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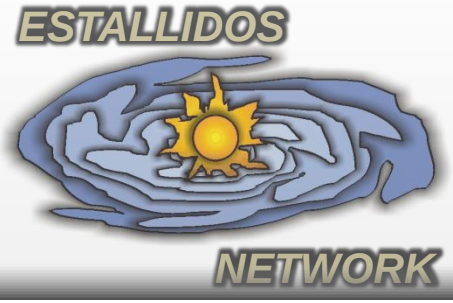


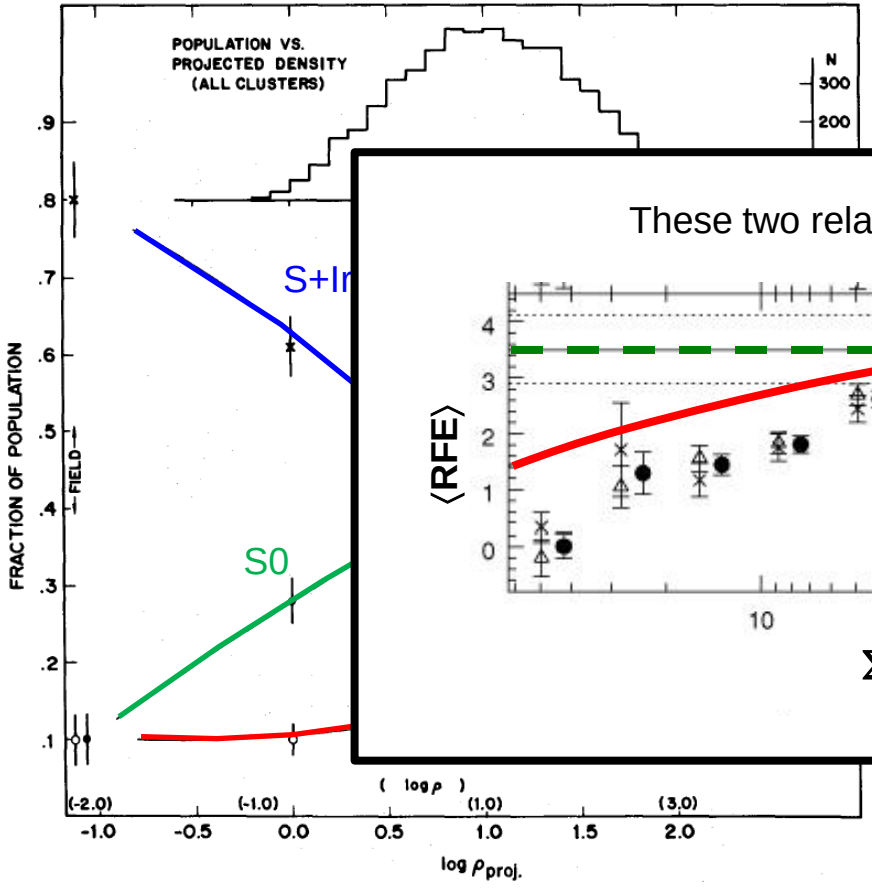
Chemical history of star-forming galaxies in nearby clusters

Jorge Iglesias-Páramo
Vasiliki Petropoulou
J.M. Vílchez

Instituto de Astrofísica de Andalucía - CSIC

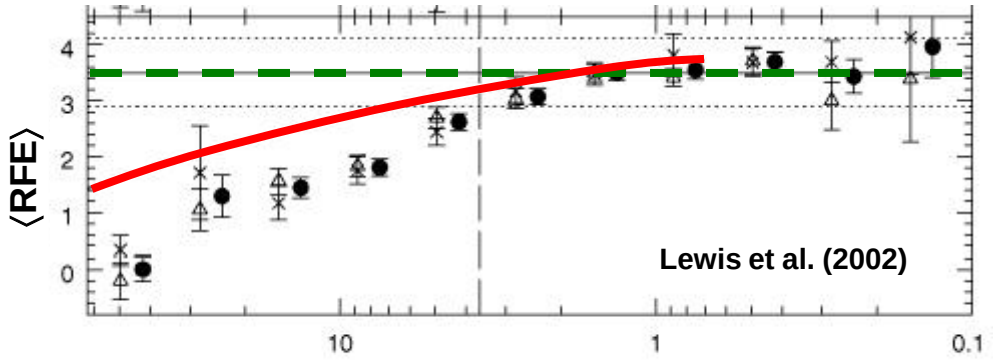
Evidences of the effect of the cluster environment on galaxies

