Do galaxies die?

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ESAC science seminar, 13/12/2018

Outline

# Theory

My *biased* [t]he[o]retical view
## of galaxy formation and chemical evolution

The orthodox scenario
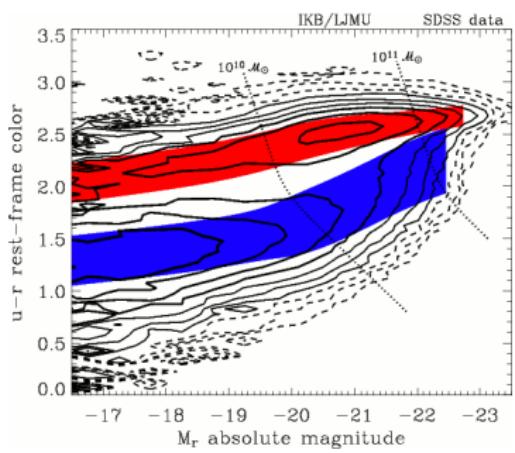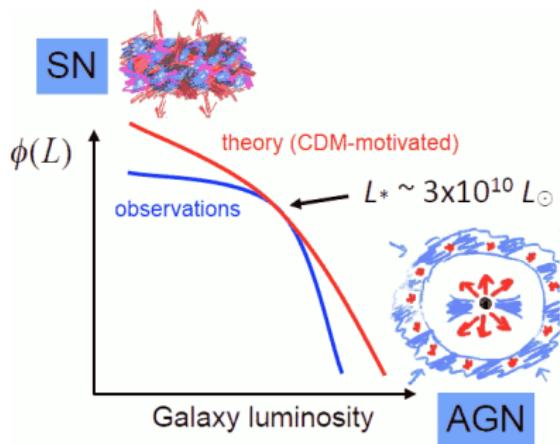
The gradual conversion of gas into stars

Infall →

Diffuse gas: M_{HI}

$\frac{M_{HI}}{\tau_{CF}}$

$\eta_{diss} \frac{M_c}{\tau_{SF}}$

$\eta_{wind} \frac{M_c}{\tau_{SF}}$

$R \frac{M_c}{\tau_{SF}}$

Molecular clouds: M_c

$\frac{M_c}{\tau_{SF}}$

Stars: M_*

# The gradual conversion of gas into stars
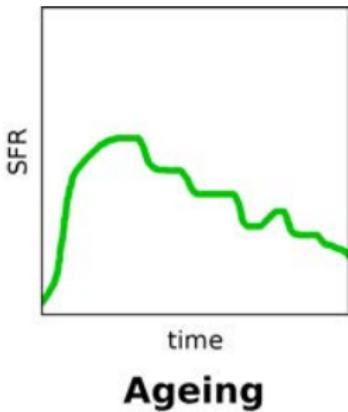
Ageing

¿Nature or nurture?

- Initial conditions + secular processes
- Interactions with the environment

¿Local or global?

- Surface/volume density, metallicity
- Galaxy morphology, halo mass

"Discrete" ($\sim$ Myr) events?

Theory
Observations
Conclusions

Scaling relations
Discrete events
AGN feedback

Observations

Theory
Observations
Conclusions
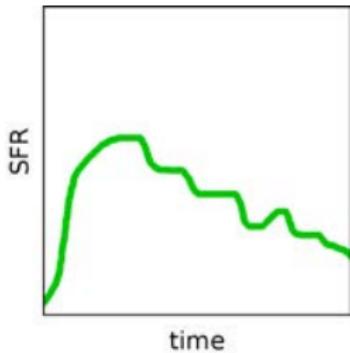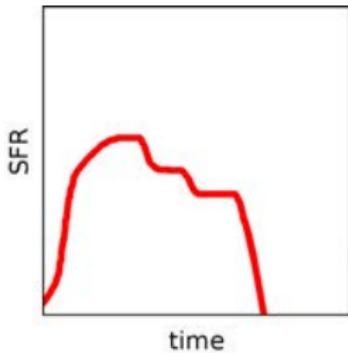
Scaling relations
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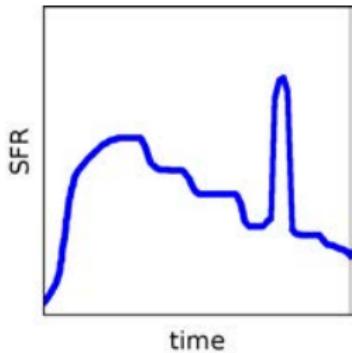
Scaling relations

Disney et al. (2008)

Scatter plots (original data)

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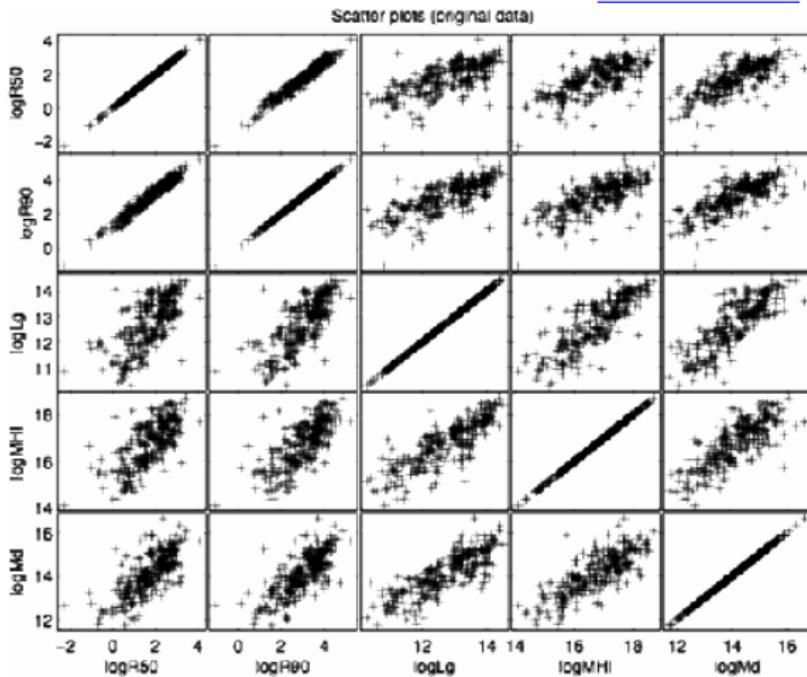
Scaling relations
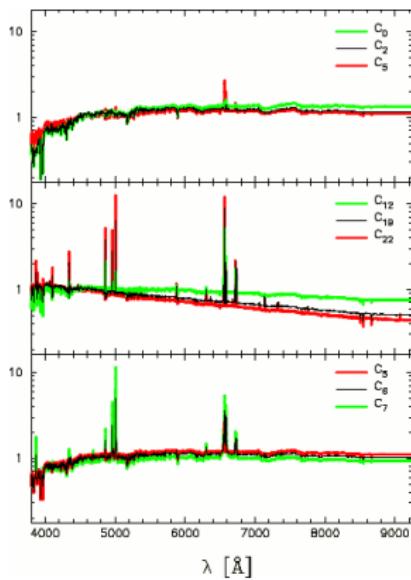
Ascasibar & Sánchez-Almeida (2011)

