

1 Galaxies

The spiral nebula were once thought to be within the Milky Way
These galaxies are islands of stars



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1.1 Types of galaxies

We describe galaxies by their shapes. We will find that present day galaxy shapes are different than galaxies in the distant past.

1.1.1 Elliptical Galaxies



Round or elliptical collections of stars, dust and gas
Some are small dwarf ellipticals, containing as few as 10 million stars
Some are giants, containing 50 times the mass of the Milky Way
Make up about 60% of all galaxies

Shapes of Elliptical Galaxies Measured on a scale E_0 , E_1 , E_2 , E_3 , E_4 , E_5 , E_6 , E_7
 E_0 is spherical in shape



M 32 Andromeda

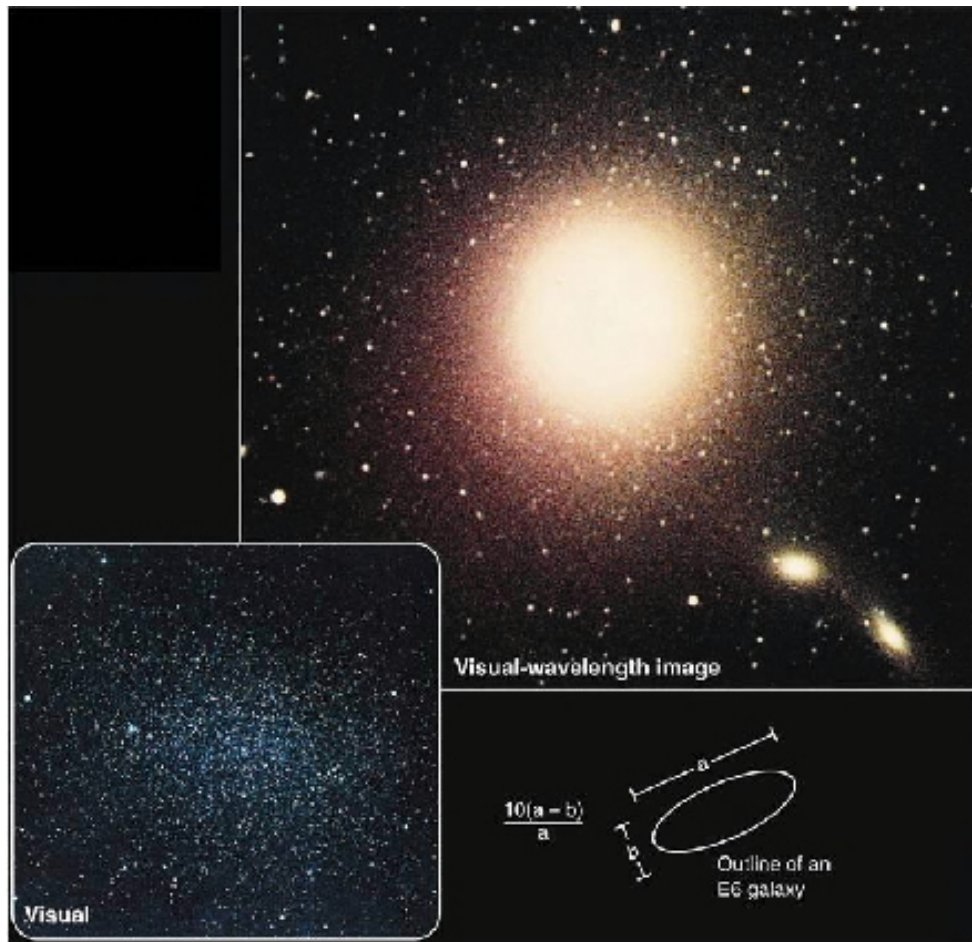
E7 is most elliptical in shape



The number comes about by using the formula

$$\frac{10(a - b)}{a}$$

rounded to the nearest integer

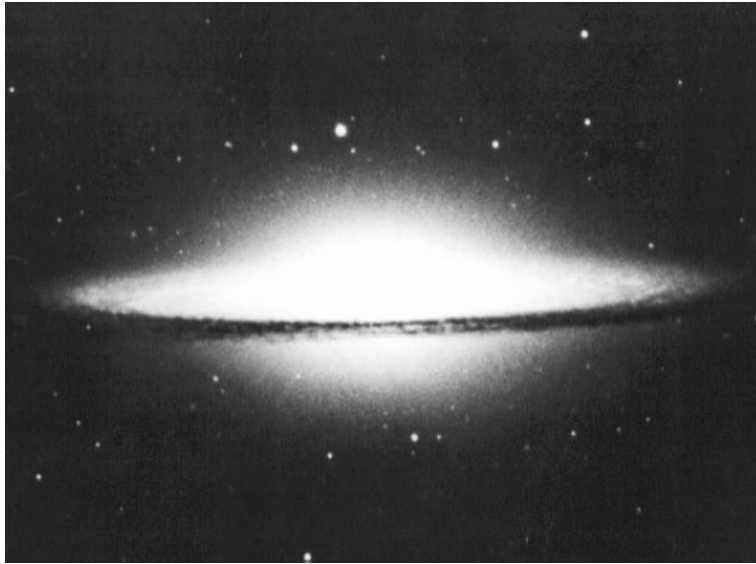


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Each star follows its own orbit around the center like swarming bees

1.1.2 Spiral Galaxies

Regular spirals - Sa, Sb, Sc where a represents tightly wound spiral arms and c represents loosely wound spiral arms



