The Milky Way

The Milky Way

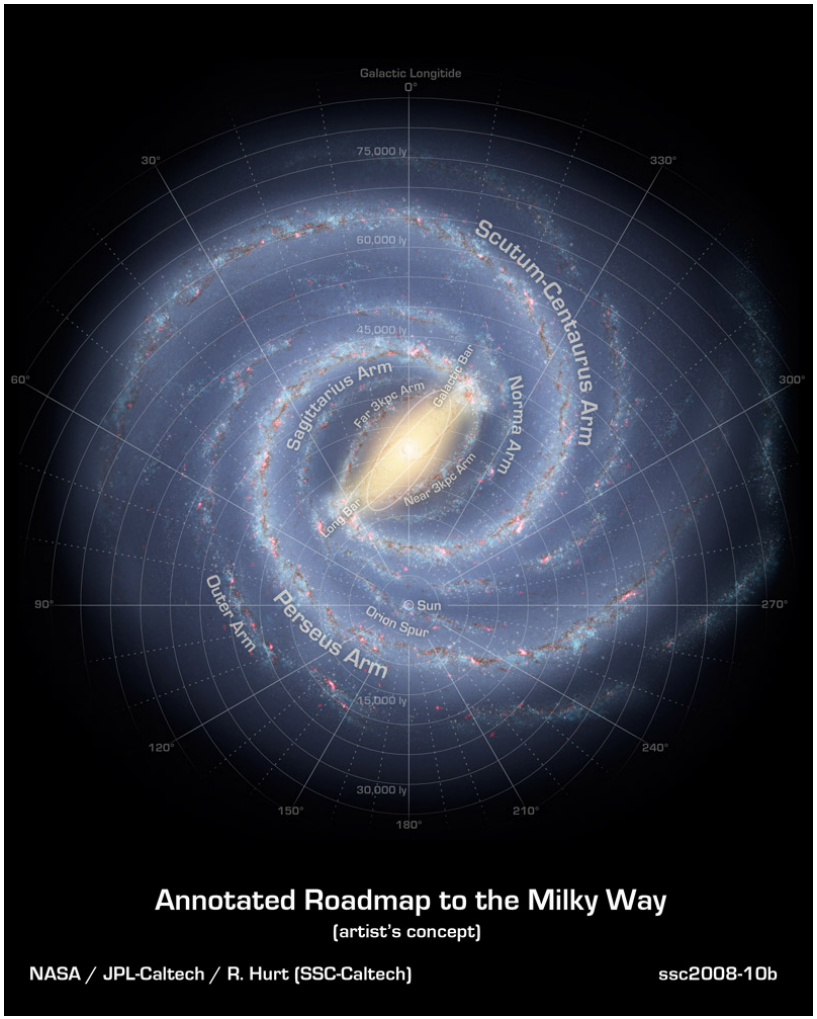
- Our galaxy, the Milky Way, appears to us as a faint band of diffuse light stretching across the sky (if there are no street lights around....)
- It is paradoxically difficult to work out its structure, because we are inside it. Dust obscures much or most of it from our view.
- First person to describe its structure accurately was Thomas Wright of County Durham (but Immanuel Kant often gets the credit)

The Milky Way

The Milky Way

- The Milky Way is a *spiral galaxy*. It consists of a central bulge, with several arms of stars and gas winding outwards from it.
- It is about 100,000 light years across.
- We are about two thirds of the way out from the centre to the edge.

The Milky Way



The Milky Way

- There are about 200 billion stars in the galaxy ($2x10^{11}$). As well as stars, there are also bright nebulae and dark clouds of dust and gas.
- Many of the stars are in clusters, which come in two type: *open clusters* and *globular clusters*

The Milky Way

The Milky Way

The Milky Way

- Over millions of years, star clusters tend to disperse gradually.
- Many of the stars in the Plough are members of a dispersed star cluster. They continue to move through space in roughly the same direction.
- animation

Beyond the Milky Way

- Our galaxy belongs to the Local Group – a collection of about thirty galaxies at distances of up to about ten million light years.
- There are three large spiral galaxies in it: the Milky Way, Andromeda and Triangulum.
- Andromeda is the largest of the three.
- The rest of the galaxies are dwarf galaxies.

