Galaxies: Structure, formation and evolution

Lecture 3

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Barred Spiral NGC 1300

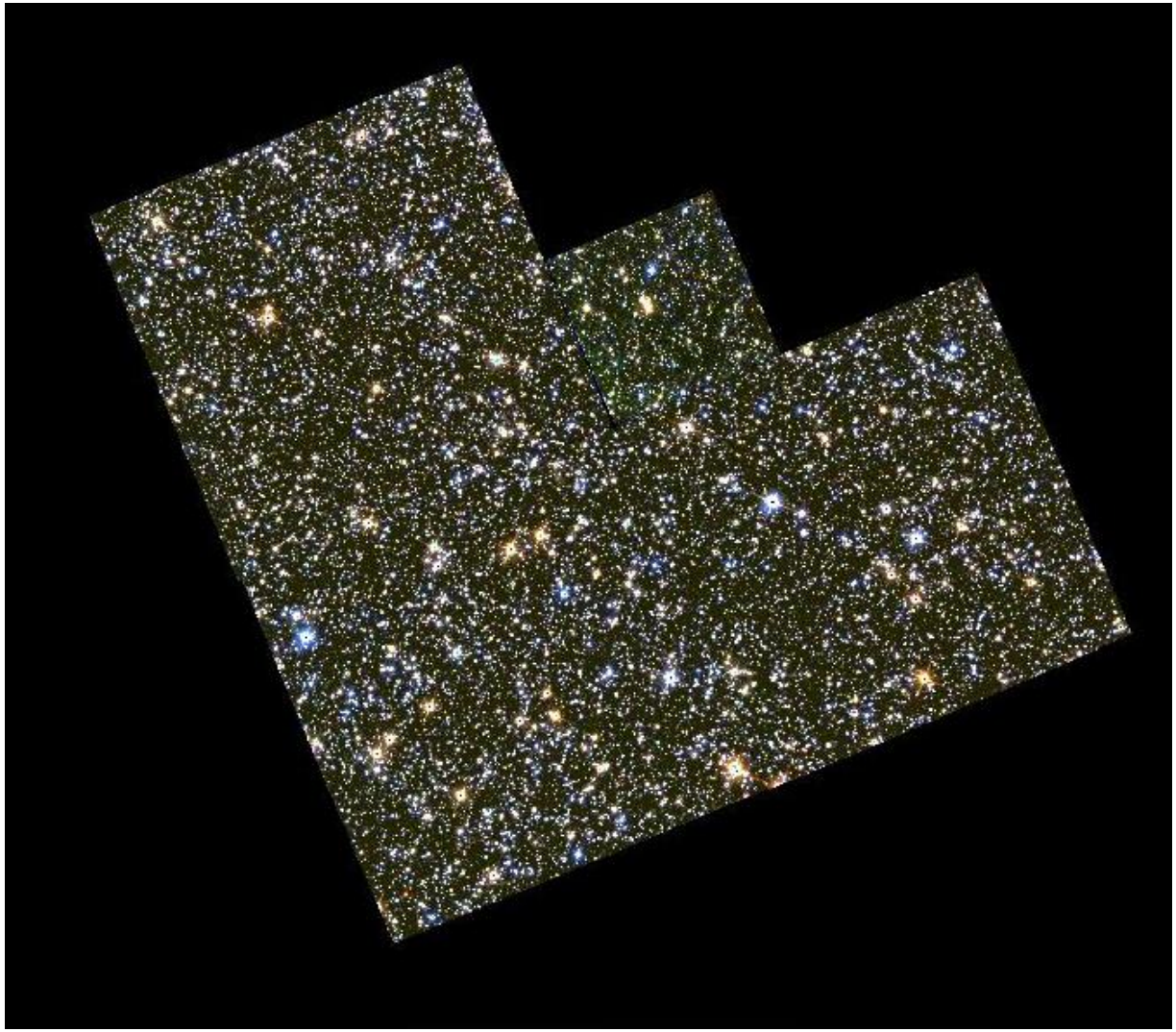
Extra lecture on Thursday?

We have a holiday for Holi on Friday. Can I take a lecture on Thursday, 17 March, at 10 to compensate?

Lopsided galaxy - unstable disks

Irregular

Large Megallanic Cloud



Wadadekar et al. (2006)

The low surface brightness Universe

Are early type galaxy profiles really smooth?