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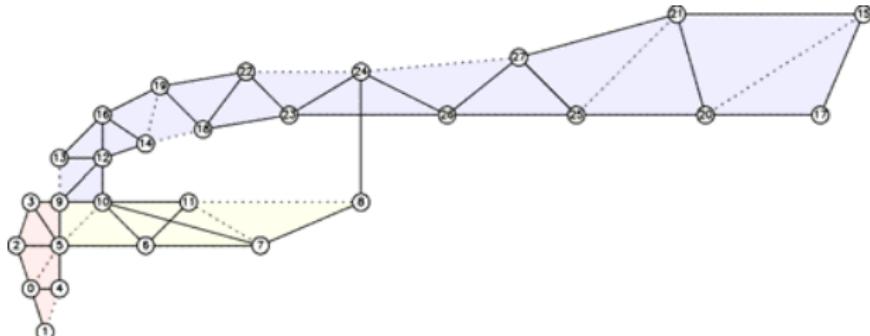
The resolved "main sequence" of star formation

Theory
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Gas surface density

Theory
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Scaling relations
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Molecular fraction

Theory
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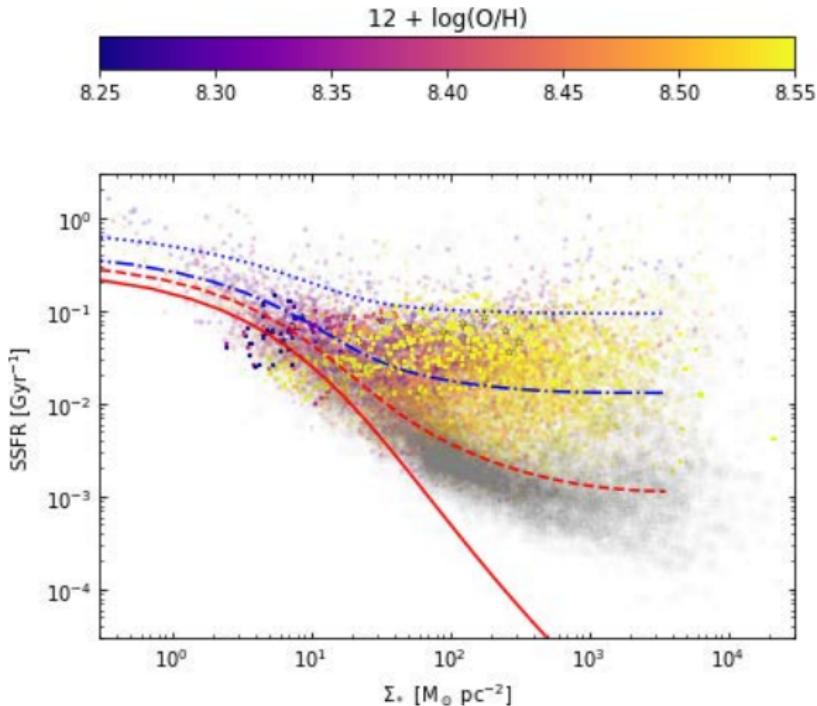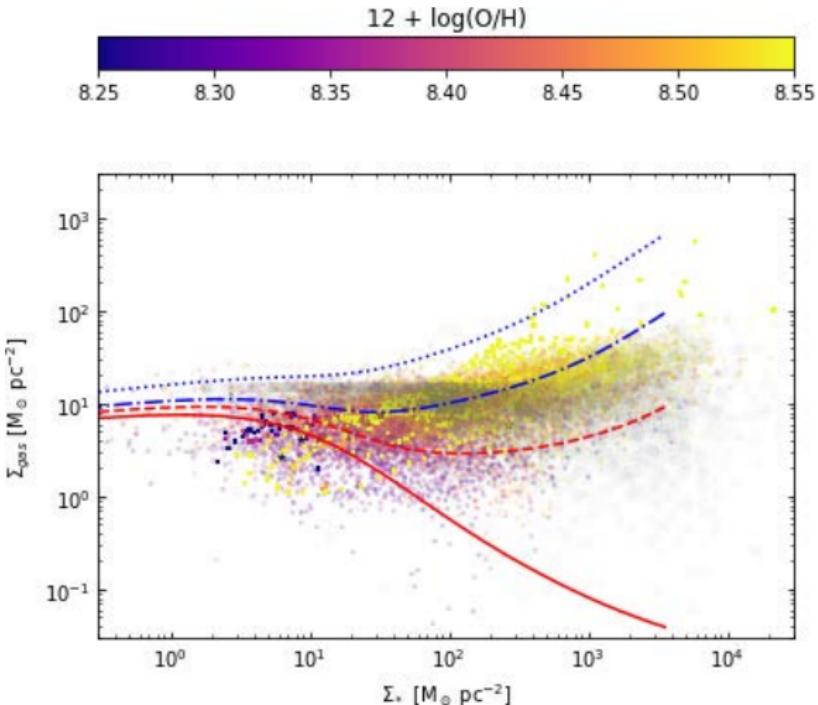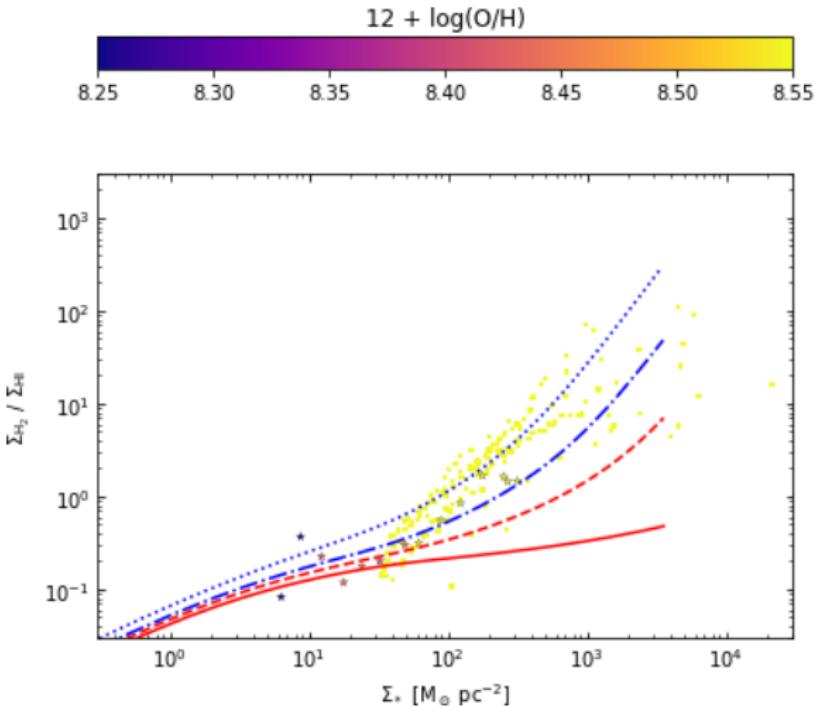
Star formation efficiency