M 104 - Sa



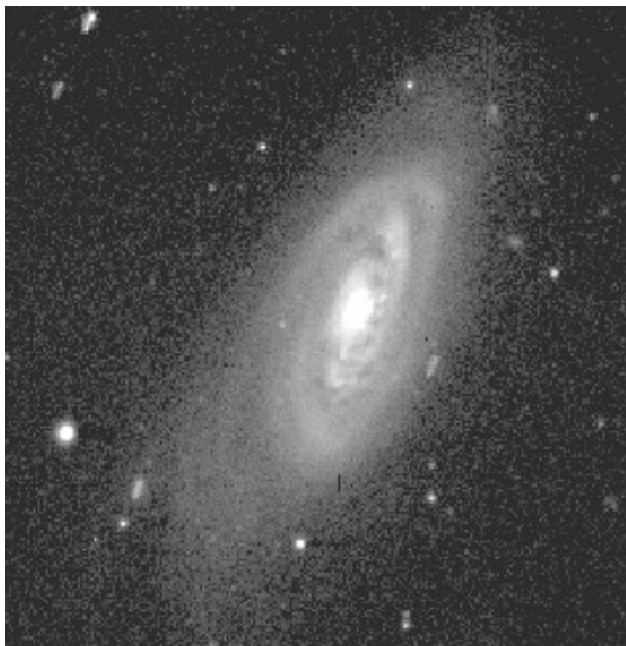
M 31 - Sb type galaxy





M 51 - Sc type galaxy

Barred spirals - *SBa*, *SBb*, *SBc* and same as above



M 90 - SBc type galaxy

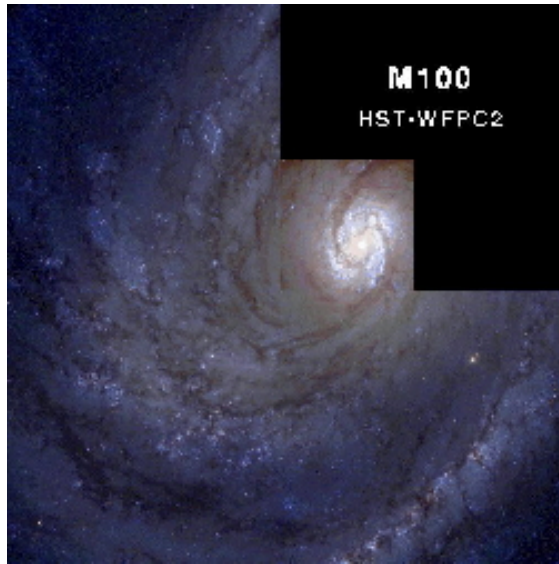
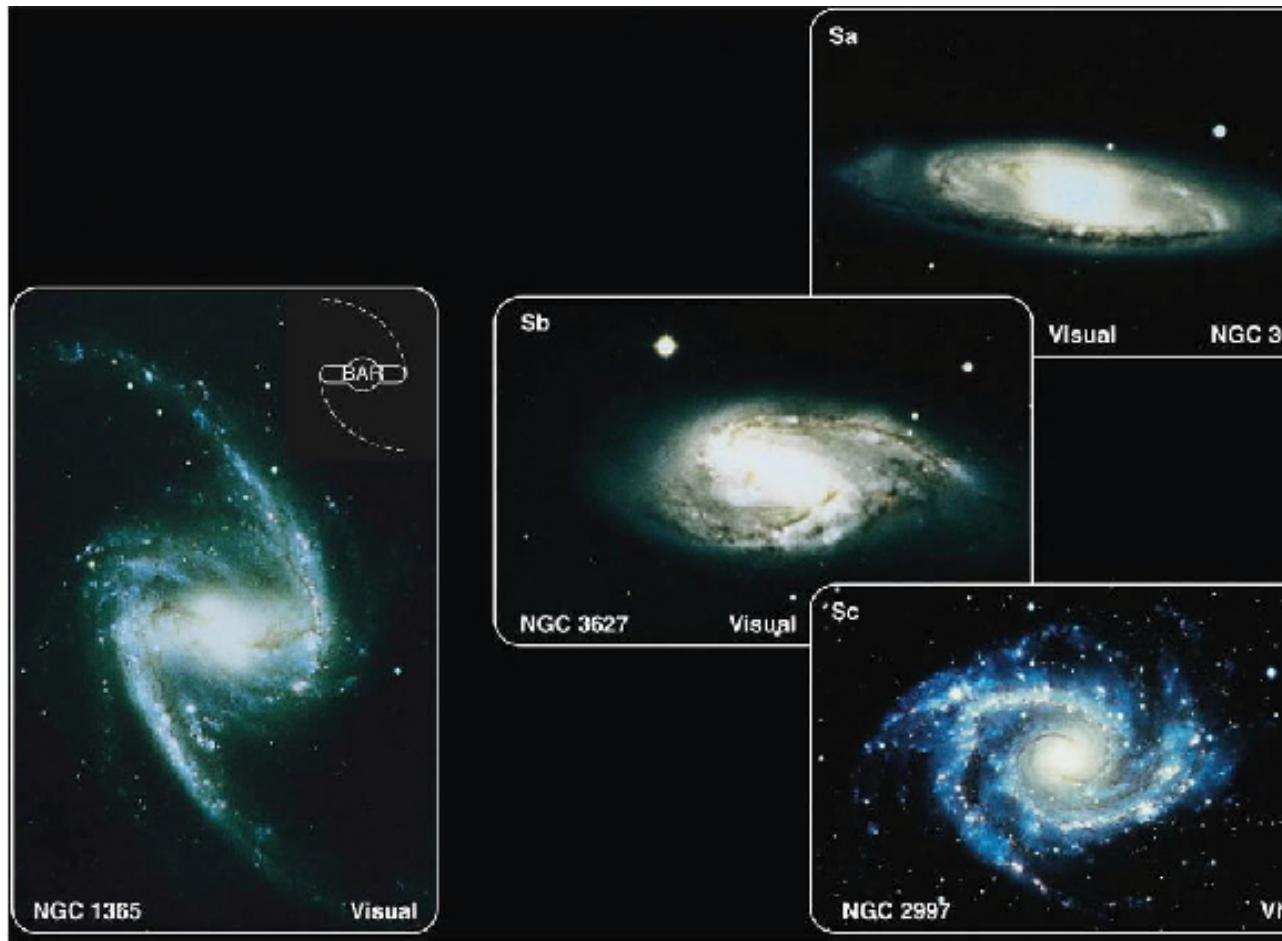