Beyond the Milky Way

Beyond the Milky Way

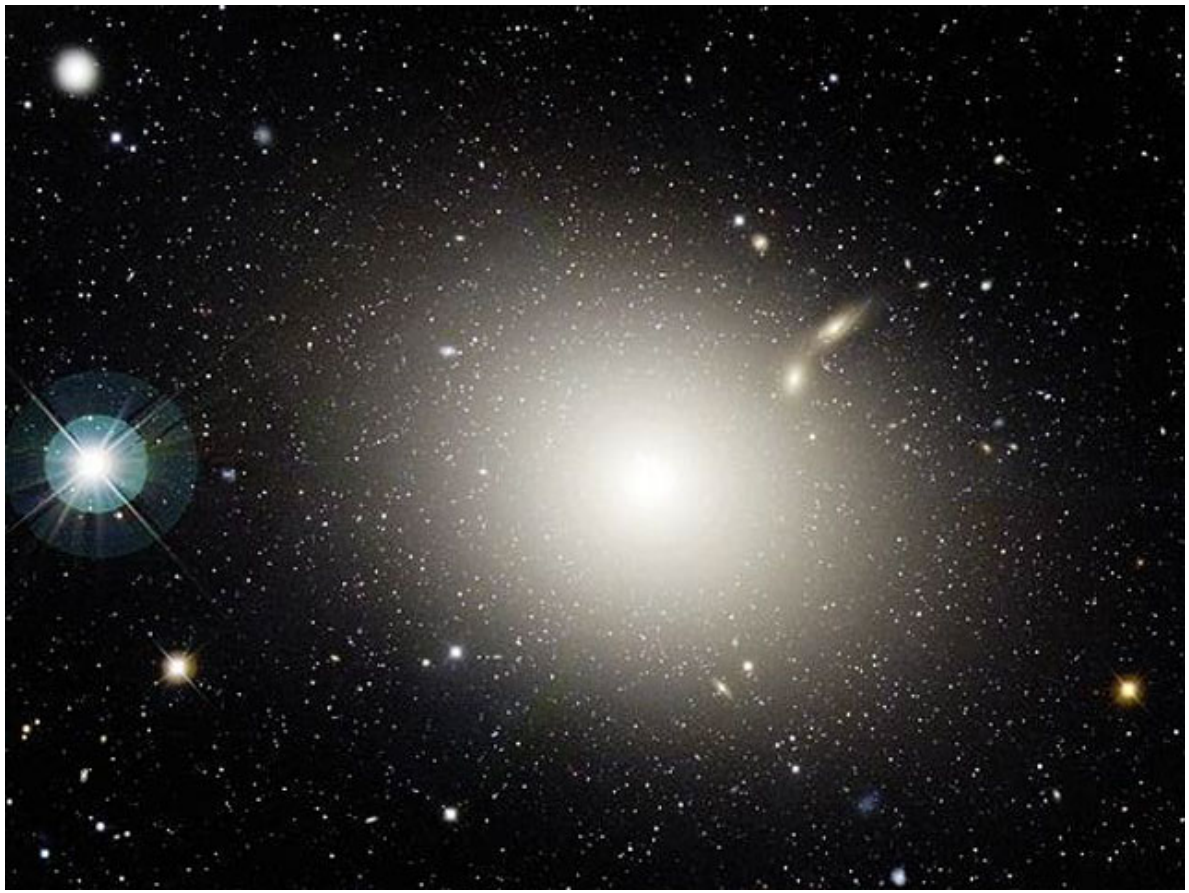
Beyond the Milky Way

Types of galaxies

- The three large galaxies in the local group are spiral galaxies.
- Spiral galaxies are either barred or non-barred

Types of galaxies

- Many of the smaller galaxies are elliptical galaxies.
- Ellipticals can be very large as well.