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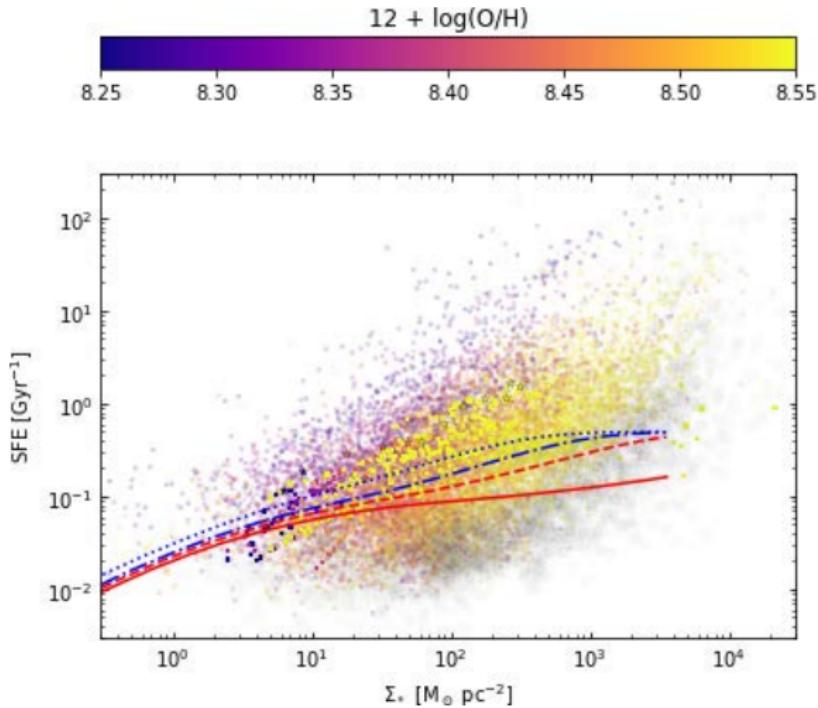
The metallicity-stellar fraction relation
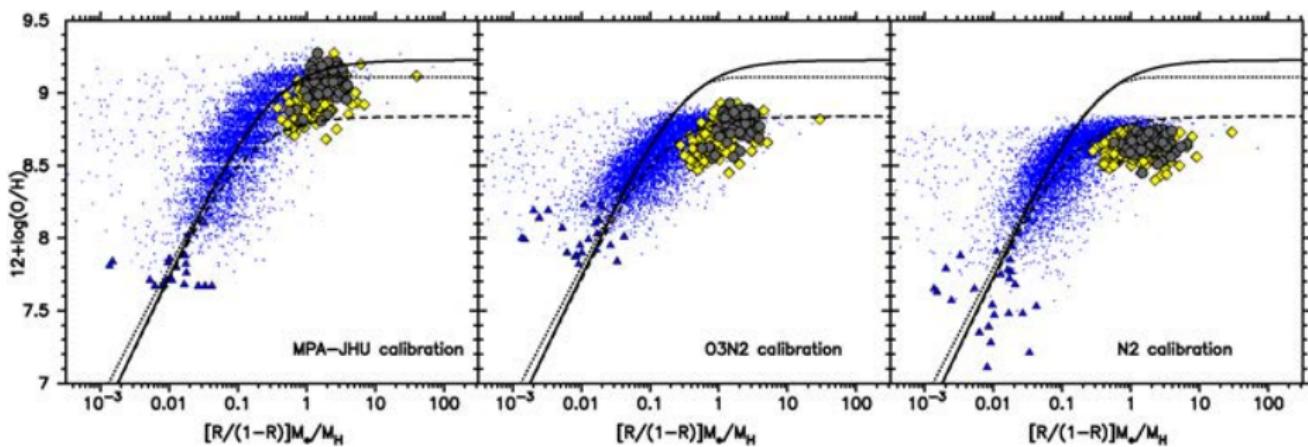
Ascasibar et al. (2015)

