

I Workshop "Challenges of New Physics in Space"

INSIGHTS ON THE BRIGHT SIDE OF THE UNIVERSE

**NATURE VERSUS NURTURE:
A CHALLENGE FOR GALAXY EVOLUTION**

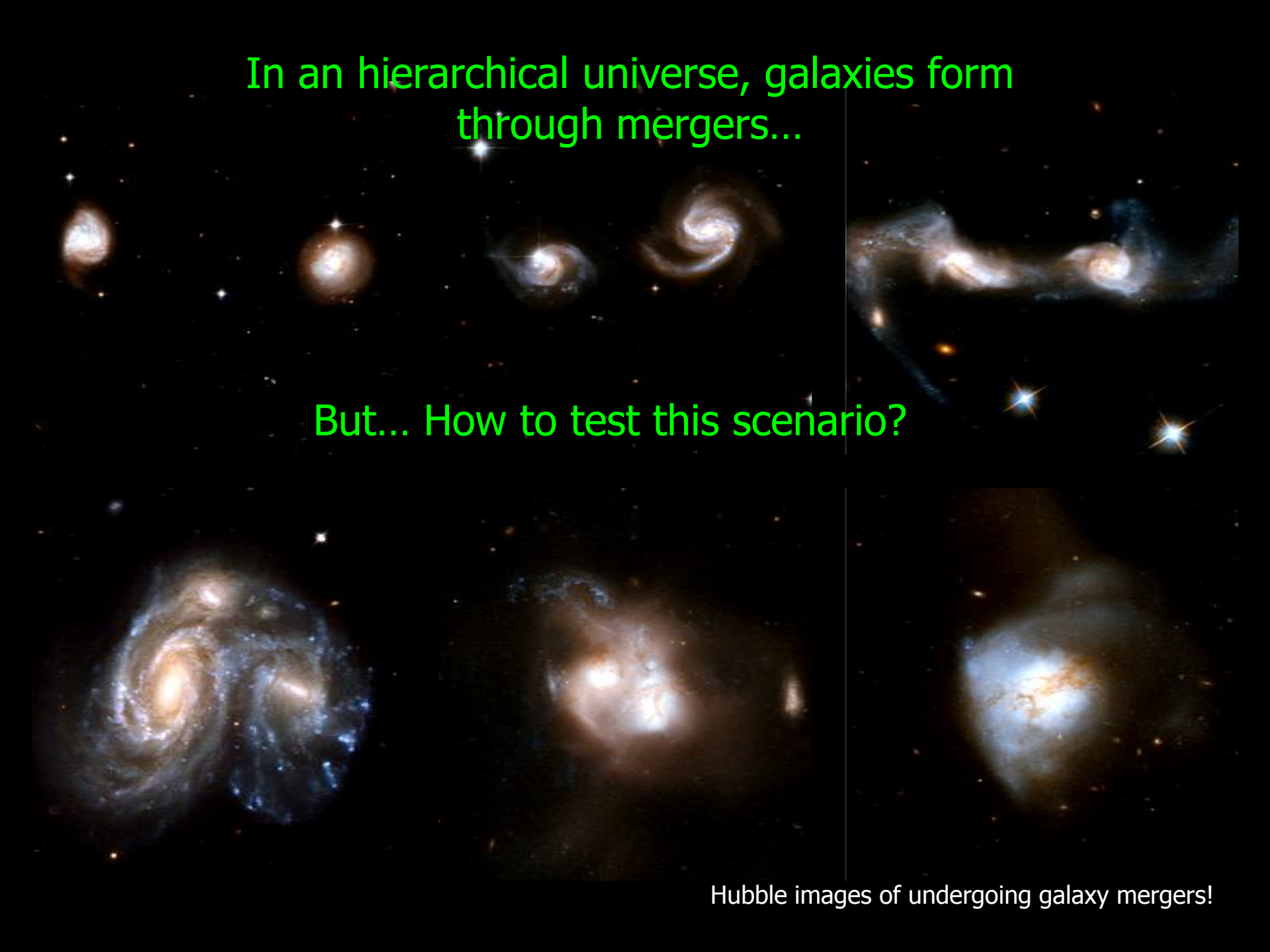
Abílio Mateus

IAG/USP

In an hierarchical universe, galaxies form through mergers...

