Week 7:
The role of galaxy structure

Introduction by S. Lilly

Questions from last week:

1. Why might evolution of centrals and satellites be different?

Centrals are at rest, at the bottom of the potential well of their haloes. Satellites are orbiting around in the potential of another larger galaxy, moving through the gas in that halo.

2. Why do some centrals become satellites of other galaxies?

This is because of the hierarchical growth of structure. DM haloes grow by accreting matter that has already formed into smaller haloes. These haloes will contain galaxies. These galaxies (centrals) then become satellites.

3. What are some ways that the environment could quench satellite galaxies?

There are many. prevention of gas-inflow onto the satellite (strangulation), ram-pressure stripping of gas, tidal disruption etc.

Questions from last week:

4. What does "separability" of f_Q tell us?

It tells us that the effects of the environment do not depend on the stellar mass of the satellite. It turns out that the distribution of parameters known to affect satellites (parent halo mass, radial position in parent halo, local density etc.) do not depend much on the mass of the satellite. But this still means that the "response" of the satellite to these drivers must also be largely independent of mass.

5. What is "conformity" and what does it tell us?

Conformity is the effect whereby the quenched state of centrals and satellites is correlated, even for fixed halo mass (and other parameters). It tells us that whatever parameters are affecting quenching that we don't yet know about (hidden variables) they must be correlated across significant distances, e.g. across the scale of a halo.

[redacted]

0th-order links between star-formation and structure

Star-forming galaxies

Flattened disks with ordered rotation of stars and gas

Passive galaxies

3-d structures supported by randomly oriented velocities of stars

Structure and morphology

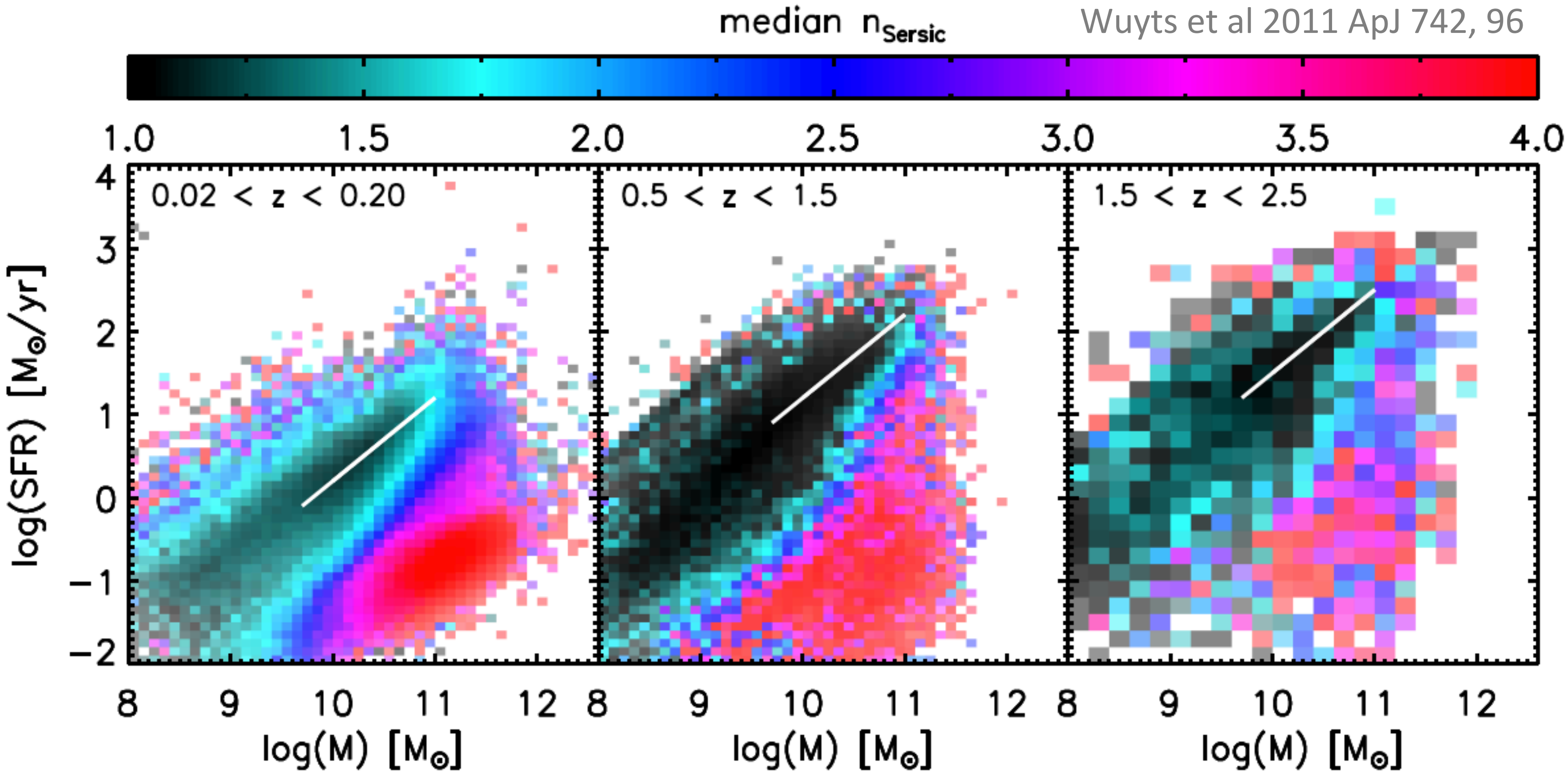
Sersic surface brightness formula:

- Exponential disk has $n = 1$
- Most spheroidal galaxies have $n \sim 4$

$$\mu = \mu_0 e^{-kr^{1/n}}$$

There is a clear correlation between n and sSFR

Wuyts et al 2011 ApJ 742, 96



How much of this is just a consequence of simple physics?

