

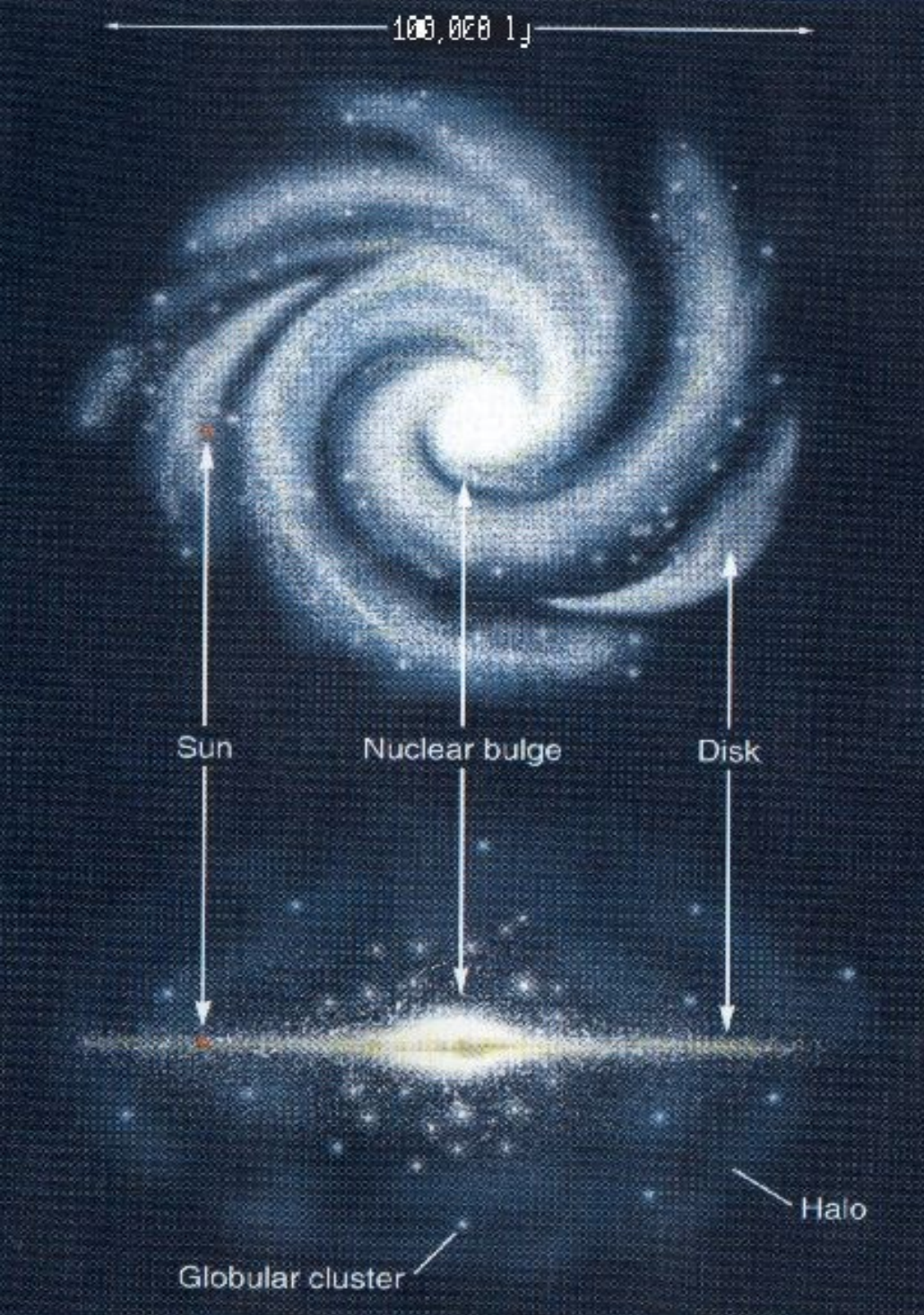
Missouri's representation on NBCnews.com



Quiz 13

Which portion of our galaxy has Pop I stars?

- A) The Bulge
- B) The Disk
- C) The Halo
- D) All of them.
- E) None of them.



Spiral galaxies have 3 parts:

The Bulge (center): Old, Pop II stars which orbit randomly.

Massive black hole.