But... How to test this scenario?

Hubble images of undergoing galaxy mergers!

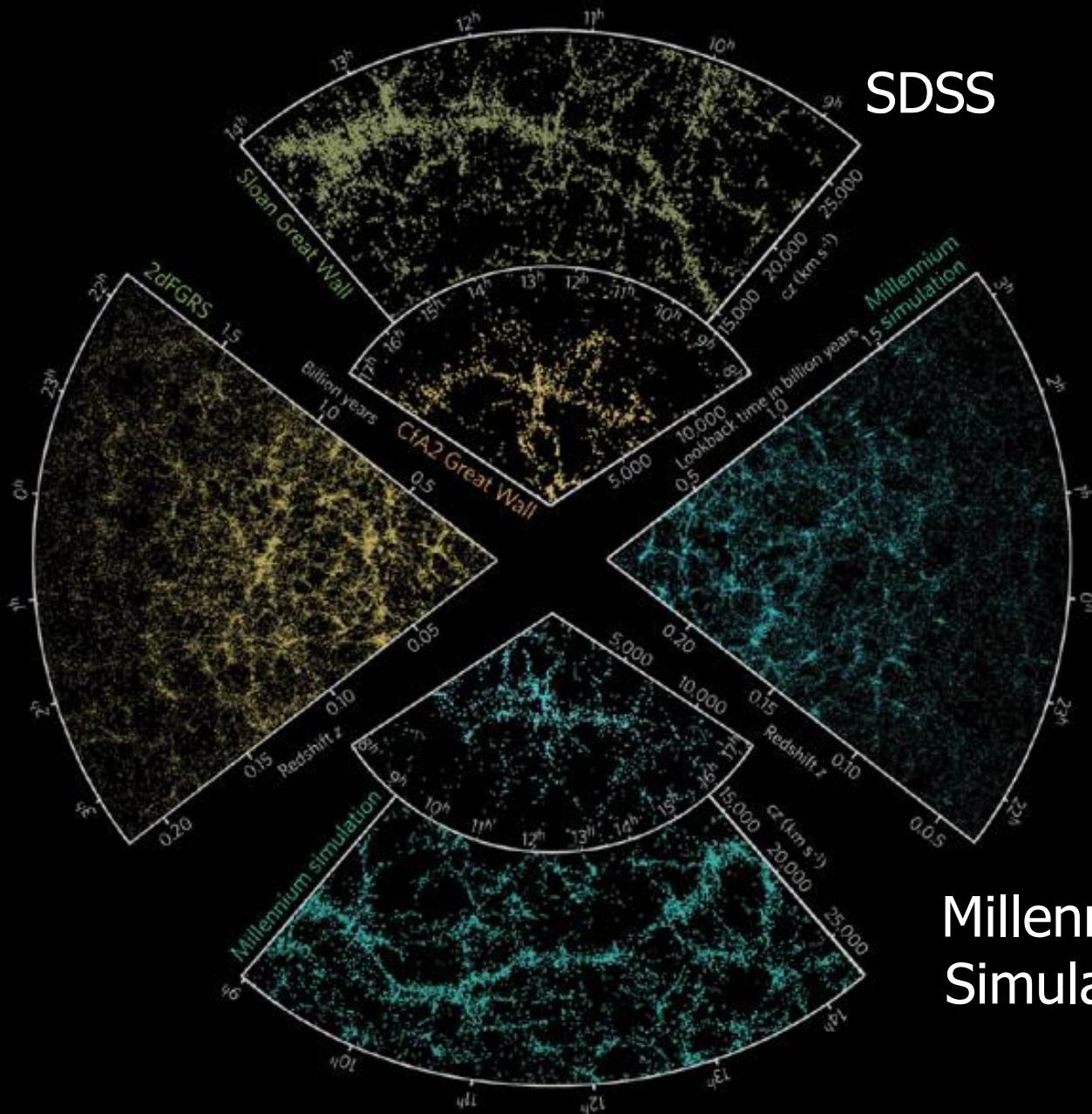


Galaxy clustering

Nowadays,
data isn't a
problem!