Gas usually ends up in a spinning disk in which angular momentum of gas particles are aligned, with gas particles on circular orbits. WHY?

So, almost all star-formation will be in flat 2-d structures (galaxy disks).

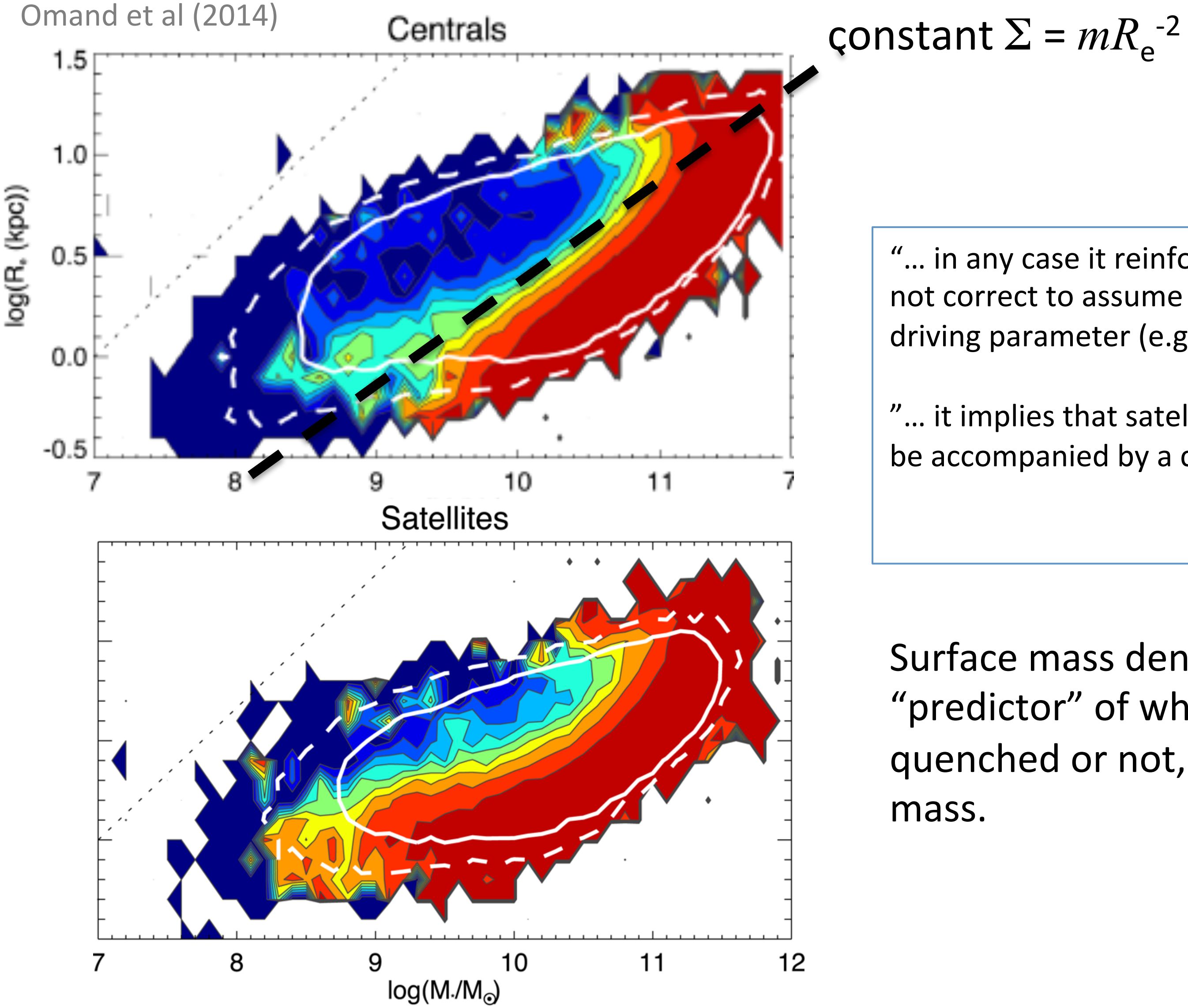
Once made in disks, there are ways to scatter stars into 3-d spheroidal structures

- Instabilities in the disks (bars etc)
- Mergers with other galaxies, minor and major

So, having young recently formed stars in disks and older stars in spheroids is not particularly surprising.

Apparent importance of stellar density in quenching

Omand et al (2014)



> "… in any case it reinforces the fact that is not correct to assume galaxy mass is the driving parameter (e.g. Peng et al. 2010)".
>
> "… it implies that satellite quenching *must* be accompanied by a change in structure."
>
> Omand et al 2014

Surface mass density Σ is a <u>far</u> better "predictor" of whether a galaxy is quenched or not, than is it's stellar mass.

Apparent importance of stellar density in quenching

We know that at a given mass, galaxies were smaller (denser) in the past (we'll see why).

Are quenched galaxies denser because density quenched them, or because they quenched in the past when all galaxies were denser?

Questions for today

1. Why is star-forming gas always in a rotating disk?

2. What sets the size of that disk and how would that change with redshift (time)?

3. How can stars in a disk end up in a spheroidal distribution?

4. Can we see differences between these channels in say v/σ?

5. What if anything can we say from the tight correlation between quenched state and Σ?