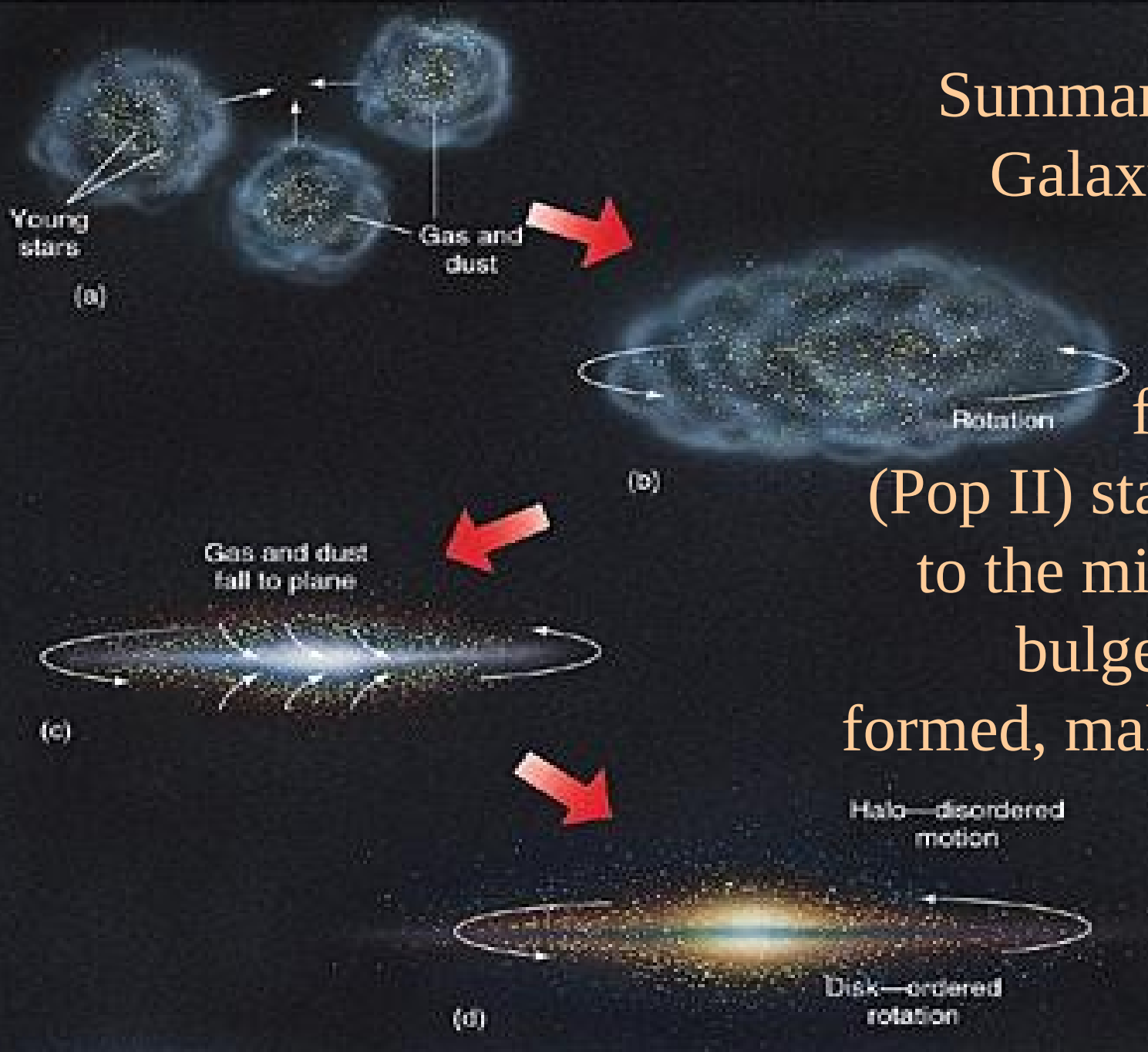
The Disk: Young, blue, Pop I stars which orbit uniformly.

Gas/dust are here too.

The Halo: Globular clusters: orbit randomly, old Pop II stars.