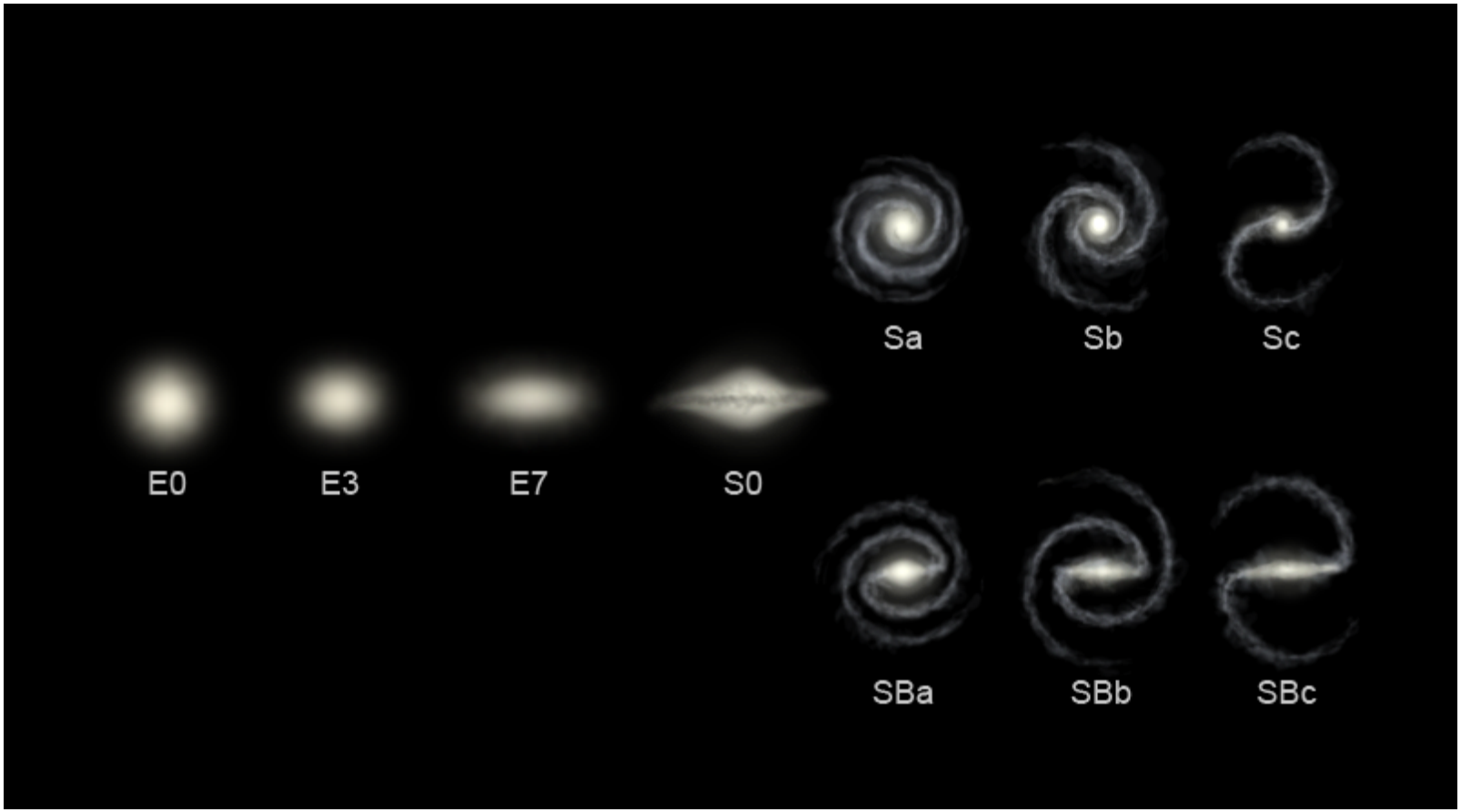


Types of galaxies

- Most small galaxies are irregular – they have no definable shape.

The ‘Tuning fork’ diagram

- Edwin Hubble presented galaxies on this sort of diagram:



The ‘Tuning fork’ diagram

- Hubble thought that this might represent an evolutionary sequence.
- He referred to elliptical galaxies as ‘early-type’, and spirals as ‘late-type’.
- This terminology is occasionally still encountered but in fact, ellipticals contain the oldest stars. Spirals are much younger

Galaxy types

- Elliptical galaxies are made of old, yellow stars.
- No new star formation is occurring, and no star-forming nebulae are seen.
- Spiral galaxies and irregular galaxies are sites of active star formation, sometimes extremely vigorous. Nebulae are common.

Galaxy types

- Ellipticals do not ‘evolve’ into spirals.
- The opposite can happen though...