Figure 1: Hubble photo



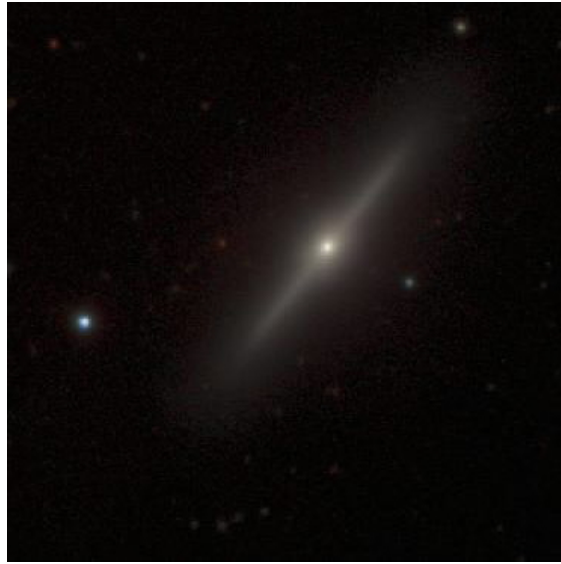
M 109 - SBc type galaxy



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1.1.3 SO Galaxies - Lenticular Galaxies

Cross between an elliptical and spiral



NGC 1381

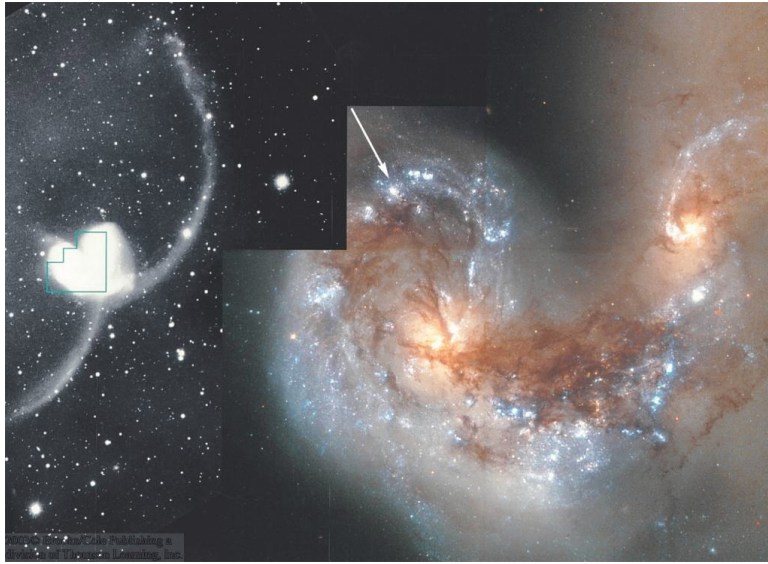
■ **Table 16-1** | **The Properties of Galaxies***

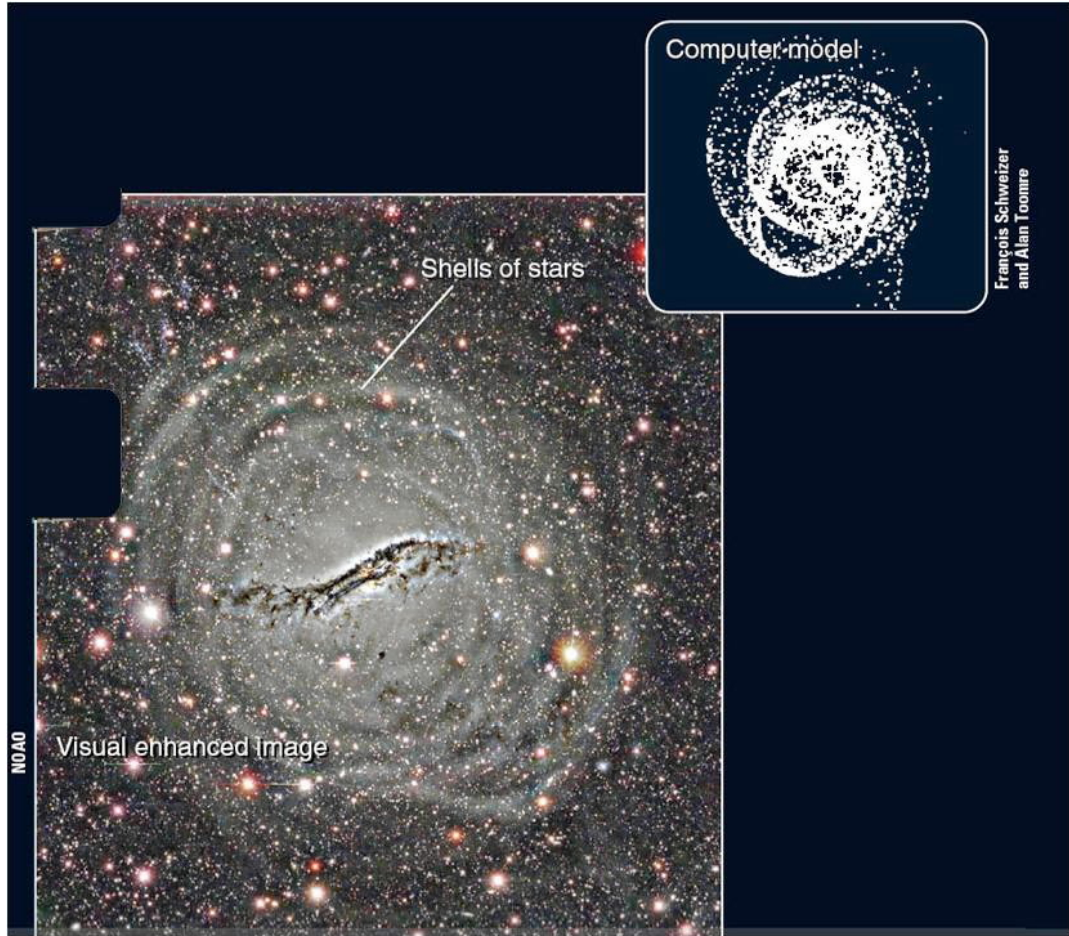
	Elliptical	Spiral	Irregular
Mass	0.0001–50	0.005–2	<0.0005–0.1
Diameter	0.01–5	0.2–1.5	0.05–0.1
Luminosity	0.00005–5	0.005–10	0.00005–0.1

*In units of the mass, diameter, and luminosity of the Milky Way.