2dFGRS

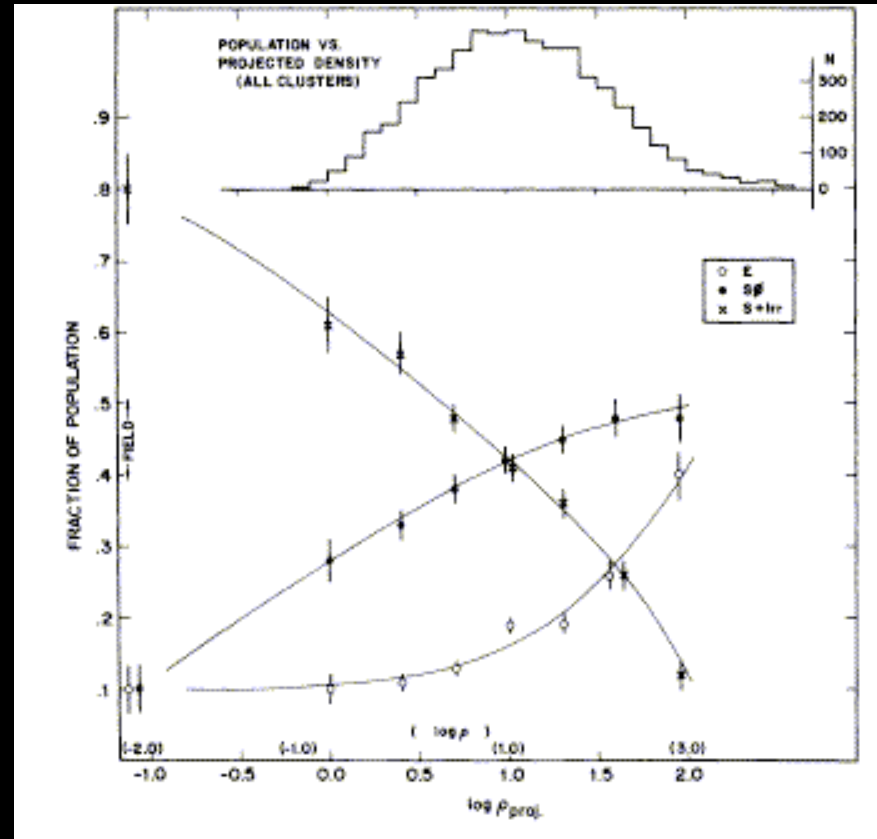
SDSS



Millennium
Simulation

Basic relation

- ❑ Morphology-density relation (Dressler 1980)
- ❑ Star-forming galaxies in dense environments are rare objects
- ❑ Galaxy types are segregated
- ❑ What originated such behaviour?



Galaxy clustering: what the role of environment in driving galaxy populations?

Two perspectives

- ❑ **Nurture** ➡ galaxies properties are affected by the environment ➡ very known physical mechanisms (e.g. ram pressure stripping and tidal interactions)
- ❑ **Nature** ➡ relations between galaxies properties and the surrounding environment were established during the epoch of galaxy formation