Galaxy collisions

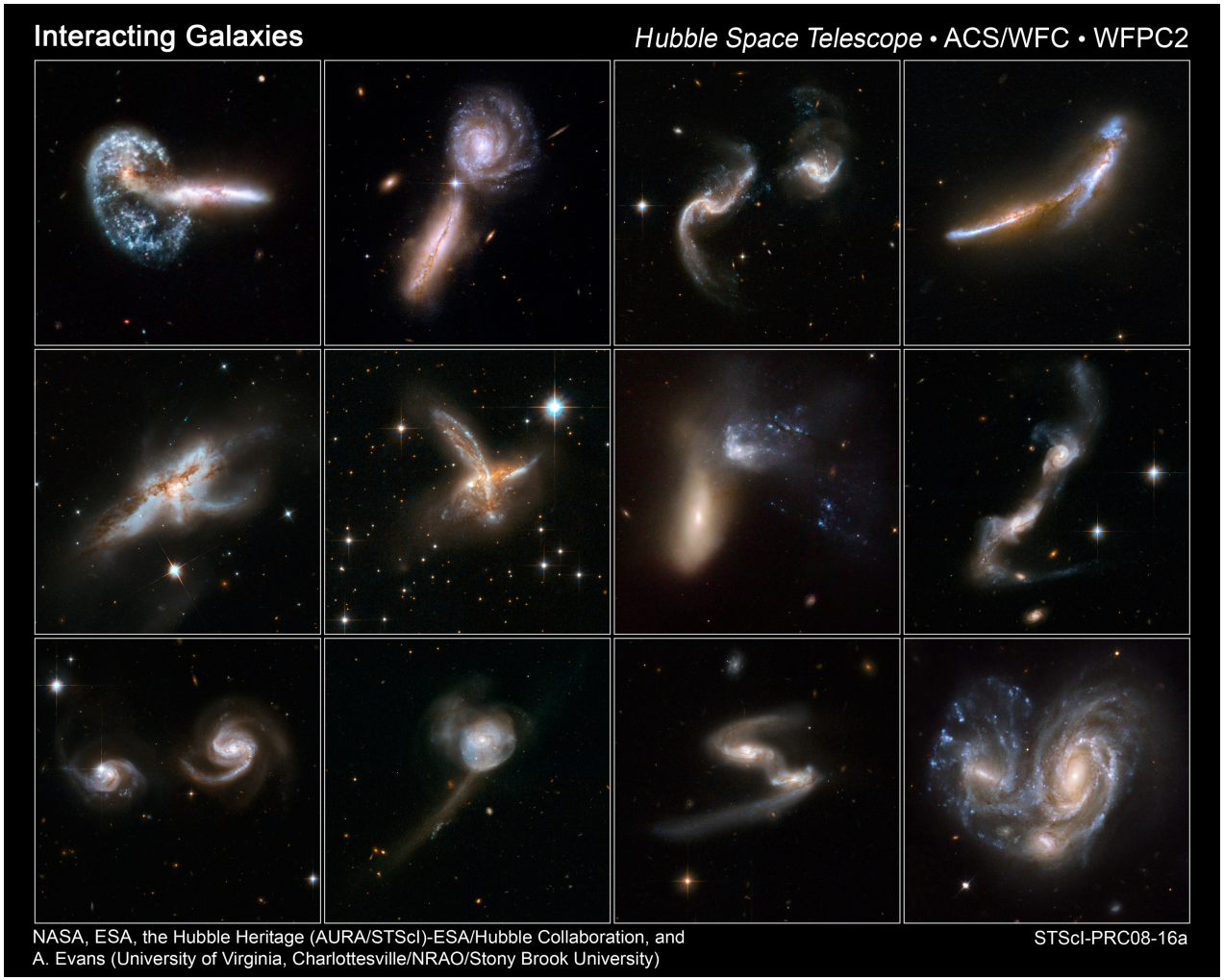
- A typical star is about 500,000km across, but the typical distance between stars is about 3 light years – 50 million times larger. If the Sun was a football in London, Proxima Centauri would be roughly in New York.

- Stars are following broadly circular orbits around the galaxy, all in the same direction.
- So, collisions between stars are extremely rare

Galaxy collisions

- For galaxies, the situation is different: for example, the distance from the Milky Way to the Andromeda Galaxy is about twenty times as large as the diameter of the Milky Way.
- If the galaxy was a football in this room, Andromeda would be roughly at the end of the room.
- Motions within clusters are disordered
- So, collisions are very common.
- Collisions trigger massive bursts of star formation.
- If two spirals merge, then all the gas and dust is stripped, the structure is lost, and what emerges afterwards is an elliptical galaxy.

Galaxy collisions



Active galaxies

- Many galaxies contain vast amounts of matter (millions of times the mass of the Sun) in a very small region at their core (perhaps only a few light-hours across).
- Our galaxy is one such galaxy.

Active galaxies

- gcsmall.wmv

Active galaxies

- You can see that whatever is at the centre of the Milky Way is not emitting any visible light.
- It is thought to be a black hole – an object so massive that even light cannot escape its gravity.

Active galaxies

- Often, material orbiting a black hole gets so hot that emits extreme amounts of radiation.
- Quasars (Quasi-stellar objects) are some of the most luminous objects in the universe, and are powered by black holes.