1.1.4 Interacting Galaxies



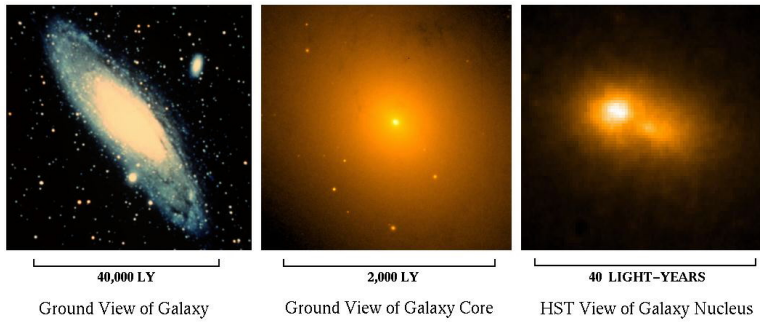




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M 31

The Andromeda Galaxy



Two nuclei in M 31

Another Example

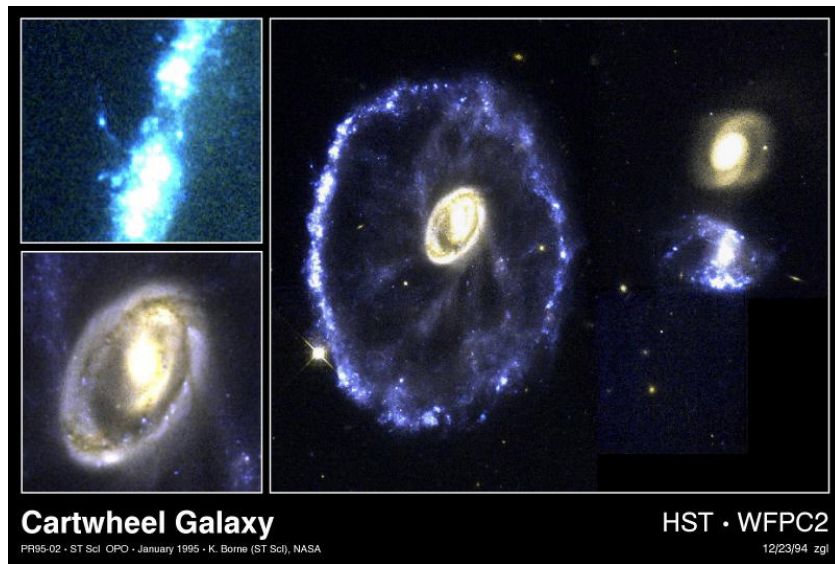
Evidence of galactic cannibalism: Giant elliptical galaxies in rich clusters sometimes have multiple nuclei, thought to be the densest parts of smaller galaxies that have been absorbed and only partly digested.

Multiple nuclei

Michael J. West

Visual false-color image

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1.1.5 Irregular Galaxies



Large Magellanic Cloud



Figure 2: M 82



Small Magellanic Cloud

Galaxies are found in clusters and filaments.