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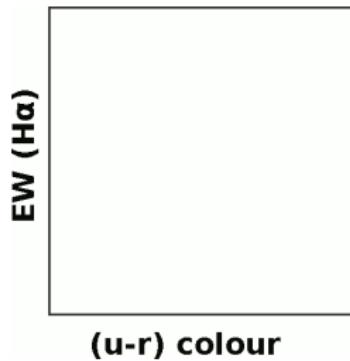
Scaling relations
Discrete events
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The (optical) colour-equivalent width diagram

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The (optical) colour-equivalent width diagram

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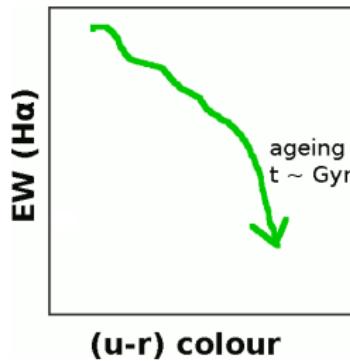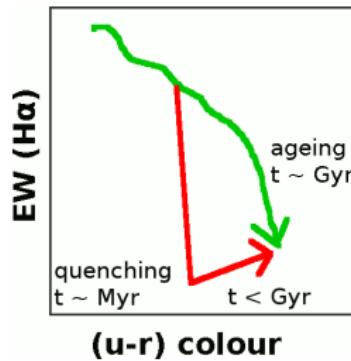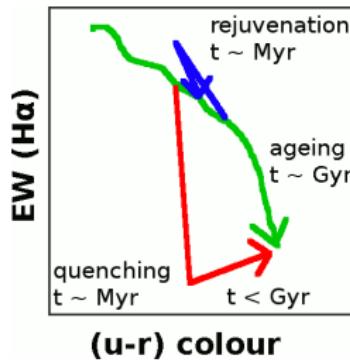
The ageing sequence

Casado et al. (2015)

Theory
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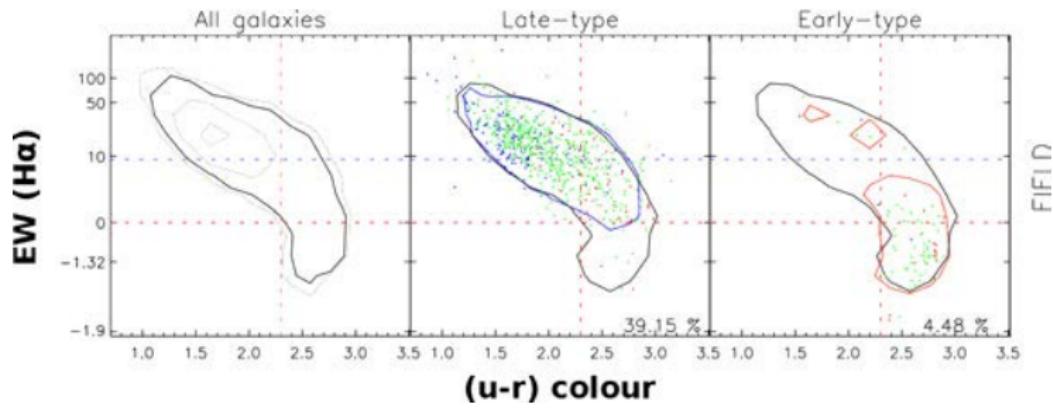
The "quenched" sequence?

Casado et al. (2015)

Theory
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Scaling relations
**Discrete events**
AGN feedback
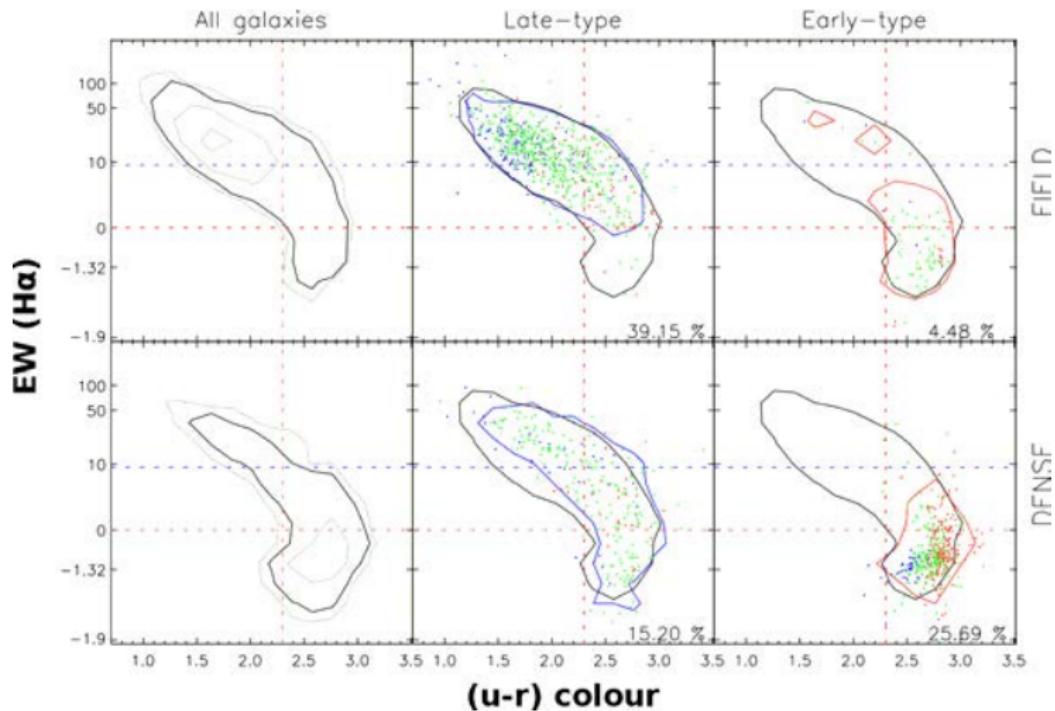
Mergers and interactions

Gas-rich

- Enhanced star formation (rejuvenation?)
- Disturbed morphology ($\rightarrow$ late-type)

Gas-poor

- No star formation
- Elliptical morphology

Theory
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Mergers and interactions