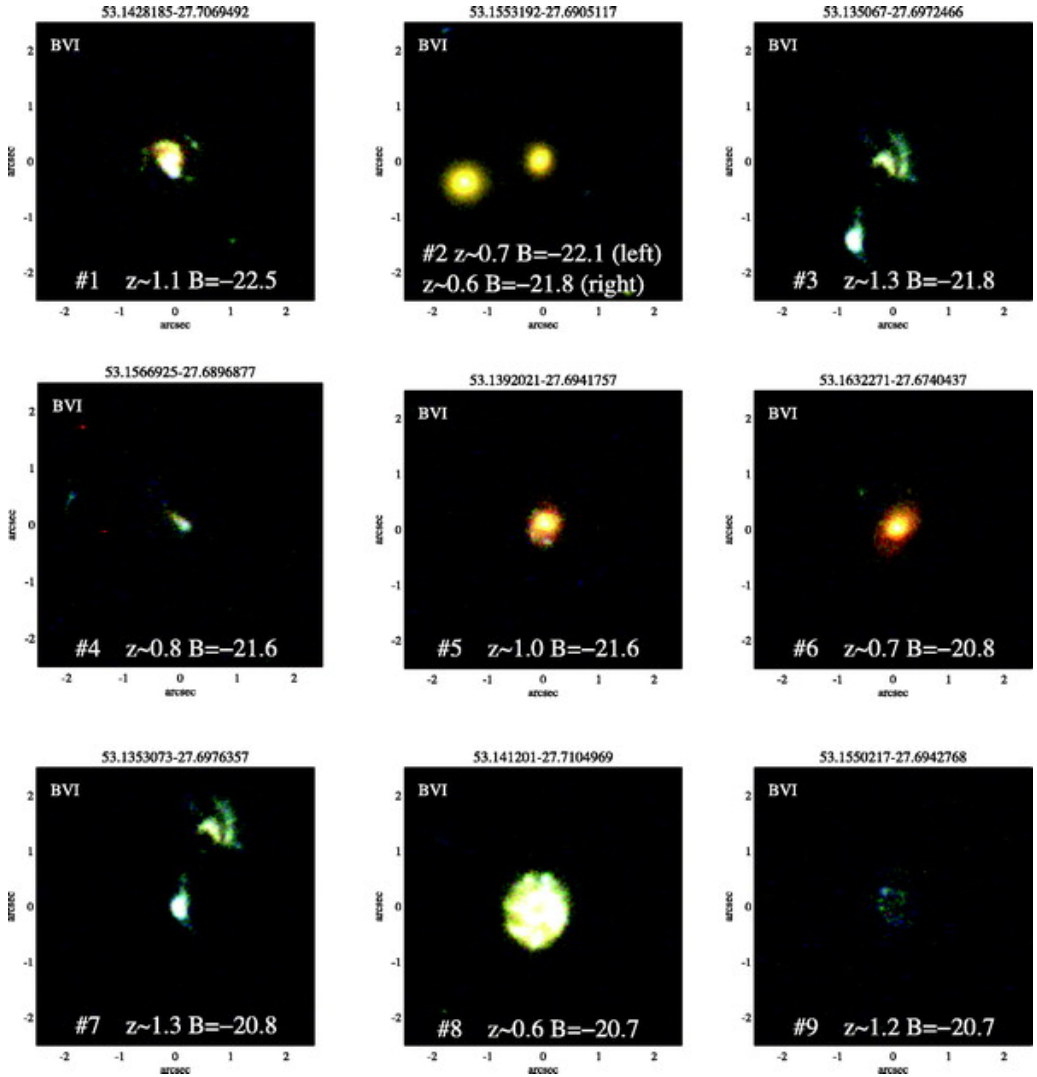
Nomenclature: Early and late type

Objects along the sequence are often referred to as being either an early-type or a late-type. Ellipticals and S0 galaxies are collectively called and early-type and spirals are called late-type. Within spirals, an Sa galaxy is called an early-type spiral, and an Sd galaxy a late-type spiral.
This nomenclature is not a statement of the evolutionary stage of the objects but is merely a nomenclature of purely historical origin.

Galaxy classification affected by projection

Morphological classification is at least partially affected by projection effects. If, for instance, the spatial shape of an elliptical galaxy is a triaxial ellipsoid, then the observed ellipticity ϵ will depend on its orientation with respect to the line-of-sight. Also, it will be difficult to identify a bar in a spiral that is observed from its side ("edge-on"). Similarly, a weak disk in an "face-on S0" is hard to spot.

