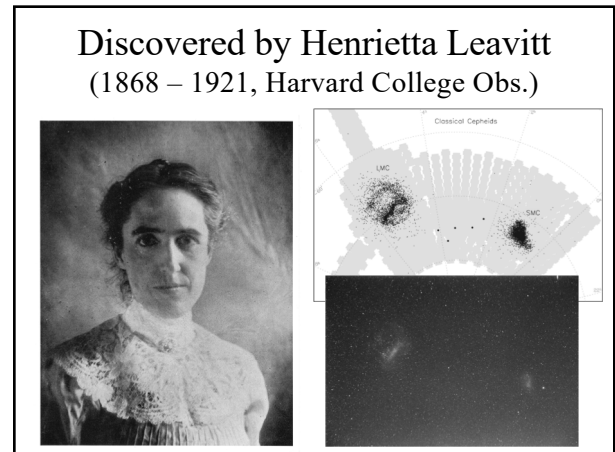
Cepheid variable stars are very luminous.

Luminosity related to pulsation period.

18



19



20

Nature of Spiral Nebulae?

Spiral nebulae:
local clouds or
Island universes?

Edwin Hubble (1924)
found Cepheid
variable stars in M31
using the Mt Wilson
100-inch telescope:
Distance = 700 kpc
(23x Milky Way diameter)

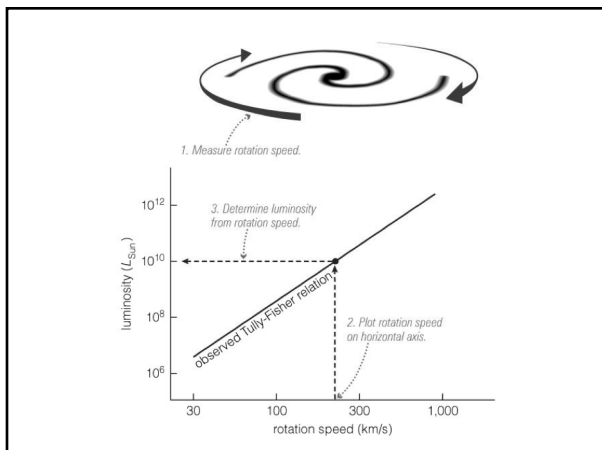
**Milky Way just one of
billions of galaxies in
visible universe!**

21

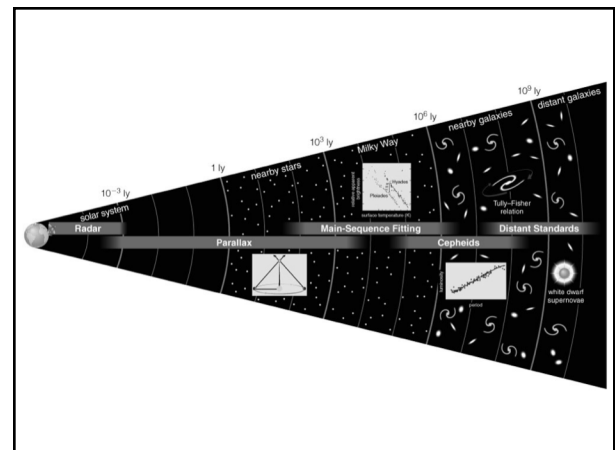
Standard Candles

- Cepheid and other variable stars
- Brightest stars
- Novae
- Supernovae (esp. white dwarf explosions)
- Mass – luminosity relations for entire galaxies (Tully Fisher Relation)