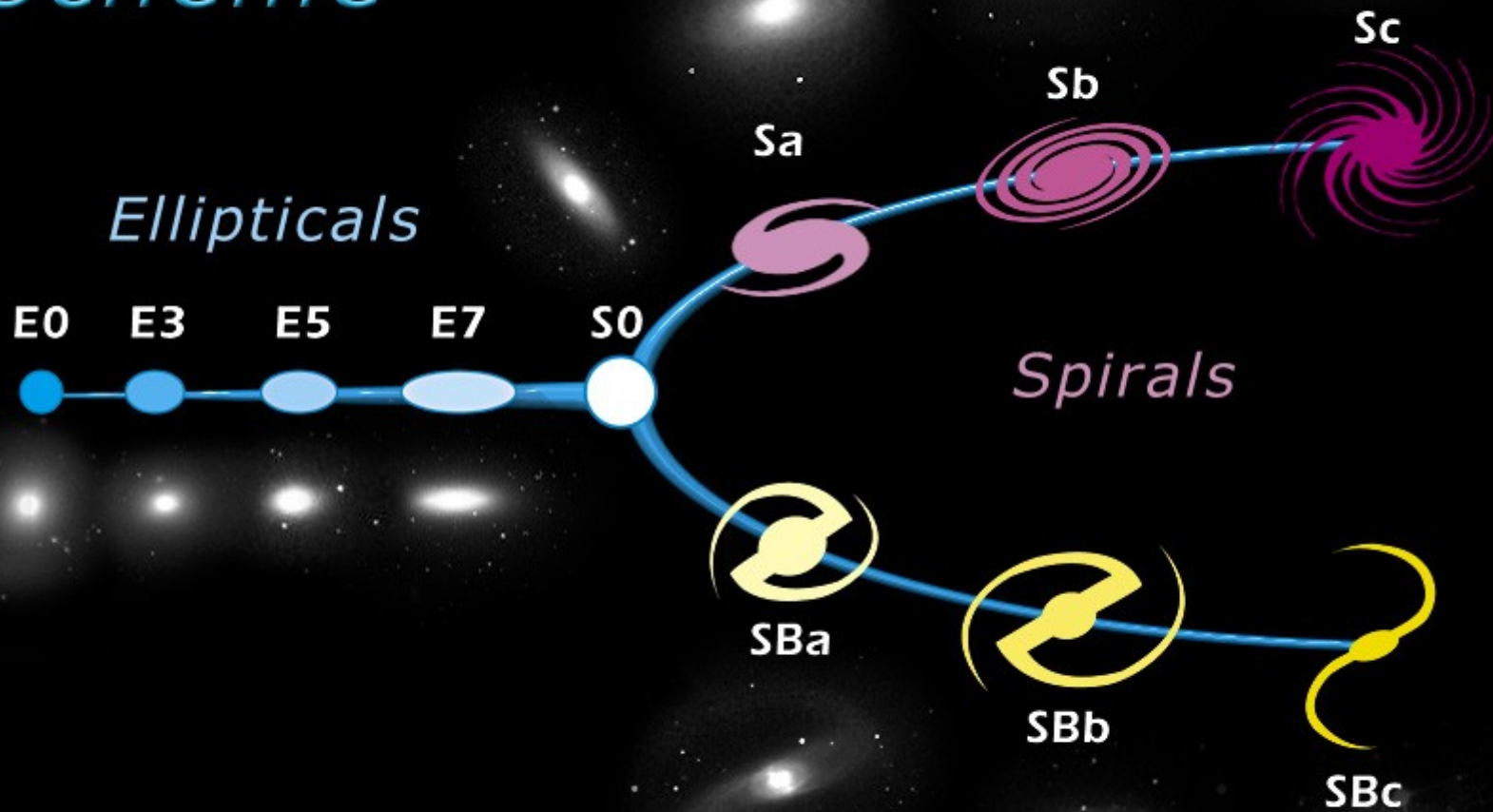
Galaxy Formation





Summary of Formation:
Galaxy began as giant spherical ball of gas, which formed the first (Pop II) stars. Gas also fell to the middle to form the bulge. Later, the disk formed, making Pop I stars.

Edwin Hubble's Classification Scheme



Irregular galaxies:
These are not on the Hubble
tuning fork.



Take-aways

Our galaxy is a barred spiral galaxy, but that is just one type among several.

Galaxies are characterized by their appearance: elliptical, spiral, barred spiral, or the in-between S0 type. There are also irregular galaxies which don't fit on the tuning fork diagram.

Appearance is based on orbits of stars (elliptical=random, disk=organized) and amount of gas.

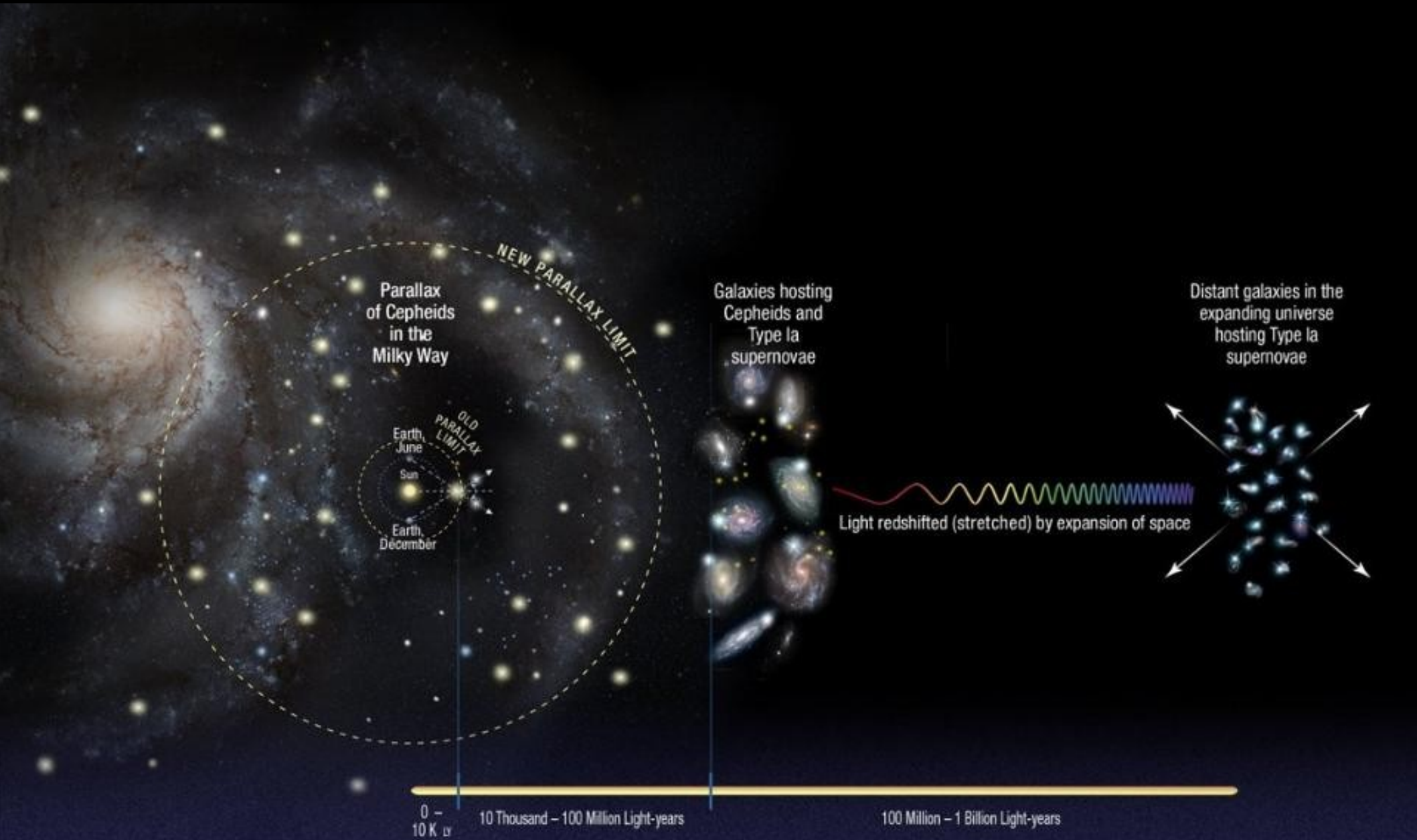
Distances. How far away is everything
and how can I tell?