Morphology – Density relation

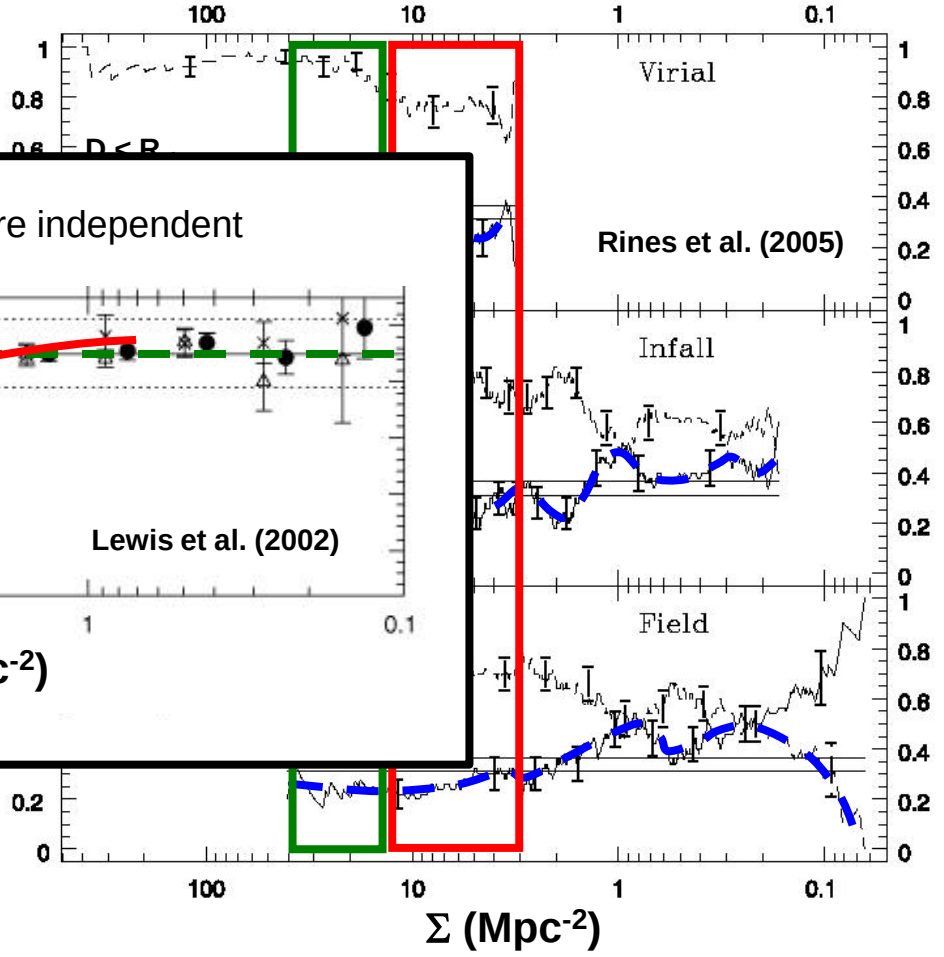


Dressler (1980)