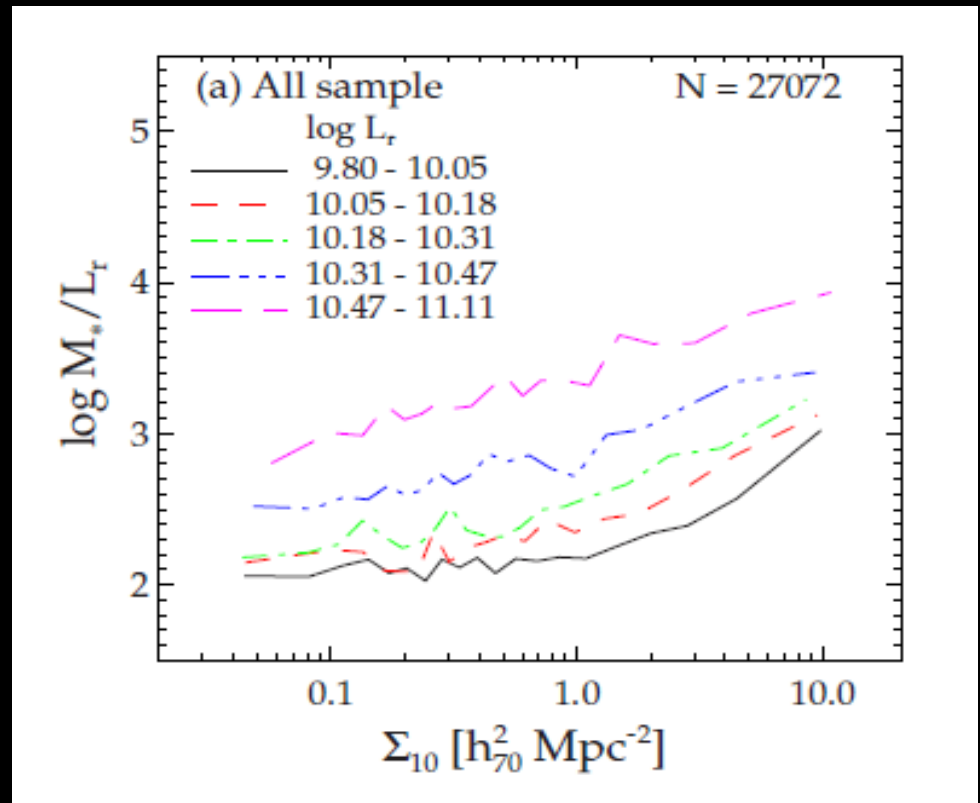
A nature via nurture scenario for galaxy evolution

- ❑ In Mateus et al. (2007) we investigated the environmental dependence of physical galaxy properties, like stellar ages, stellar metallicities, mass, etc.
- ❑ Using a volume limited sample extracted from the SDSS: 50 thousand galaxies in the nearby universe.
- ❑ Galaxy properties obtained from spectral synthesis method: STARLIGHT algorithm (Cid Fernandes et al. 2005) → **astropaleontology**

More about spectral synthesis approach in Laerte Sodré talk (Session VII)