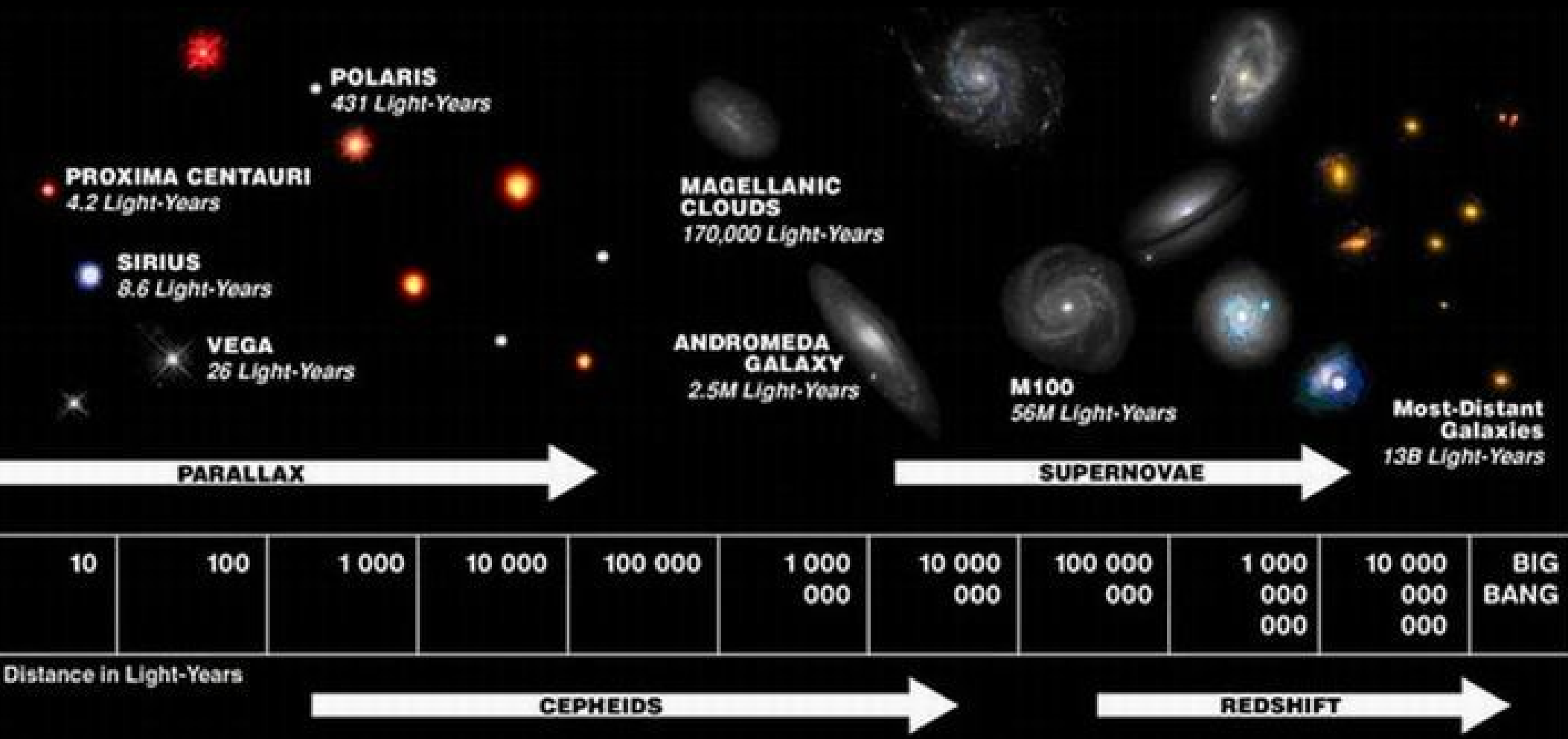
Summary of Extra-Galactic Distances

- Parallax- good for nearby stars (inside our $\frac{1}{2}$ of our galaxy)
- Main sequence fitting- Good for nearby galaxies where individual stars can be resolved
- Variable stars: Cepheids- supergiant variable stars (Galaxies out to about 150Mly)
- Supernova- Type Ia: exploding White Dwarfs (any distance)