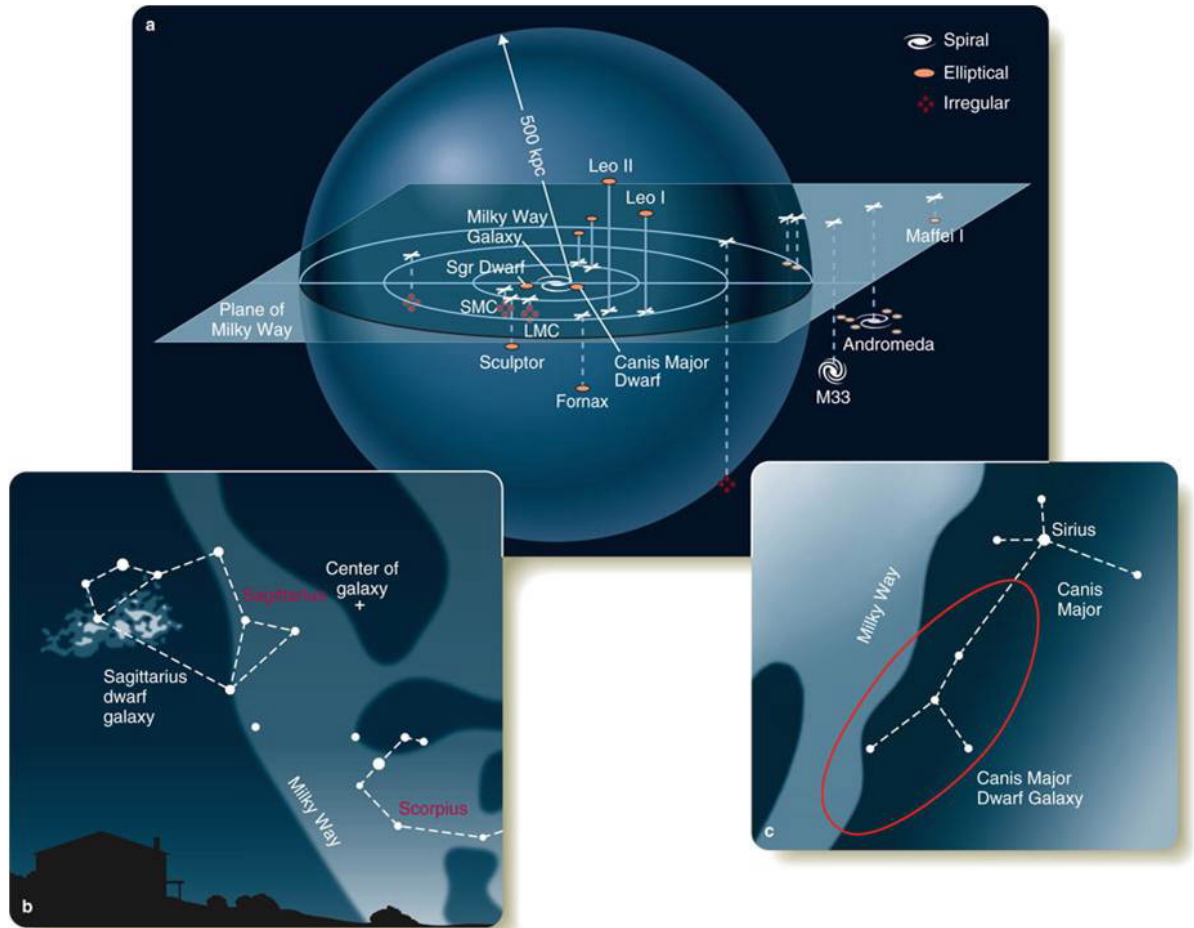
Visual-wavelength

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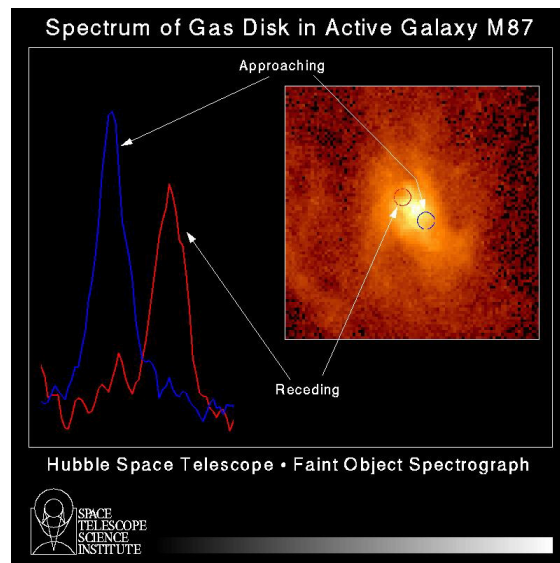
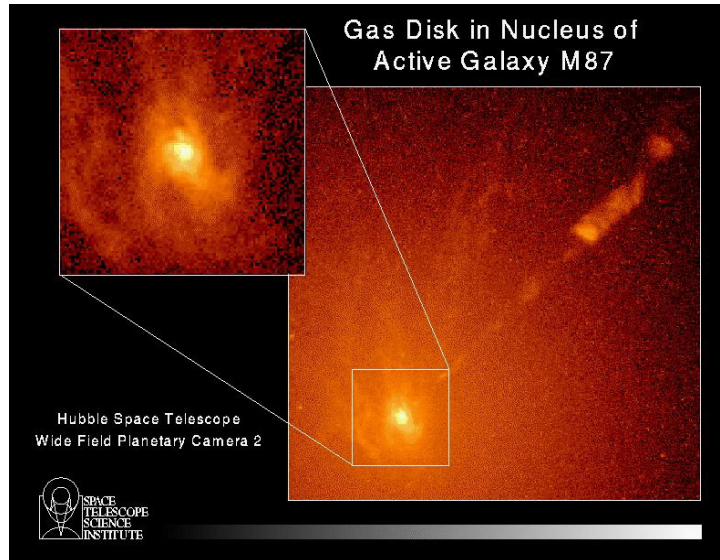
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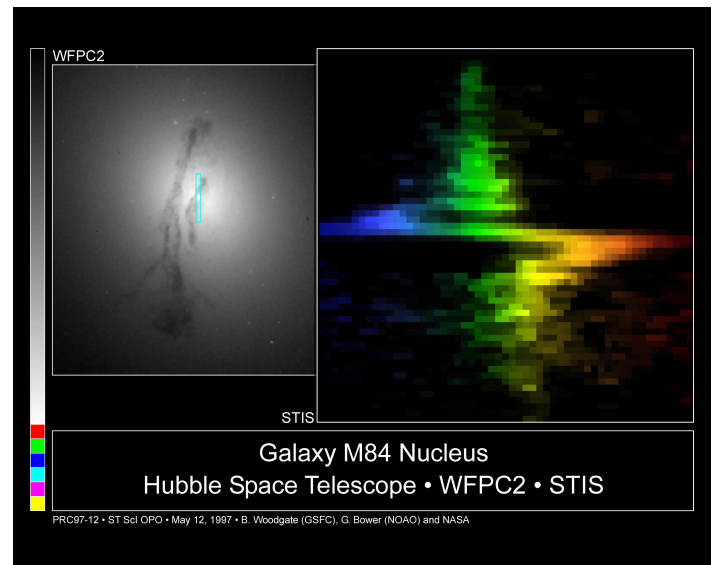
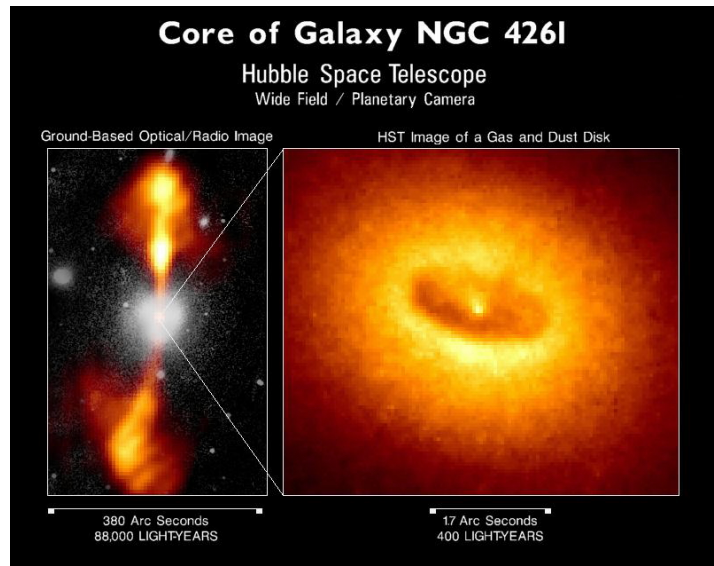
1.1.6 Our Neighborhood



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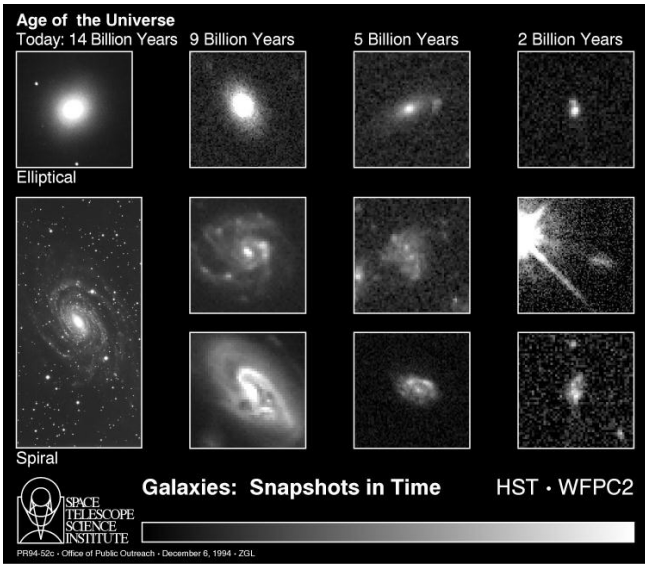
1.1.7 Evidence for Supermassive Blackholes in Galaxies