∼30% of galaxies at $z \sim 1$ are peculiar



de Mello et al. (2006)

Dwarf galaxies

Dwarf galaxies are also not included in the Hubble sequence.

- Low-luminosity: $10^6 - 10^{10}$ $L_\odot$, low-mass: $10^7 - 10^{10}$ $M_\odot$, small in size, $\sim$few kpc, dark matter dominated
- Often low surface brightness, so they are hard to find!
- More than one family of objects:
  - Gas-poor, passive (dE and dSph)
  - Gas-rich, star forming dIrr
- Why are dwarf galaxies important?
  - Majority of galaxies are dwarfs!
  - Dwarf galaxies may be remnants of galaxy formation process: "proto-dwarf" gas clouds came together to form larger galaxies (hierarchical formation)
  - Dwarf galaxies are currently being cannibalized by larger galaxies
  - Dwarf galaxies are relatively simple systems, not merger products: in some sense, "pristine" low metallicity galaxies
  - good for *near field cosmology*, but can't be detected at cosmological distances.

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Questions

If you go look at the night sky most of the stars look white or blue with a few red ones which are all red giants. But the IMF tells us that most stars should be red looking M-dwarfs or G and K type dwarfs? Why are these common stars extremely uncommon in the night sky?

Questions

If you go look at the night sky most of the stars look white or blue with a few red ones which are all red giants. But the IMF tells us that most stars should be red looking M-dwarfs or G and K type dwarfs? Why are these common stars extremely uncommon in the night sky?
See Binney & Merrifield (1998) pp. 111-115