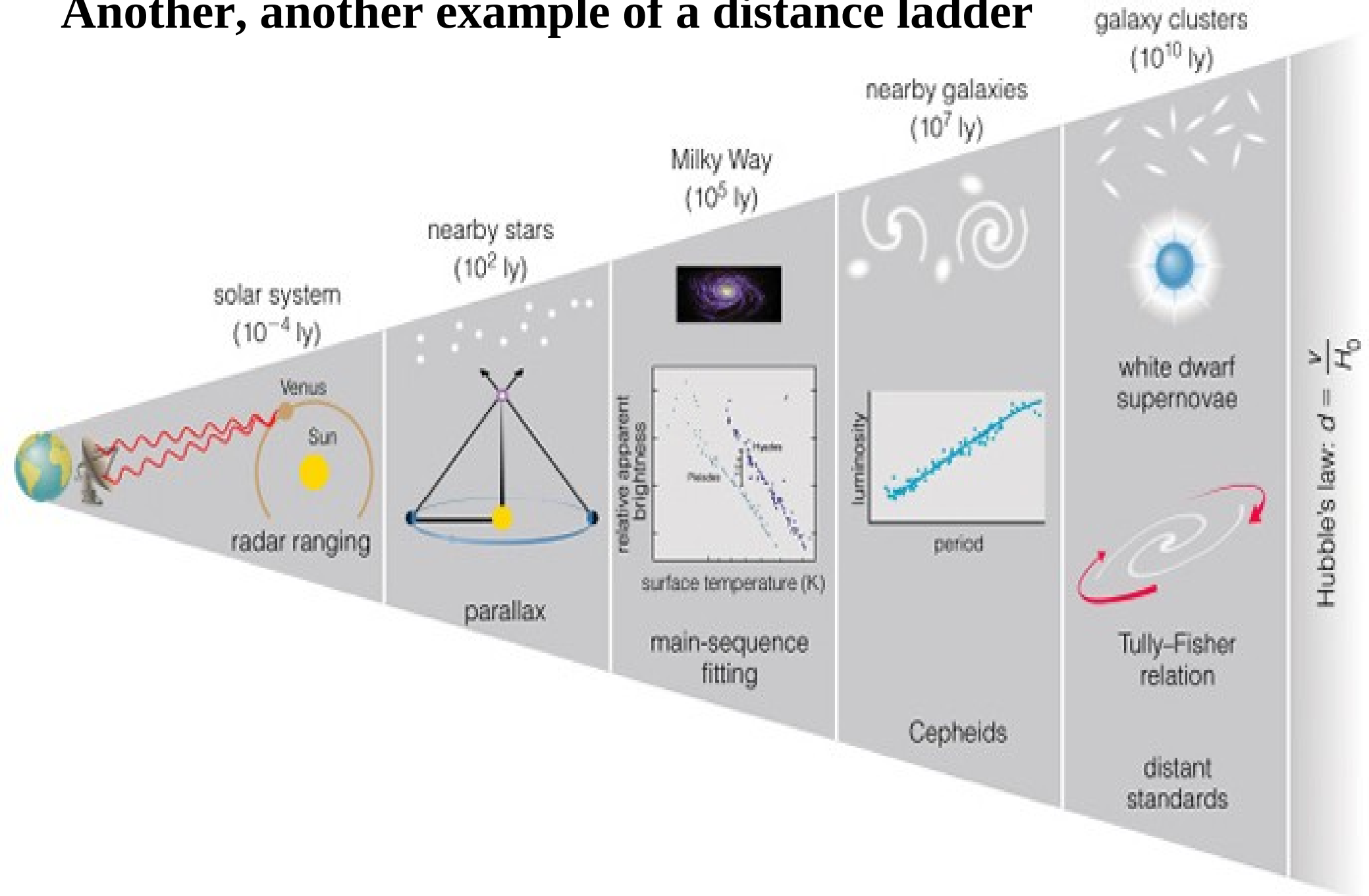
Example of a distance ladder



Another example of a distance ladder



Another, another example of a distance ladder



Cosmology.

Cosmology is the study of the Universe as a whole. It is about objects larger than individual galaxies and the evolution of the Universe and its contents.

The Local Group:

Our galaxy is a member of a small group (38) of gravitationally bound galaxies, all within about 10 million light years.

There are 3 big spiral galaxies: The Milky Way, Andromeda, and Triangulum.

Each of these 3 big galaxies have many smaller, irregular or dwarf elliptical galaxies orbiting them.

Galaxies around the Milky Way.

