

## The Great Debate: *The Size of the Universe* (1920)



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- Our Galaxy is rather small, with Sun near the center.
  - 30,000 LY diameter.
- Universe composed of many separate galaxies
  - Spiral nebulae = “island universes”



### Harlow Shapley

- Our Galaxy is very large, with Sun far from center.
  - 300,000 LY diameter.
  - Sun 60,000 LY from center.
- Spiral Nebulae are inside our galaxy.
  - “nova” magnitudes
  - “Proper motion” → rapid rotation.

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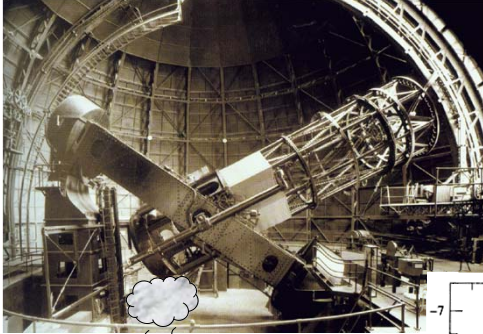
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## Astronomy in 1926

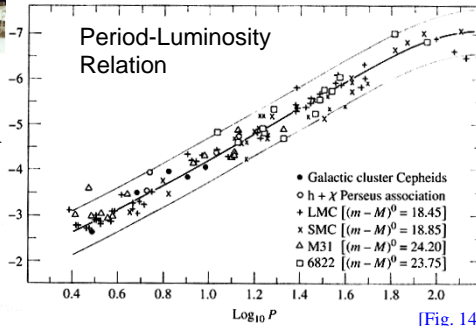
100 inch telescope  
Completed 1918



Edwin Hubble

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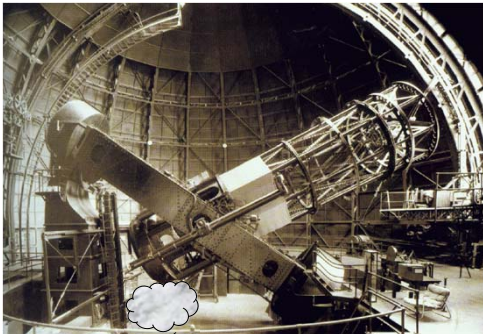
$\langle M_V \rangle$



- ~1770: Messier catalogue
- 1888: NGC, IC catalogues
- 1916: Van Maanen's results
- 1920: Curtis-Shapley debate
- **1923: Hubble measured distance to M31**
  - Pulsating variables