Casado et al. (2015)

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# AGN feedback

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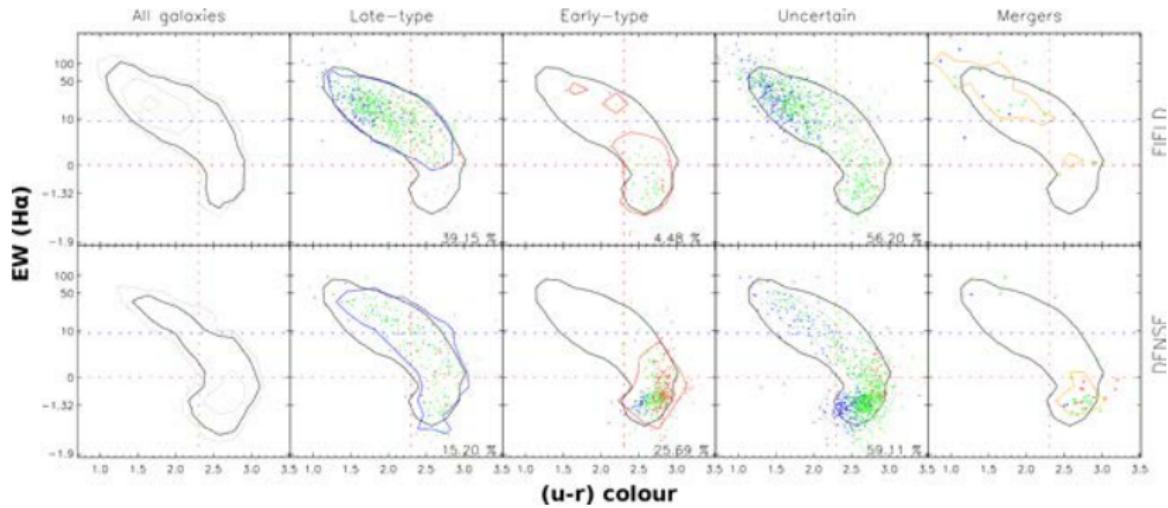
Scaling relations
Discrete events
AGN feedback
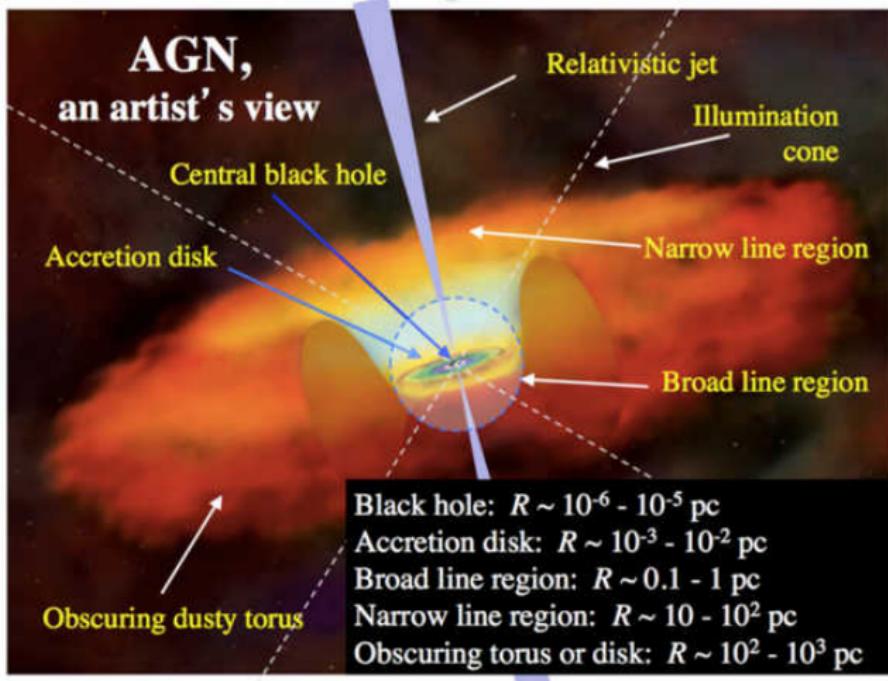
Optically-selected AGN

Kewley et al. (2006)