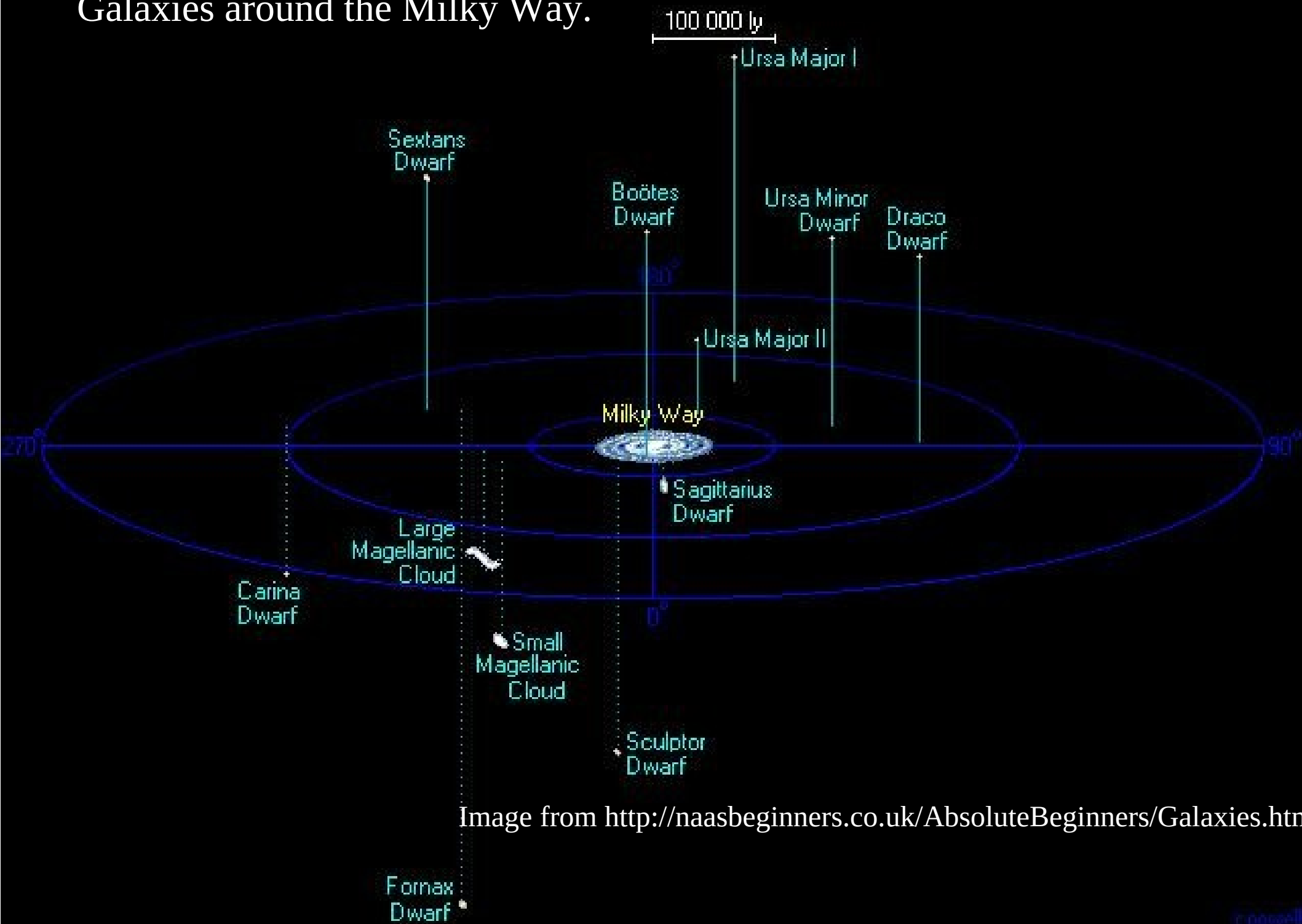
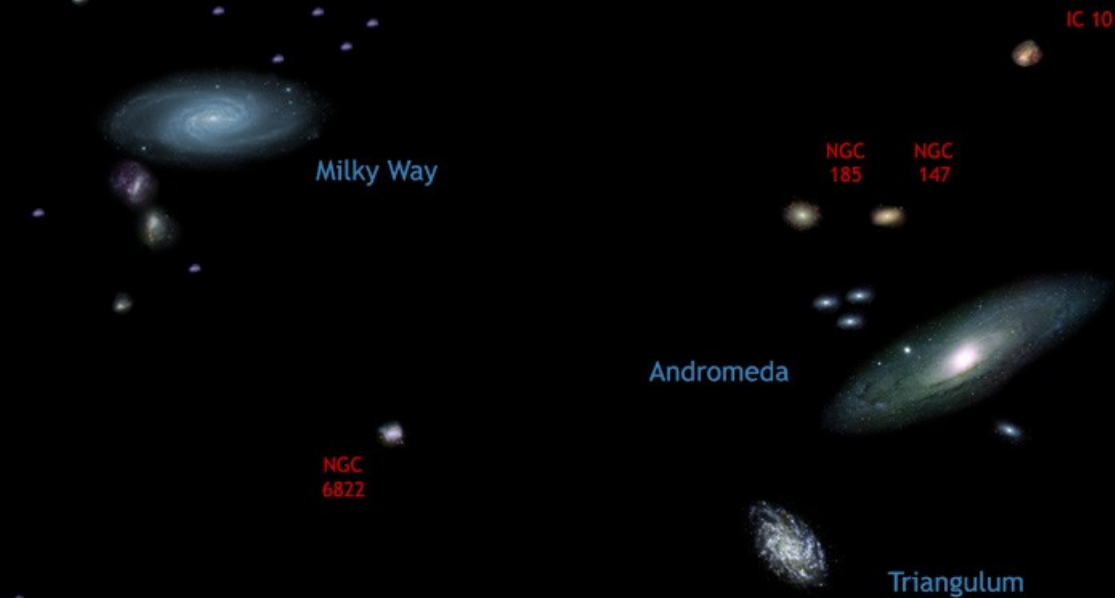
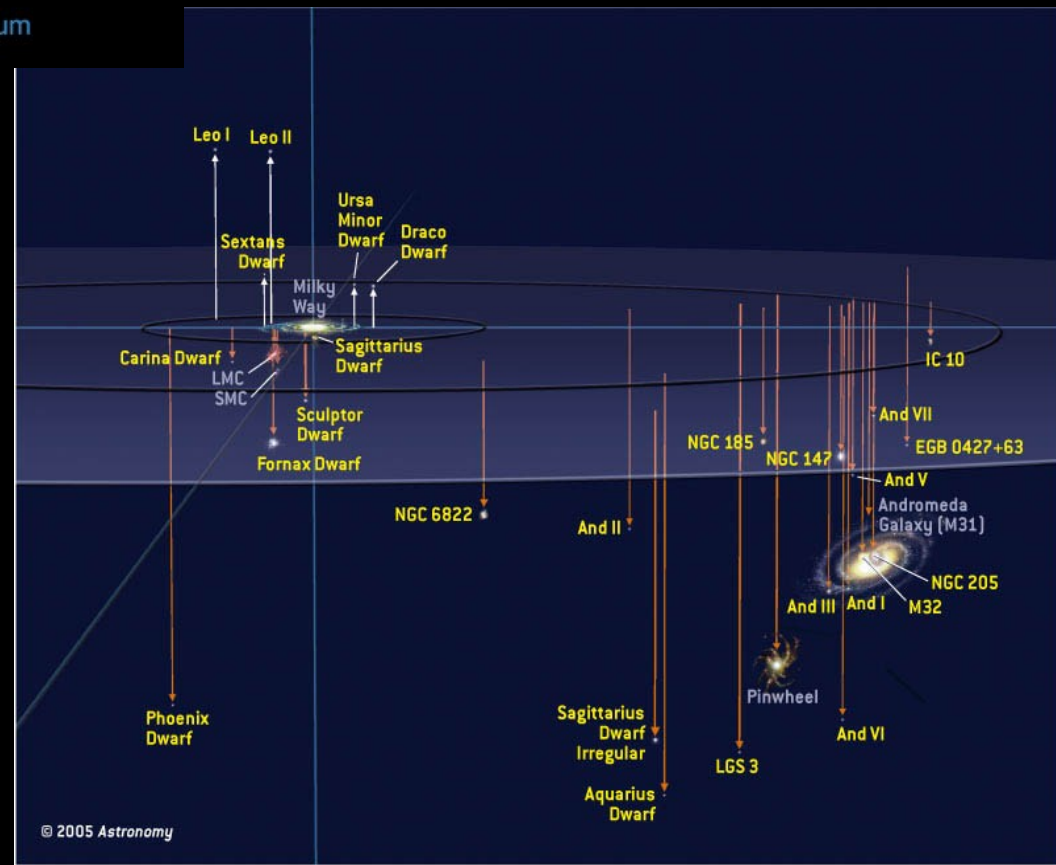