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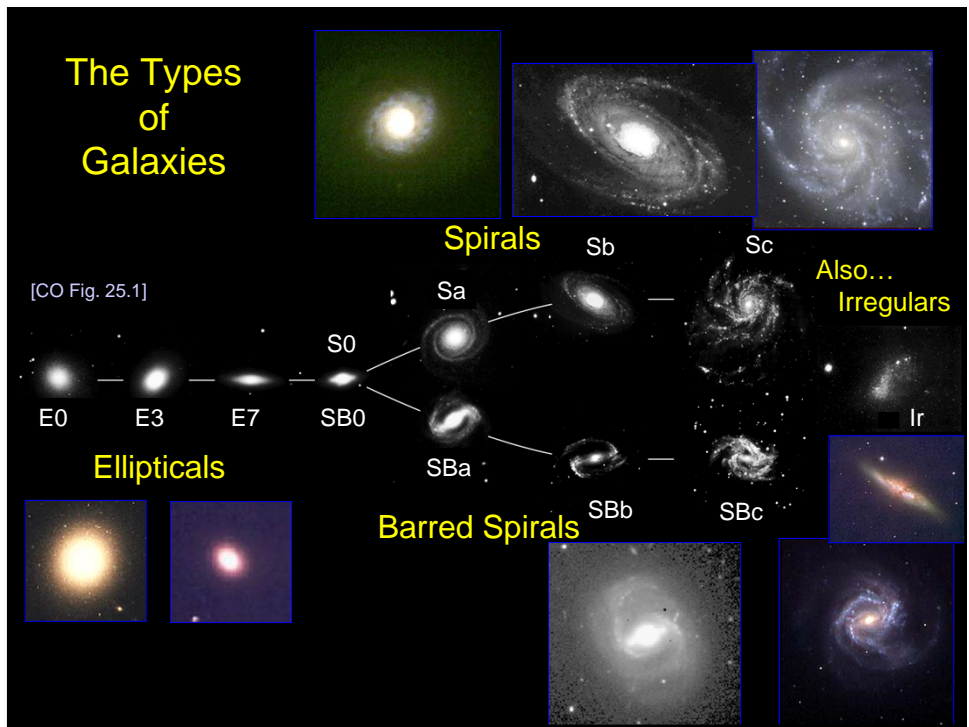
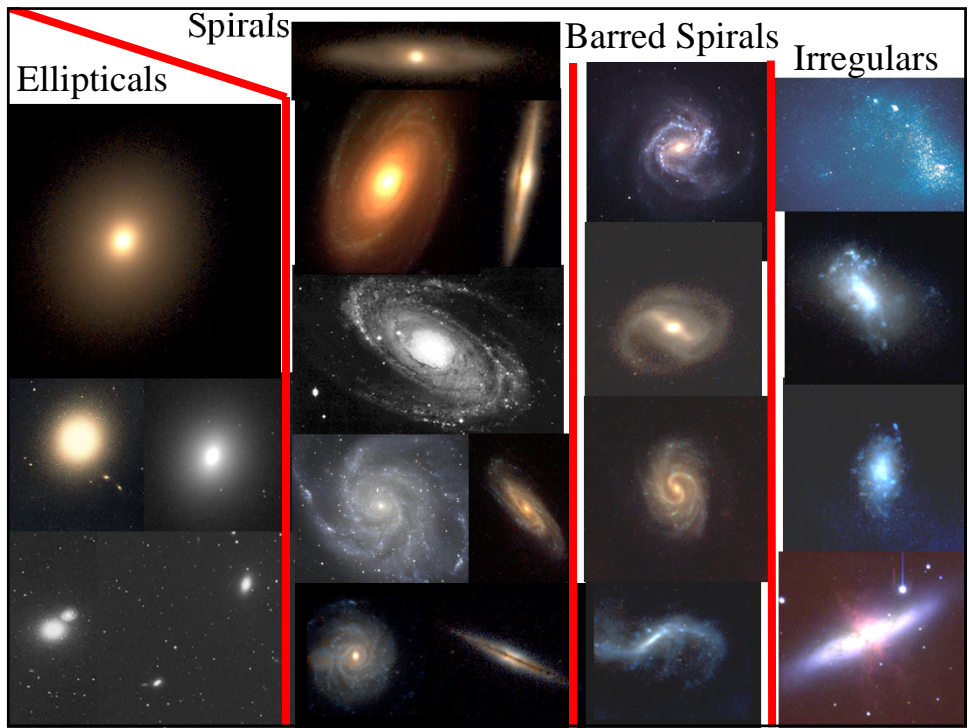