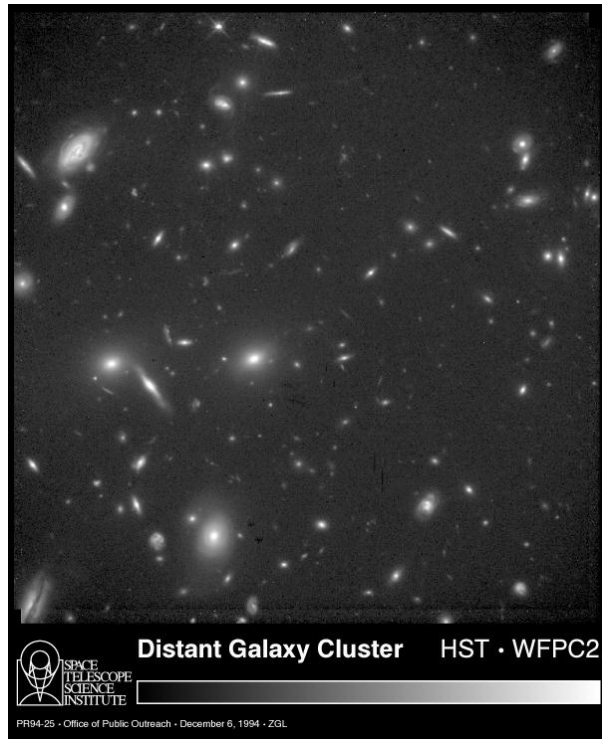
1.2 Galaxy Evolution

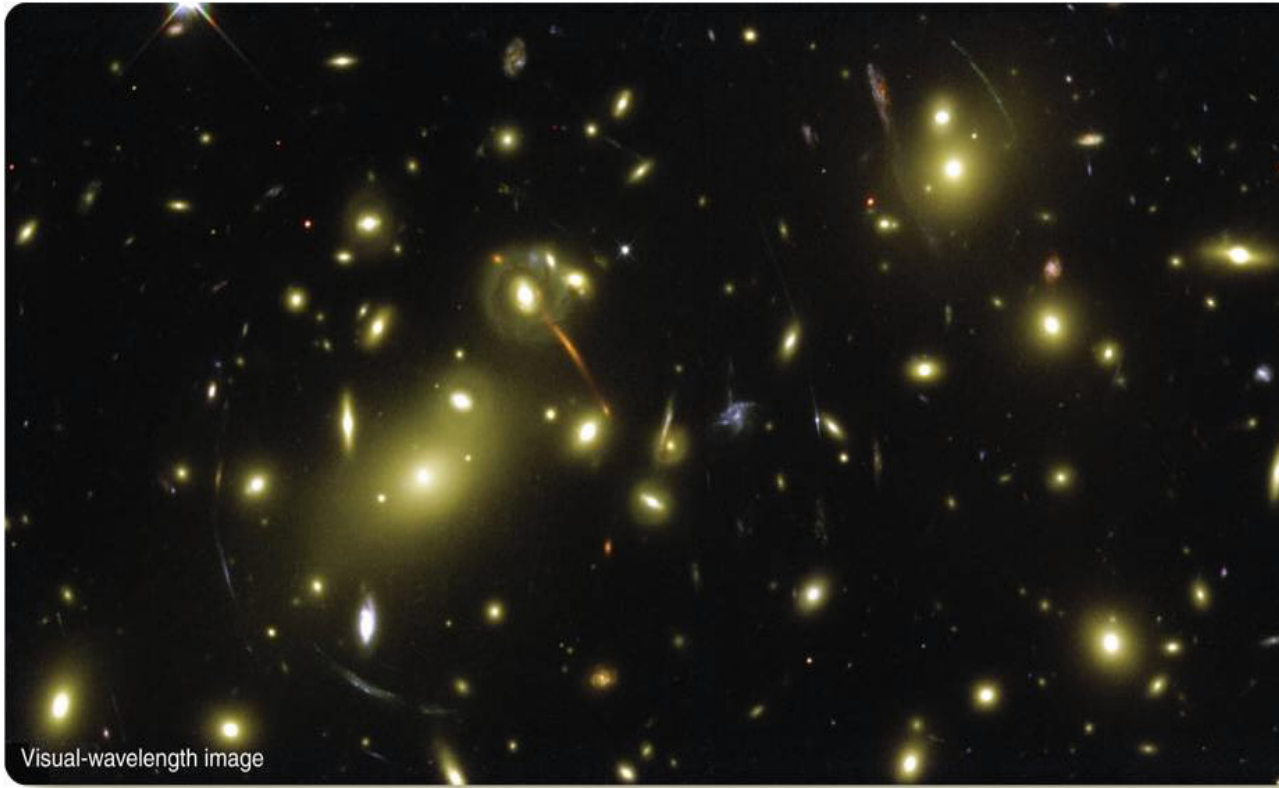
Soon after the Big Bang, the earliest galaxies were more irregular in shape