Image from <http://naasbeginners.co.uk/AbsoluteBeginners/Galaxies.htm>



Two more depictions of our local galaxy group.



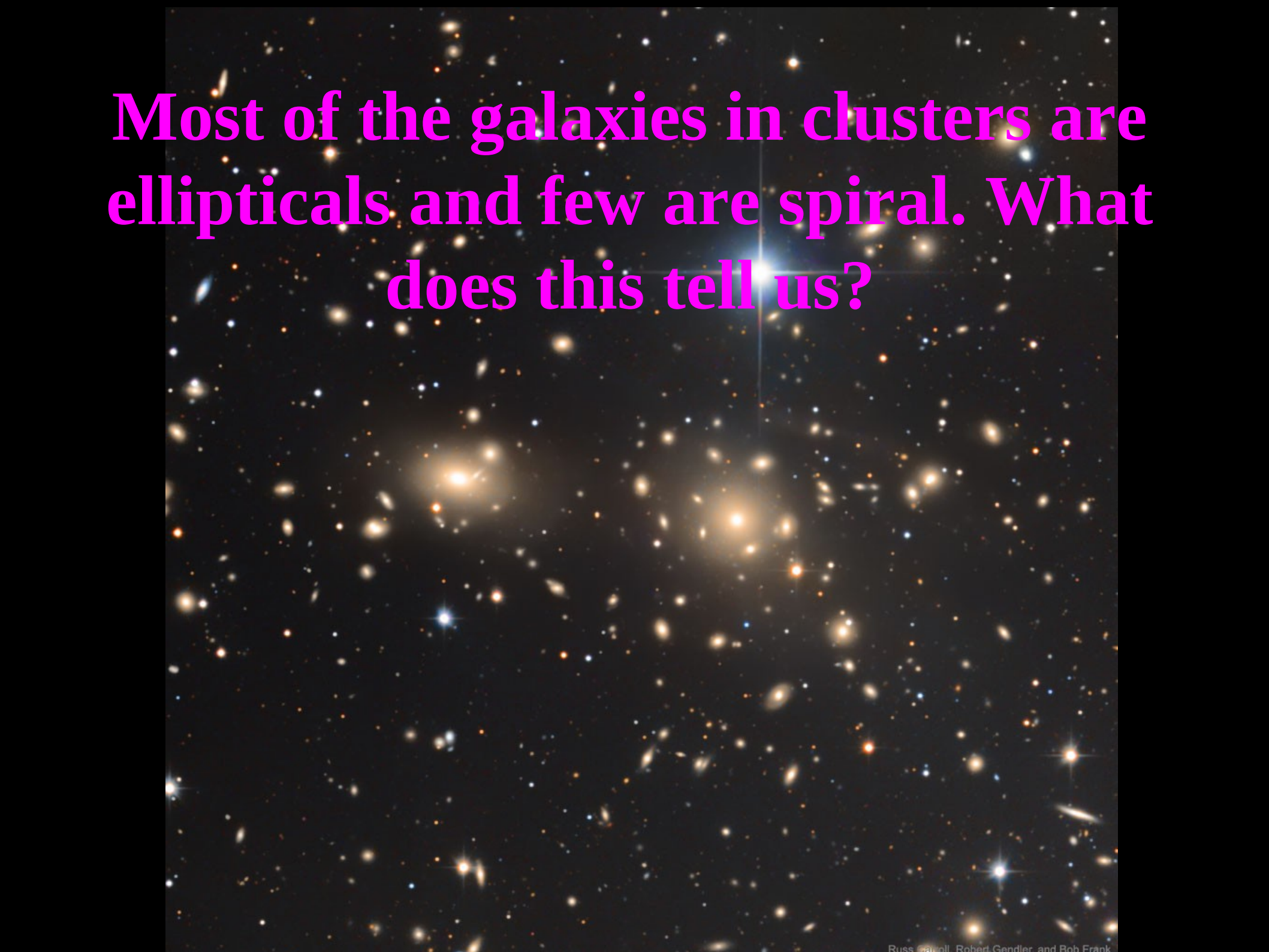
What is the biggest
question to know the
answer to?

Write this down on a
piece of paper but DO
NOT put your name on
it.

Galaxy Clusters

Most galaxies are in groups (<50) or clusters (hundreds).