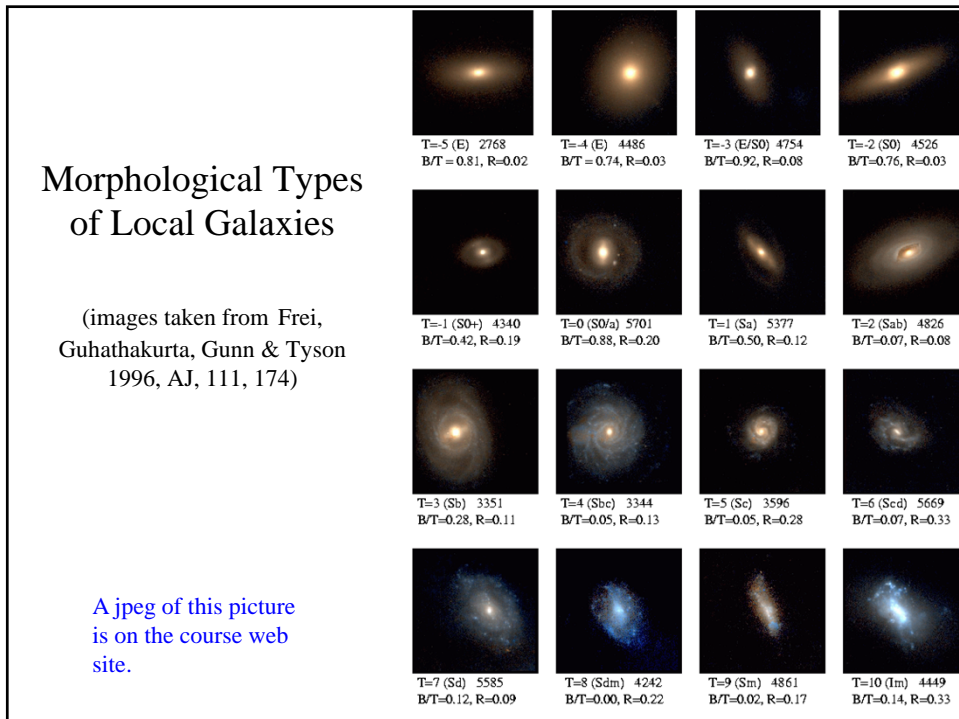
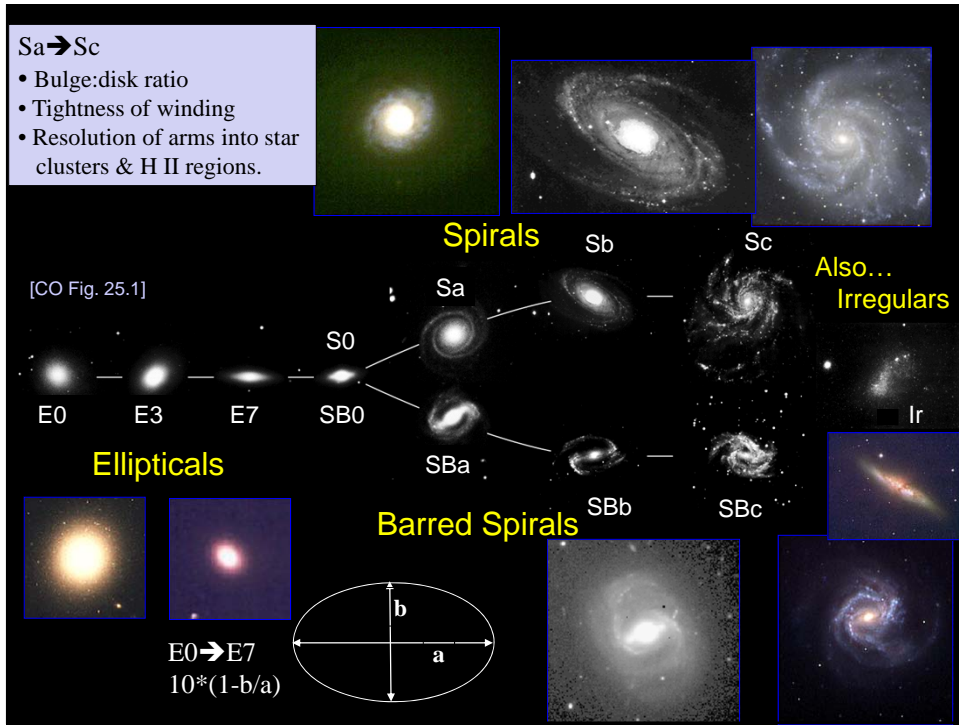
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- **1926: Hubble's E, S, I galaxy classification scheme.**

- 1929 Expanding Universe
- 1936: *Realm of the Nebulae* described Hubble classification system.





## Usual classes used at current time:

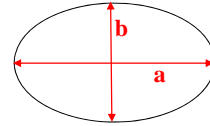
- E0-E7
- S0, Sa, Sab, Sb, Sbc, Sc, Scd, Sd, Sdm, Sm, Im, Ir (or amorphous)
- SB0, SBa, SBab, SBb, SBbc, SBc, SBcd, SBd, SBdm, SBm

### General Properties of Galaxy Types

#### • E

- Luminosity (B) =  $10^5 - 10^{12} L_{\odot}$   
 $M_B = -15$  to  $-25$
- Mass =  $10^7 - 10^{14} M_{\odot}$
- Luminous dia. <1 kpc – hundreds of kpc

E0 → E7  
 $10^{*(1-b/a)}$



#### • S

- $L = 10^8 - 10^{11} L_{\odot}$   
 $M_B = -16$  to  $-23$
- Mass =  $10^9 - 10^{12} M_{\odot}$
- Luminous dia. 5-100 kpc

Sa → Sc

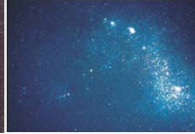
- Bulge:disk ratio
- Tightness of winding
- Resolution of arms into star clusters & H II regions.

#### • Irr

- $L = 10^7 - 10^{10} L_{\odot}$   
 $M_B = -13$  to  $-20$
- Mass =  $10^8 - 10^{10} M_{\odot}$
- Luminous dia. 1–10 kpc



LMC (Irr I, SBm)



SMC (Irr I, Im)



M82 (Irr II, Ir)