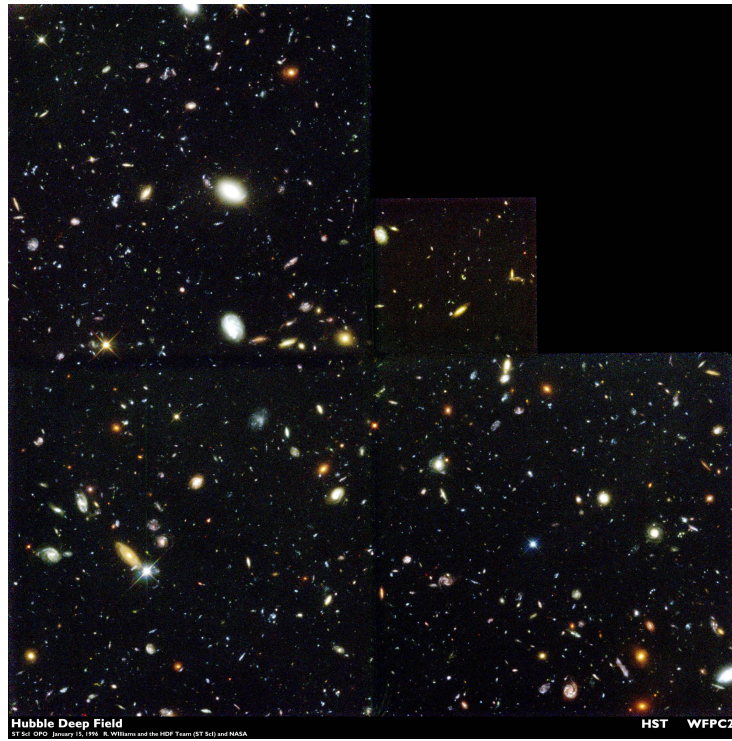
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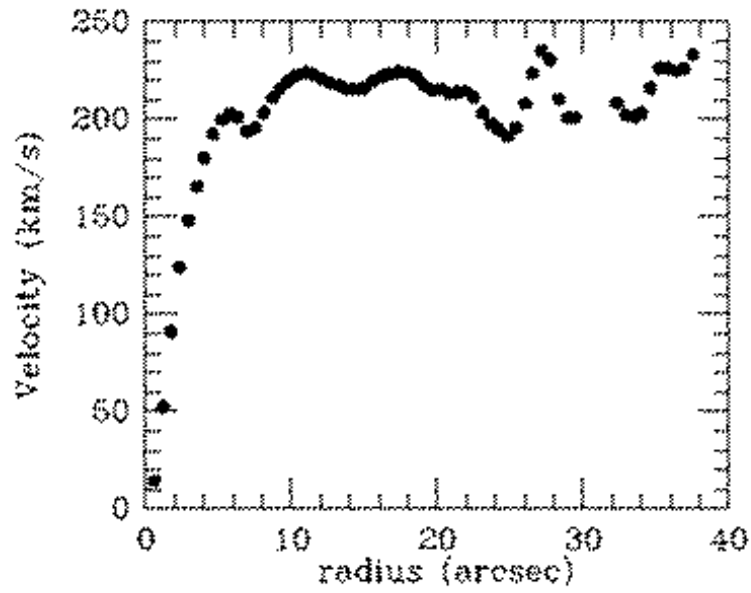
Visual-wavelength image

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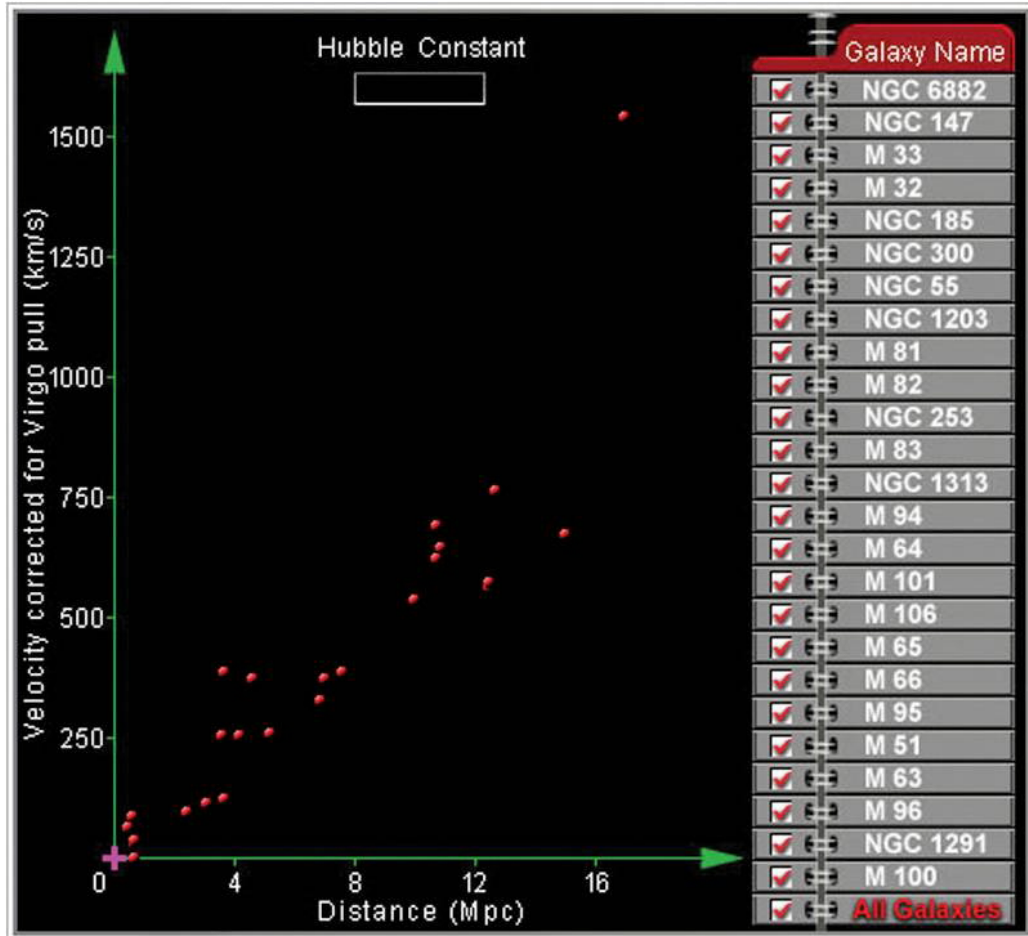
1.3 Masses of Galaxies