**The coma cluster has over 1000
galaxies in it.**

A vast field of galaxies, primarily elliptical in shape, scattered across a dark background. The galaxies vary in size and brightness, with some appearing as bright, glowing clusters and others as smaller, more distant points of light. A few spiral galaxies are also visible, providing a contrast to the dominant elliptical forms. The overall appearance is that of a rich, multi-colored galaxy cluster.

Most of the galaxies in clusters are ellipticals and few are spiral. What does this tell us?

That interactions are important.

Since the galaxies are in a cluster and close to each other, they interact. As they interact, spiral galaxies get broken apart and merge to make ellipticals.

Next are some images of galaxies either colliding, or about to collide.



Galaxy collisions

Why do these occur?

What is it that makes galaxies collide?

Galaxy collisions

Why do these occur?

What is it that makes galaxies collide?

Because the more mass there is, the stronger gravity is, and gravity only pulls, it never pushes.

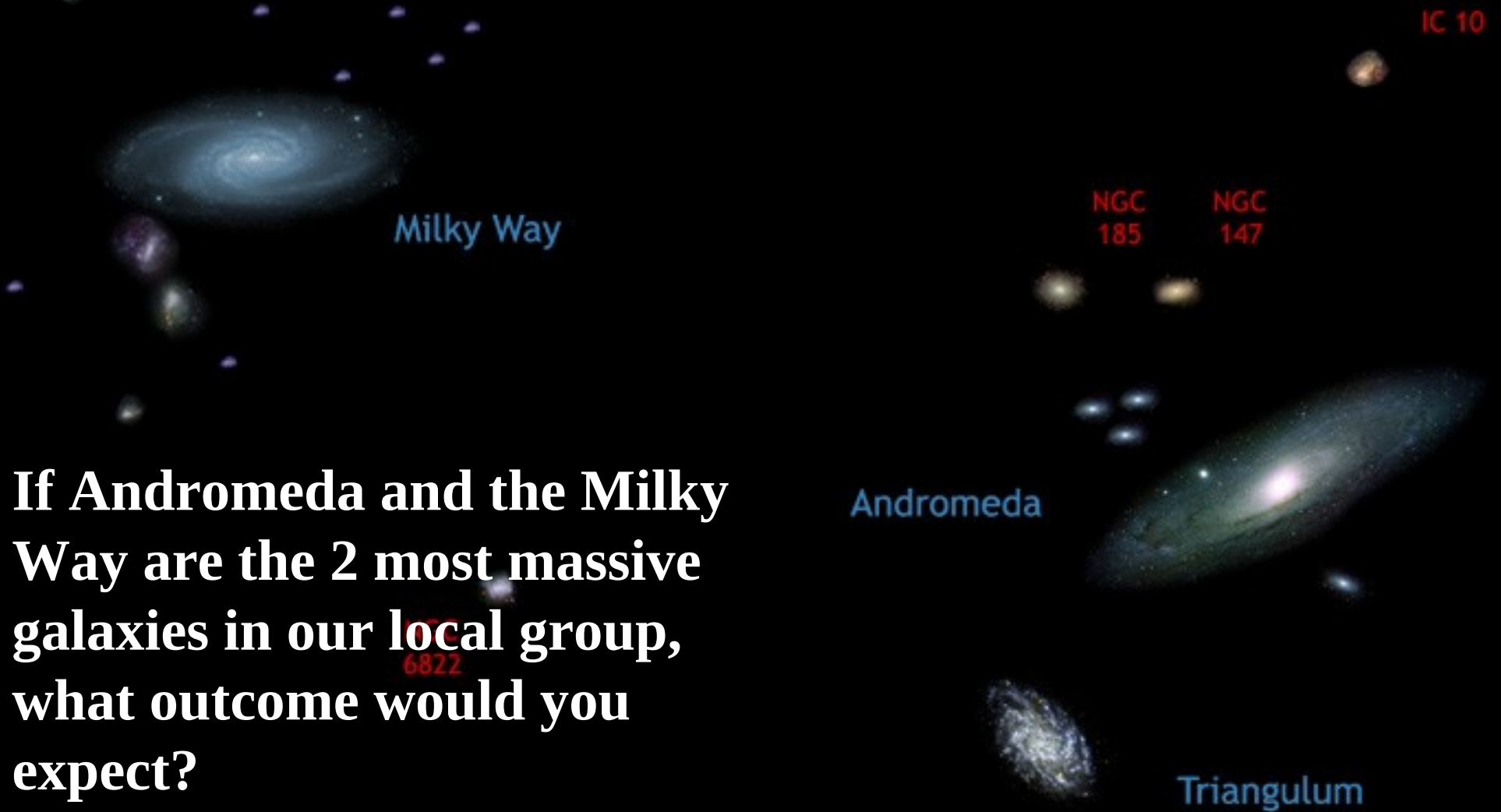
So massive things near one another will pull each other together.

Galaxy collisions

The results are usually elliptical galaxies.



If Andromeda and the Milky Way are the 2 most massive galaxies in our local group, what outcome would you expect?



Our view today

Andromeda
Galaxy
(M31)



Milky Way
Galaxy









This is also true for the Milky Way and Andromeda galaxies.

The 2 most massive galaxies in our group are pulling on each other.

And in another 3-4 billion years they will collide.

Illustration Sequence of the Milky Way and Andromeda Galaxy Colliding

What will happen to us when this happens?

GALAXY
MERGERS



$P(\text{hit}) = ??\%$

Take-aways

Most galaxies are in groups or clusters.

Most galaxies in clusters are ellipticals.

Most spiral galaxies exist in ‘the field’ (not a cluster) or in small groups.

Galaxies in clusters are likely to be disrupted into elliptical galaxies.