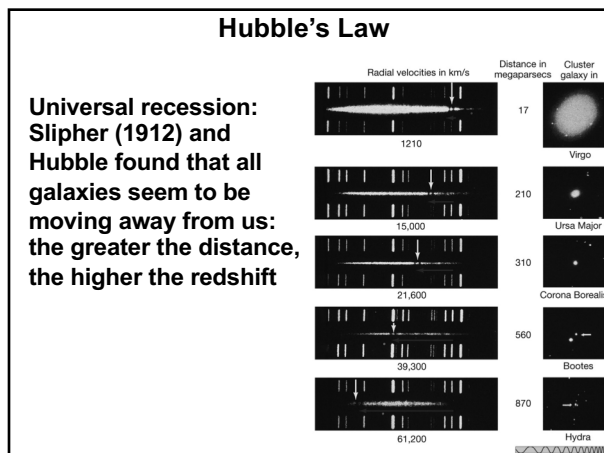
22



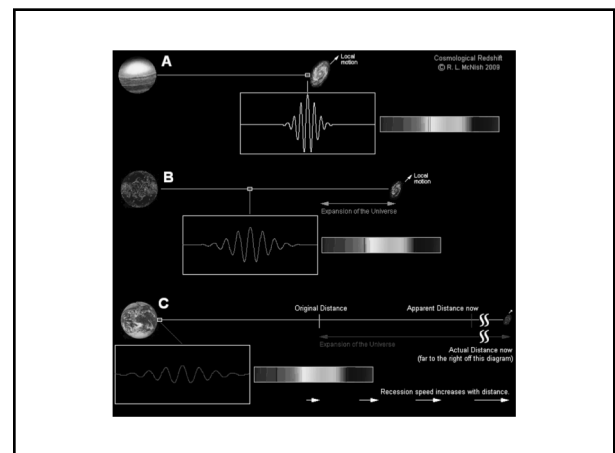
23



24



25



26

Hubble's Law

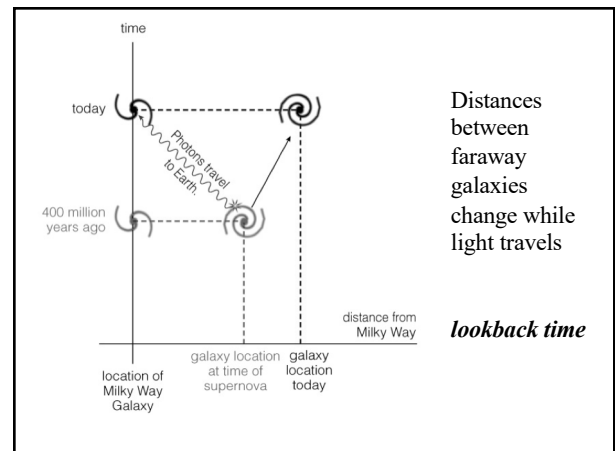
The relationship is set by Hubble's constant H_0 :

$$\text{recessional velocity} = H_0 \times \text{distance}$$

The current value for Hubble's constant is
 $H_0 = 72 \text{ km/sec/megaparsec}$
 (1 megaparsec = 10^6 parsec)

Measure Doppler shift for velocity – Hubble's law will then give distance.
Best way to make large scale maps of Universe.

27



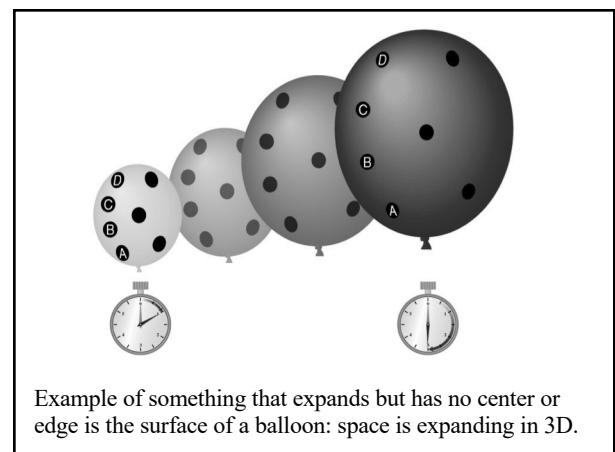
28

Cosmological Principle

The universe looks about the same everywhere.

- Expansion looks same to all observers
- No center & no edges
- Not proved but consistent with observations

29



30