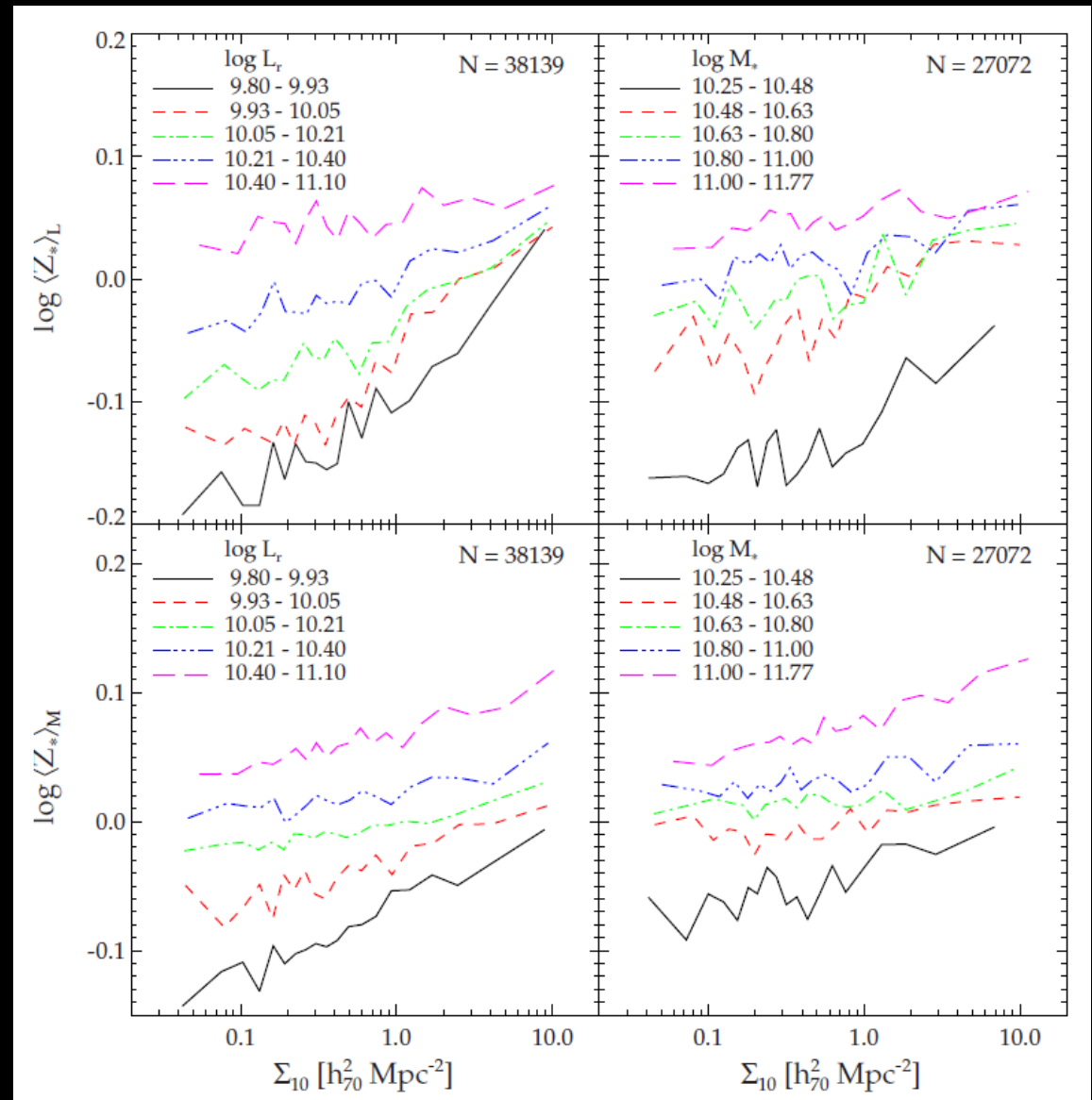
Results: mass-luminosity relation

- Galaxies with the same luminosity in denser environments tend to be 20-30% more massive.
- Downsizing in star formation is related to environment!



Results: stellar metallicities

- Dense environments: metal-rich galaxies;
- Accelerated evolution in such regions.



Nature via nurture

- A natural path for galaxy evolution proceeds **via** a nurture way, in the sense that galaxy evolution is accelerated in denser environments:
 - Massive galaxies have been formed in denser regions and evolved in an accelerated way ➔ **mergers**
 - Contrasting with a more unsocial life of low-mass galaxies that inhabit low density regions of the universe.