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SFH of the entire galaxy

Theory
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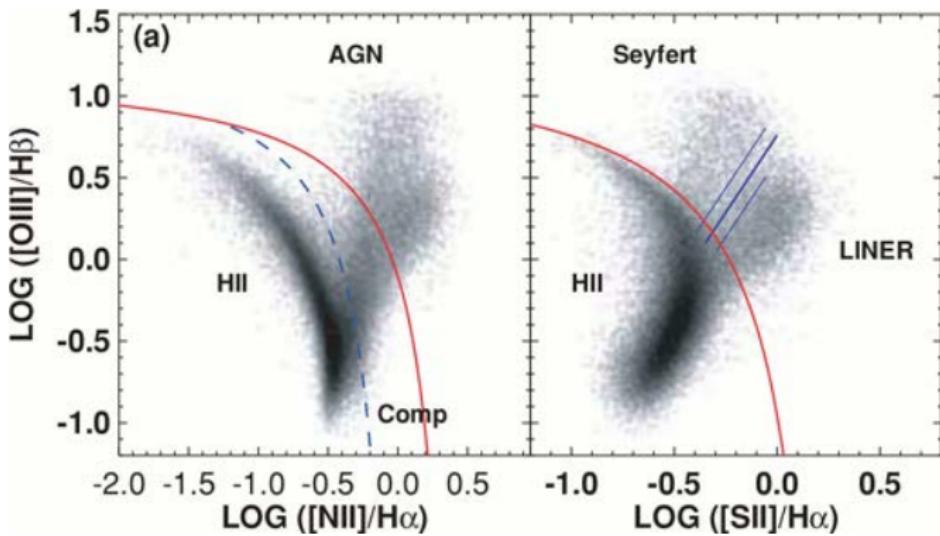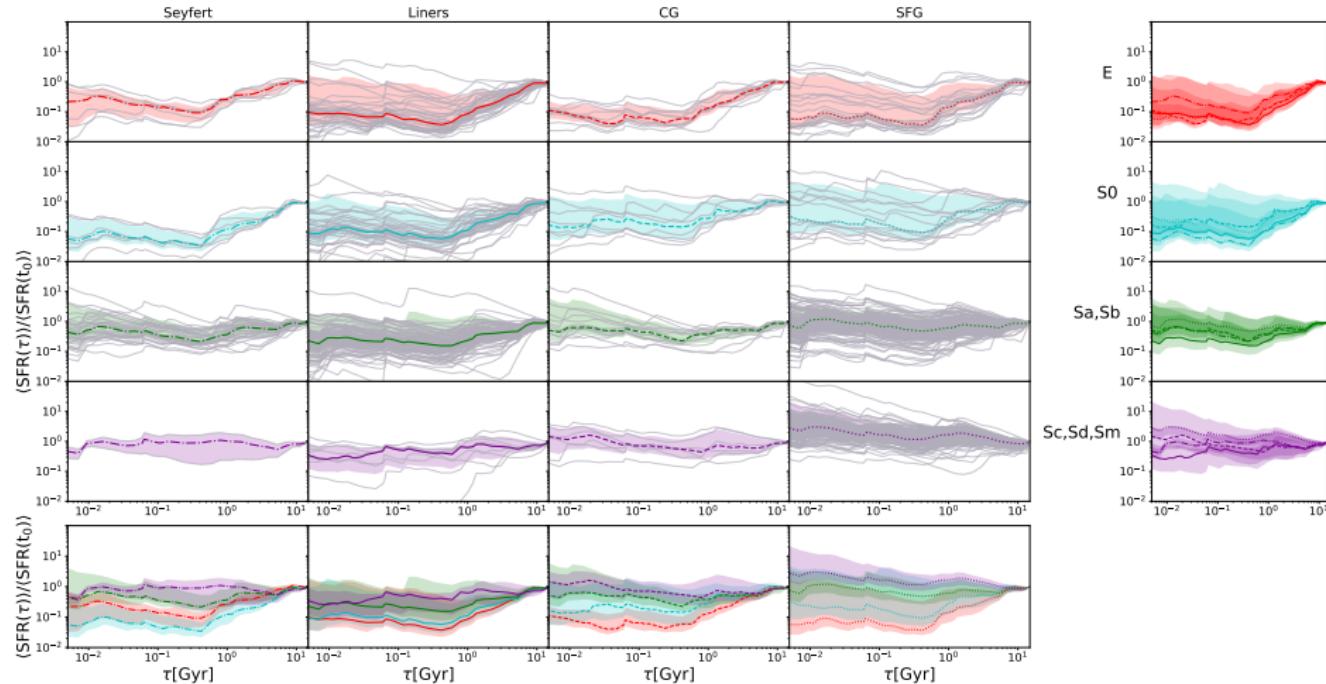
SFH of the circumnuclear (1 kpc) region

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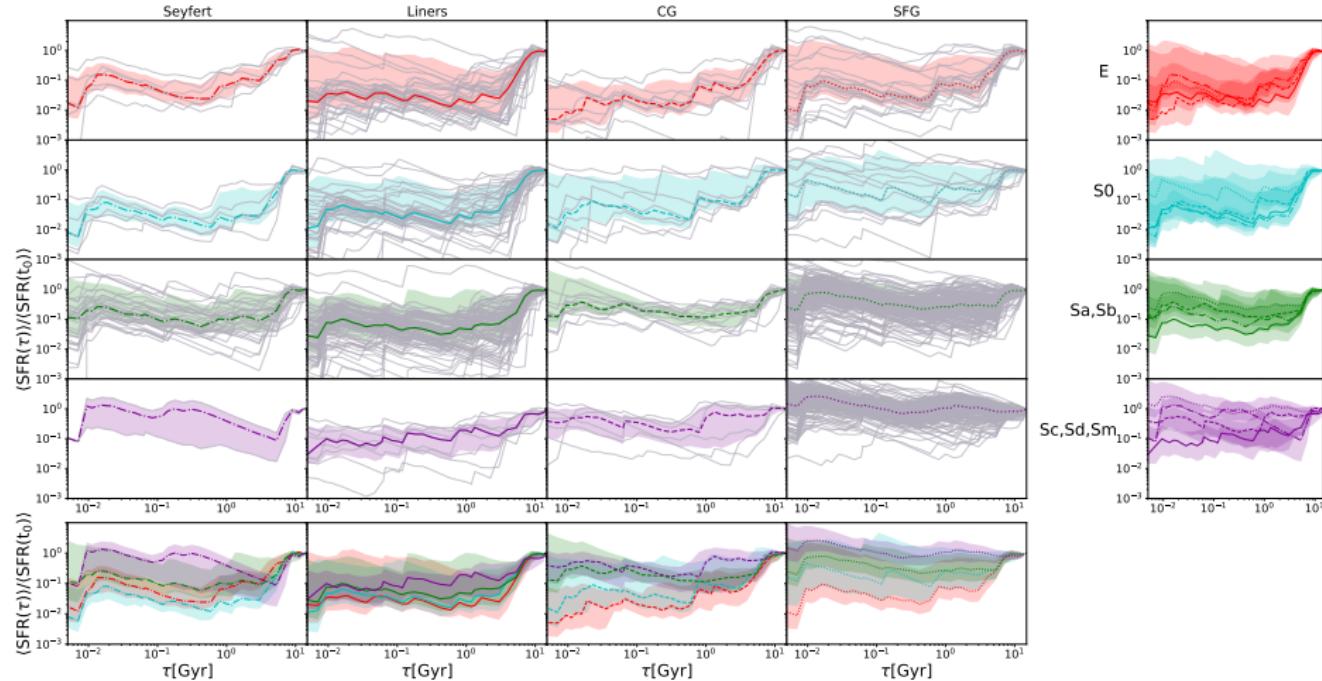
Multi-wavelength AGN selection