Rotation curves

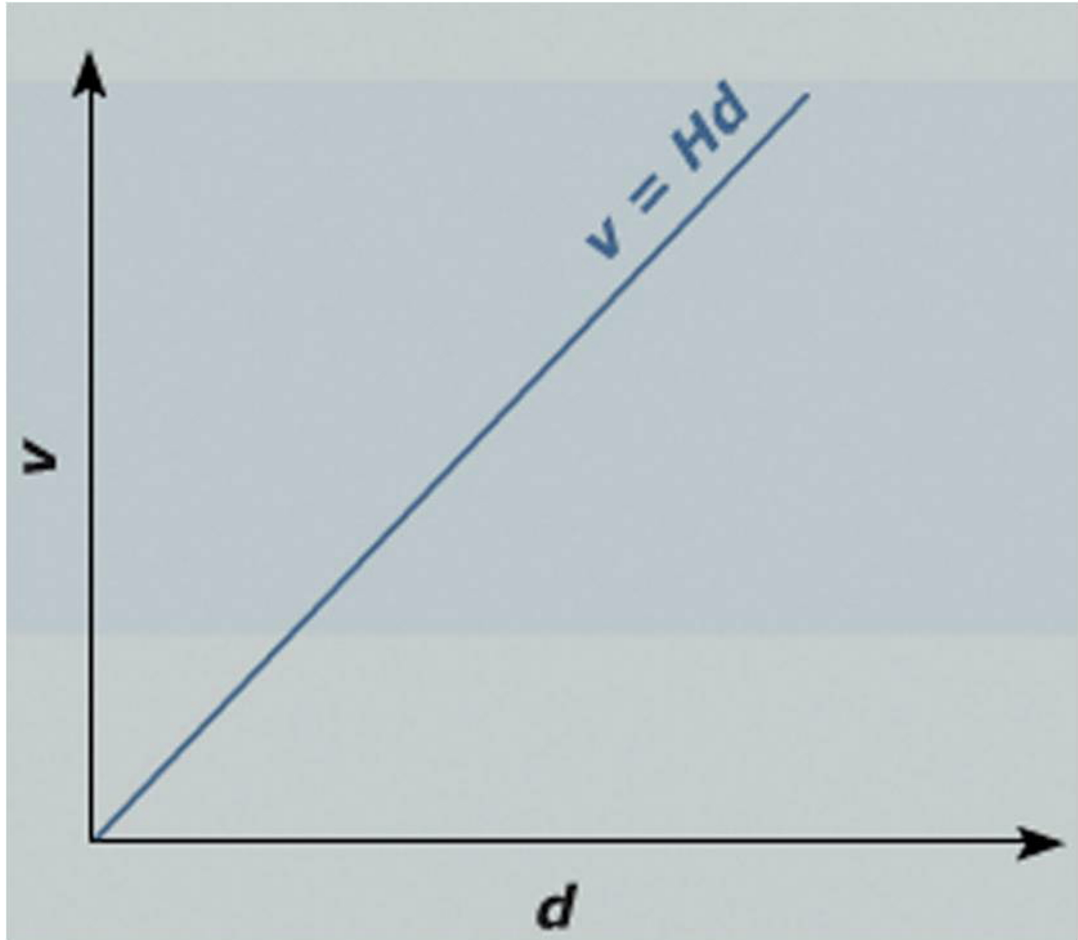


1.4 Hubble's Law

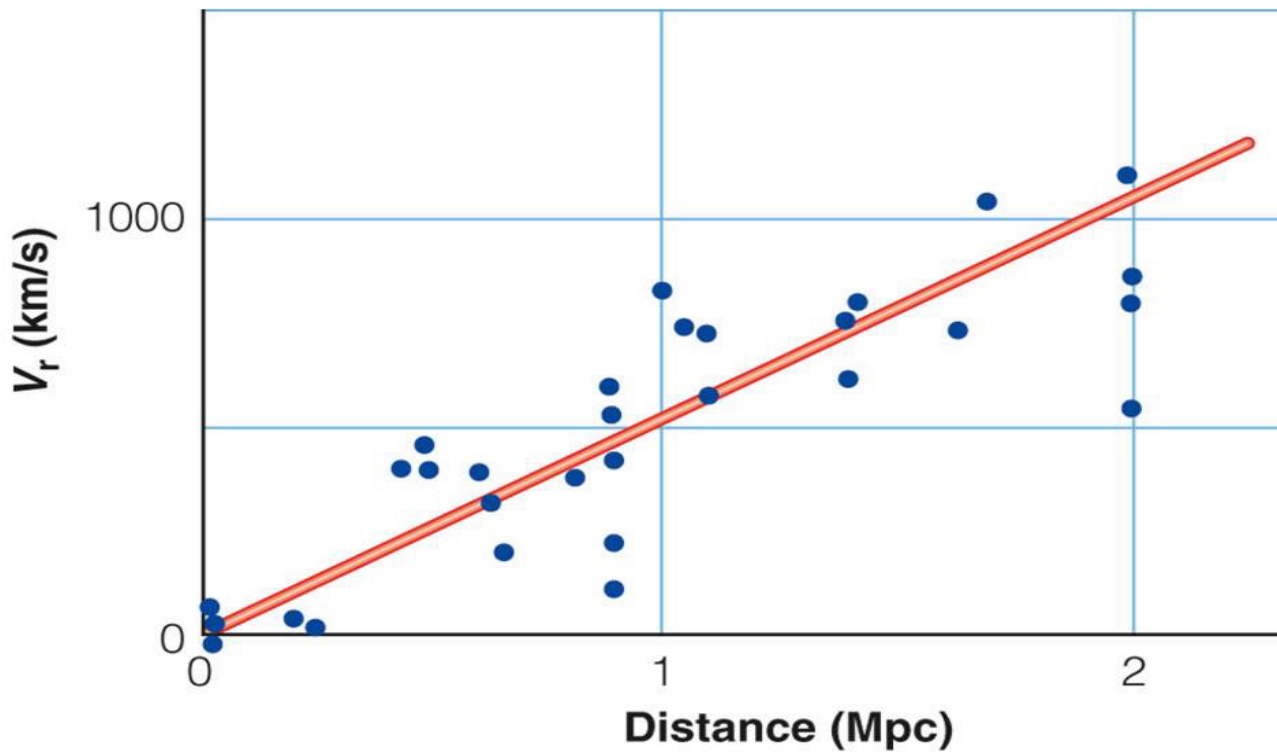
The further a galaxy is from Earth, the faster that galaxy is moving away from Earth. Edwin Hubble discovered this in 1930. It led to the idea that the universe began in the Big Bang.



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