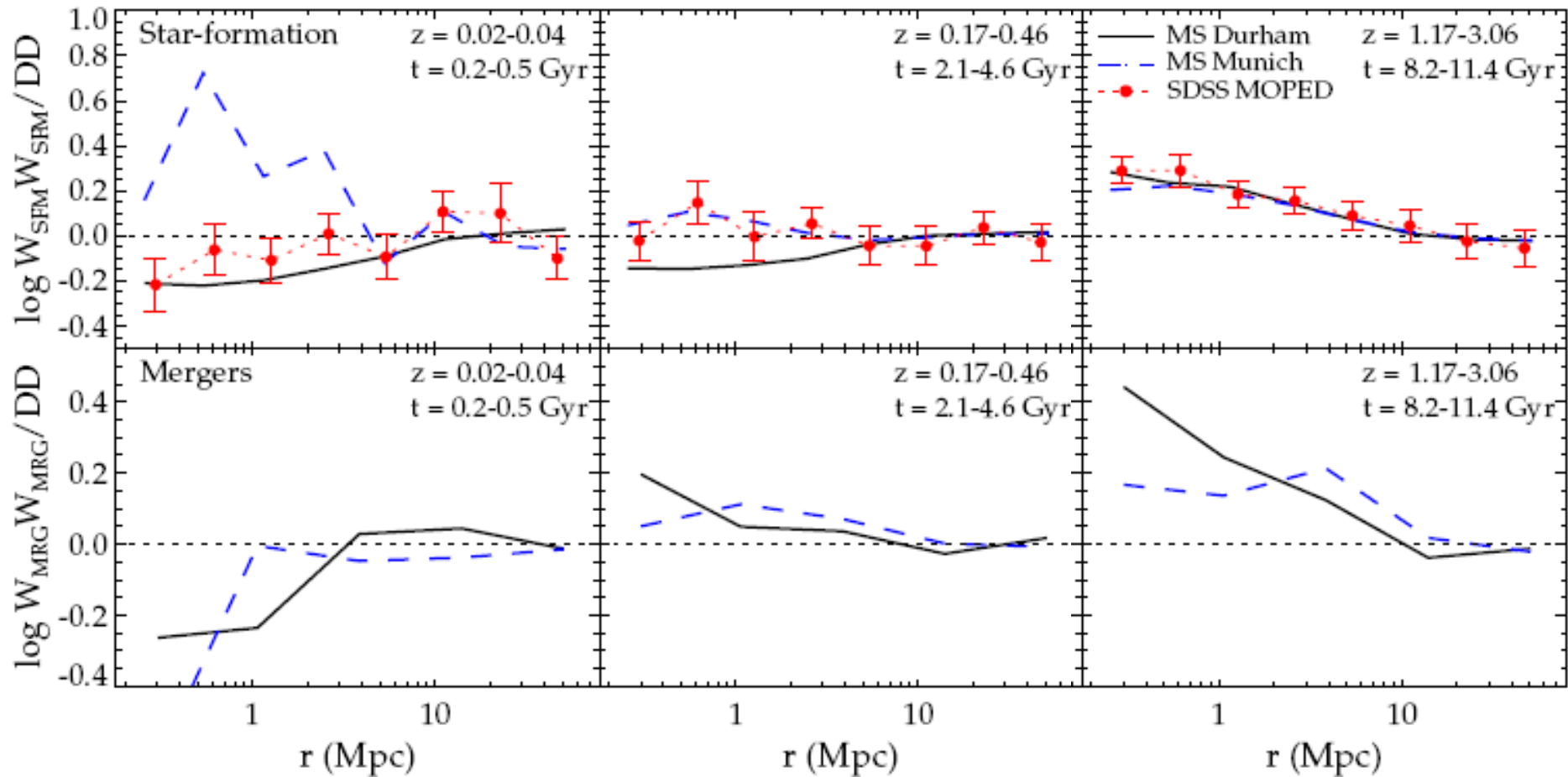
“Nature can act only via nurture. The environment acts as a multiplier of small *natural* differences...”

Matt Ridley (british zoologist)

Testing nature via nurture

- ❑ Mateus, Jimenez & Gaztañaga (2008)
- ❑ Mark correlation analysis of galaxies from the SDSS and from the galaxy catalogs drawn from the Millennium Simulation
- ❑ Two semi-analytical galaxy formation models:
 - Durham model: Bower et al. (2006)
 - Munich model: De Lucia & Blaizot (2007)
- ❑ Mark correlations weighted by the star formation history (SFH) of galaxies ➔ **mass assembly evolution**
- ❑ SDSS SFH: MOPED algorithm, spectral synthesis approach

Mark correlations: mass assembly & mergers



- The high star formation at high- z for close pairs is closely related to an excess in the number of major mergers

Main conclusions

- ❑ Our main finding is the **strong correlation** between the shape and time evolution of the **star formation** marks and the **number of major mergers** in the galaxy, which drive the **environmental dependence** in galaxy formation by regulating the star formation process.
- ❑ In this **nature via nurture** scenario, galaxy mergers in denser environments accelerated the mass assembly in galaxies at high redshifts.

*"Nature versus Nurture is dead.
Long live Nature via Nurture !"*

Matt Ridley

THE END