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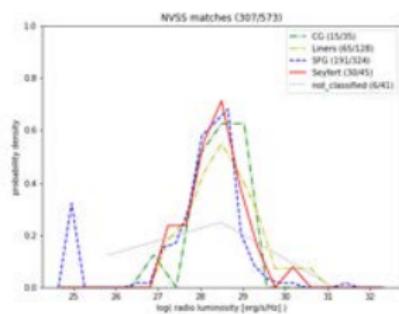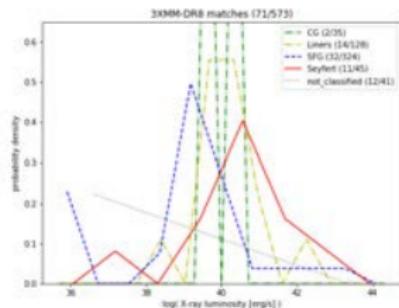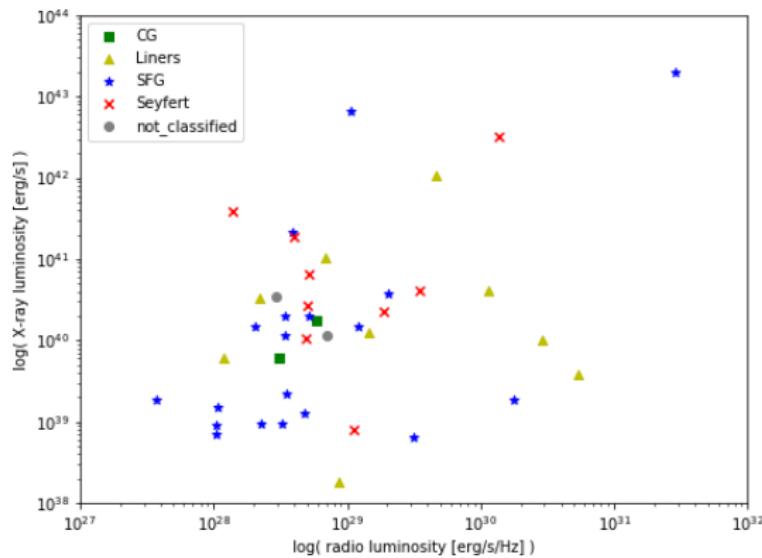
NGC6166

radio

optical

X-ray

Theory
**Observations**
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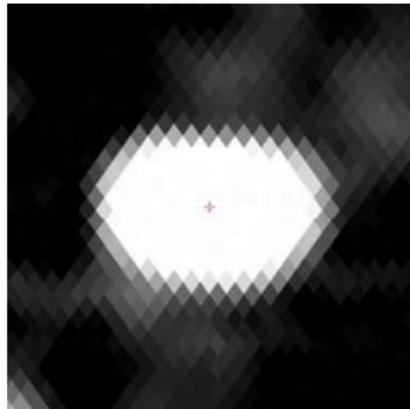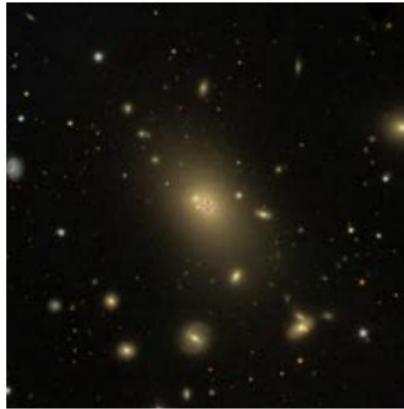
UGC03973

radio   optical   X-ray

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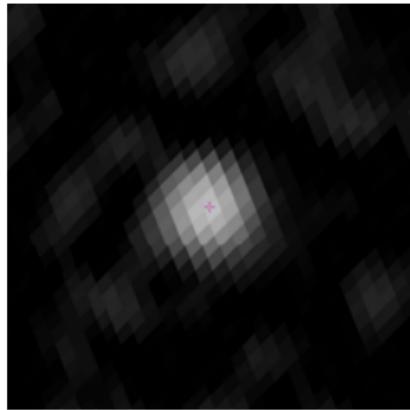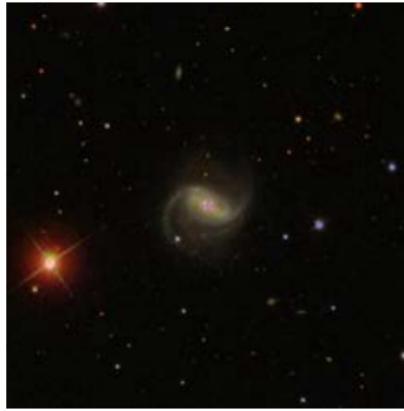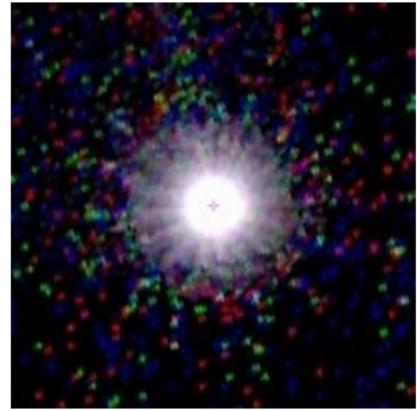
NGC1142

radio   optical   X-ray

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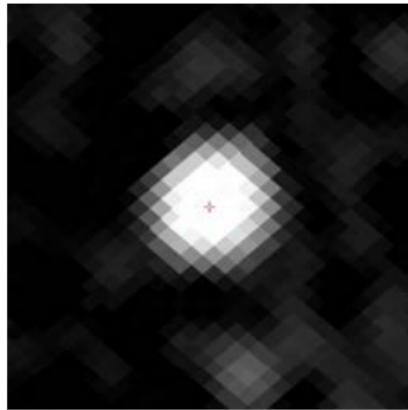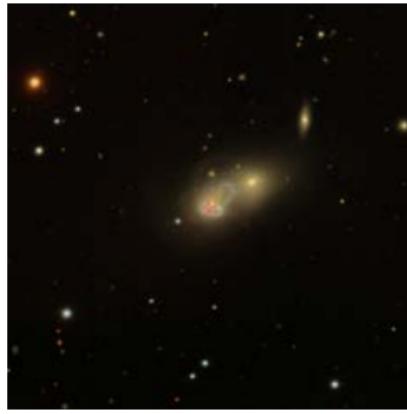
NGC6338