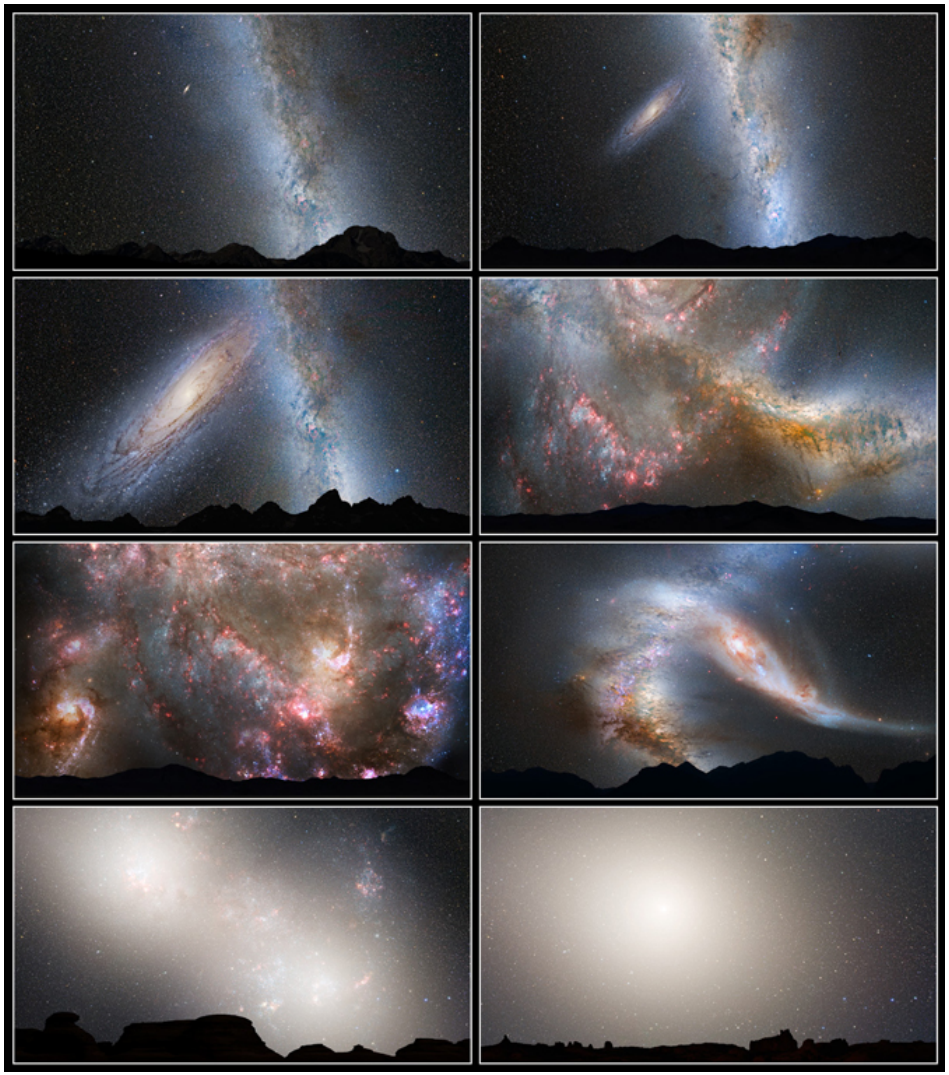
Mergers can alter morphology

Arp 273 - tidal distortions from interaction

The Milky Way - Andromeda galaxy merger

Galaxies in the process of transformation, generally from disks to ellipticals
In late stages of a merger, the 2 galaxies are no longer distinguishable.
What does the merger product look like?
Show movie

Andromeda in Earth's sky

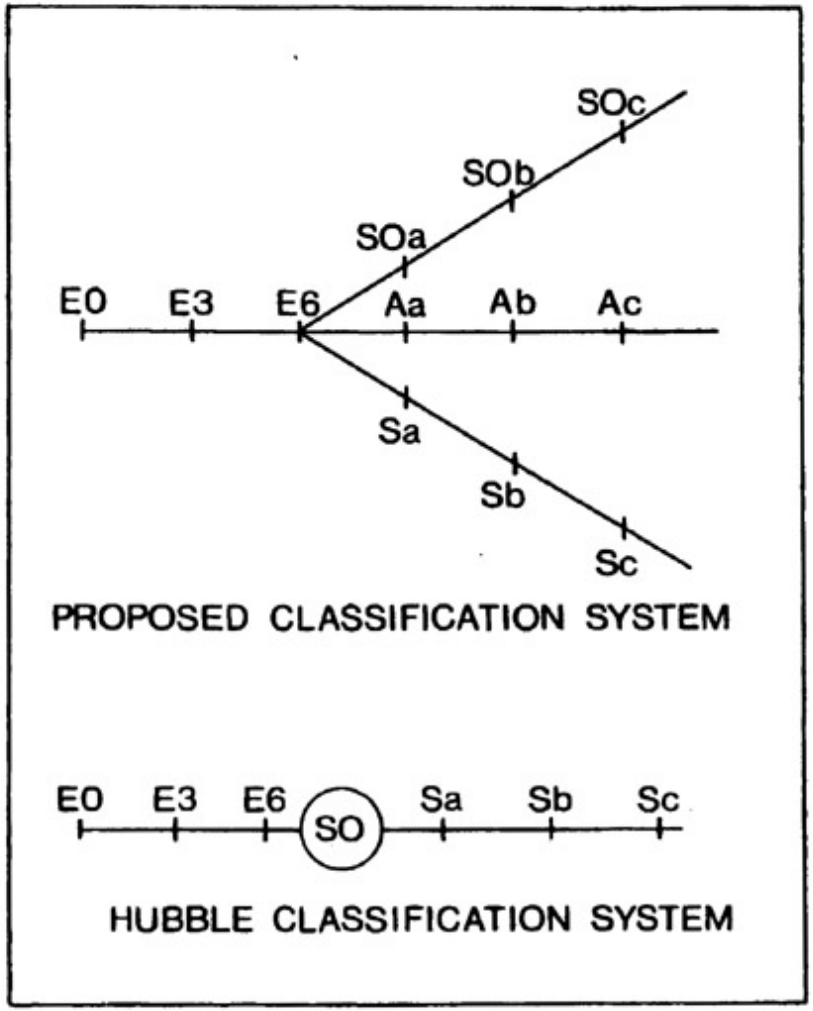


Other limitations of the Hubble classification

- Based on photographic images in the blue emphasises star formation (not ma ss distribution)Why? High z galaxies sample the rest frame UV W hy?.
- Requires reasonably good spatial resolution across the galaxy (20 elements) progressively more difficult for $cz > 8000$ km/s from ground.

To summarise, three kinds of galaxies don't fit into the Hubble scheme: (1) Disturbed or interacting galaxies (2) Galaxies at high-z and (3) Low Surface Brightness (LSB) galaxies - almost always dwarf galaxies.

Modifications to the Hubble Sequence e.g. by van den Bergh 1976



Kormendy's version of the Hubble sequence