radio

optical

X-ray

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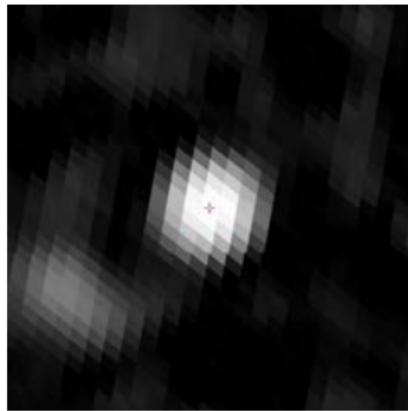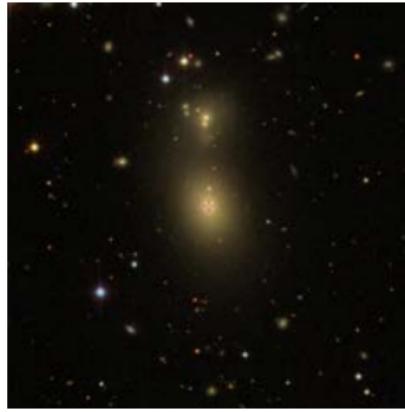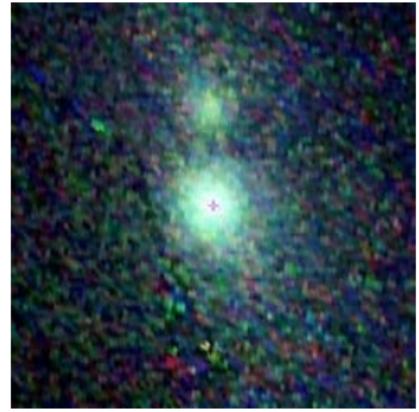
NGC1167

radio   optical   X-ray

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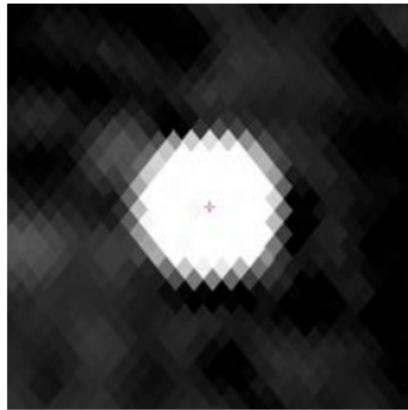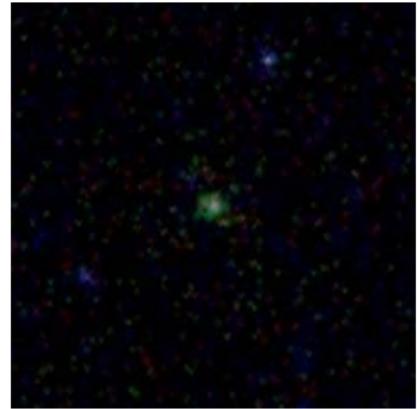
UGC12127

radio   optical   X-ray

Theory
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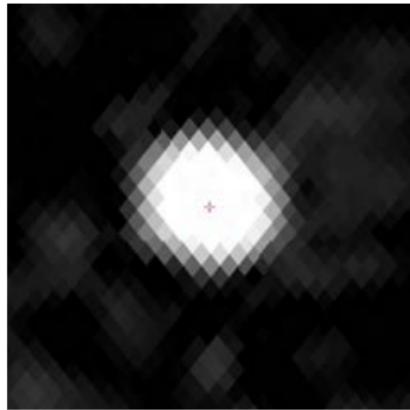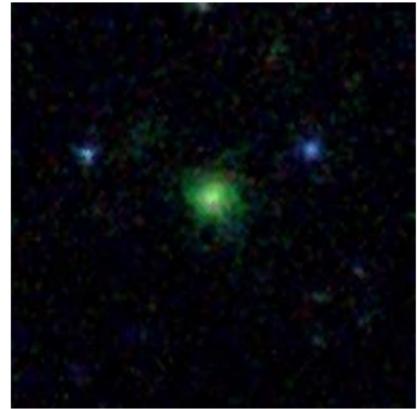
NGC0741

radio

optical

X-ray

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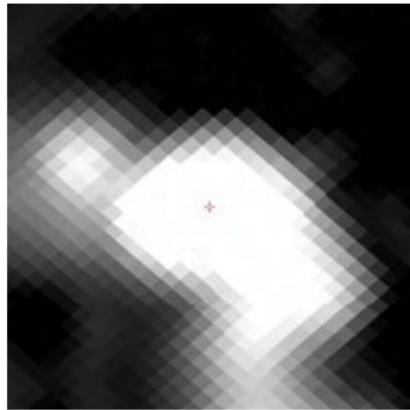
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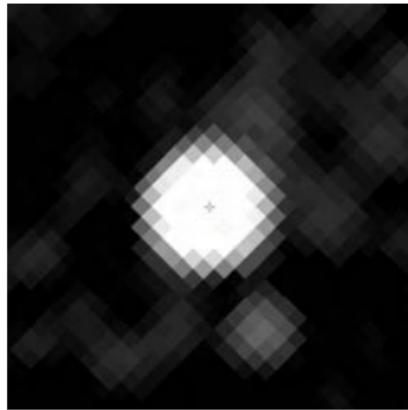
radio

optical

X-ray

Conclusions

Life and death of a galaxy

Resolved scaling relations

- Few degrees of freedom
    - surface density
    - infall timescale

Nature

- **Local processes** (H_2)
- Global processes (correlations)

Quenching

- **Old galaxies never die**
- Environment
    - starvation
- AGN feedback
    - circumnuclear region?
    - multi-wavelength selection

Nurture

- Environment
    - "ageing" sequence
    - "quenched" sequence?
- Interactions
    - rejuvenation?
    - morphology?