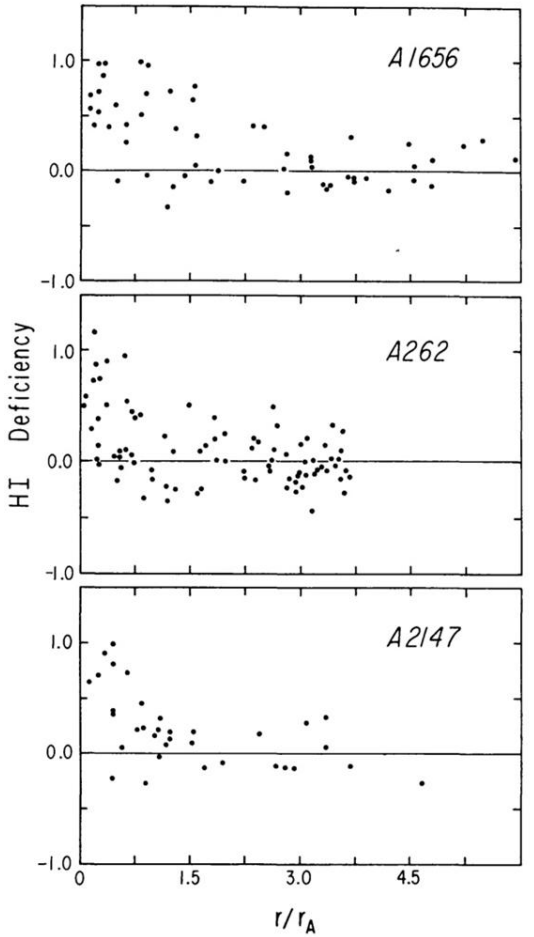
These two relations are independent



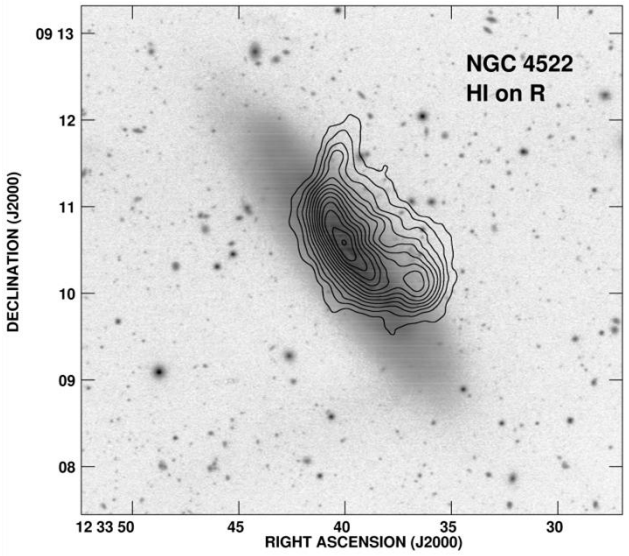
Star formation – Density relation



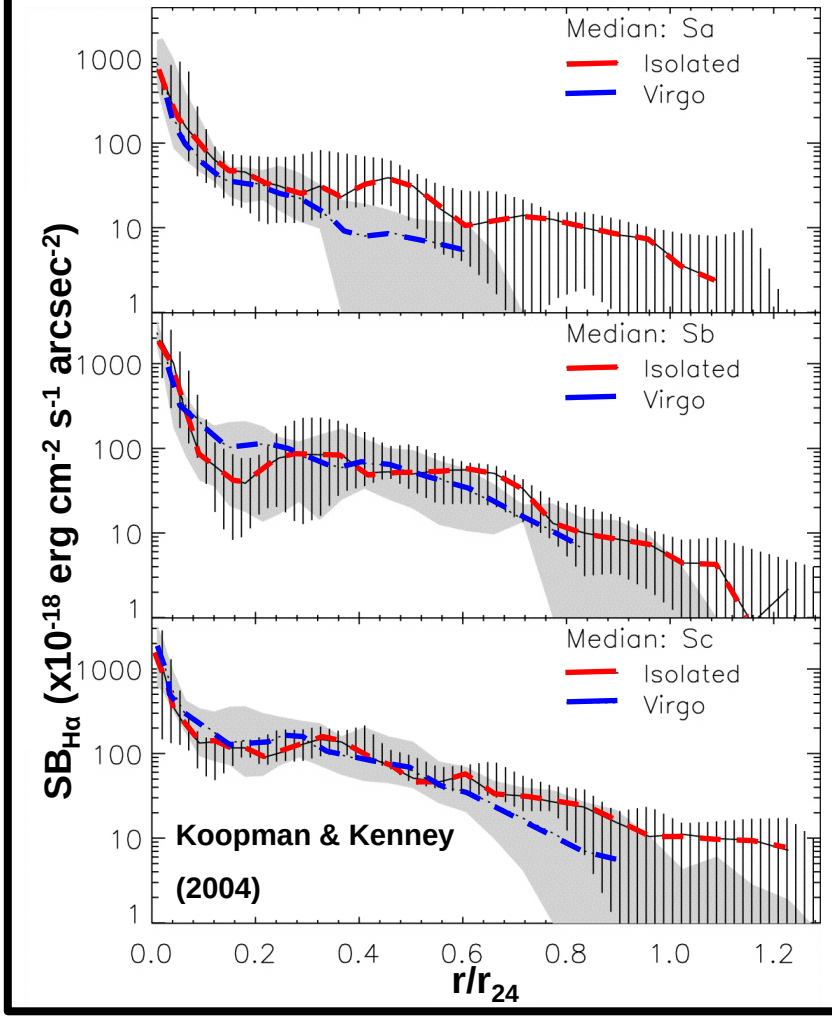
Evidences of the effect of the cluster environment on galaxies



Haynes et al. (1984)



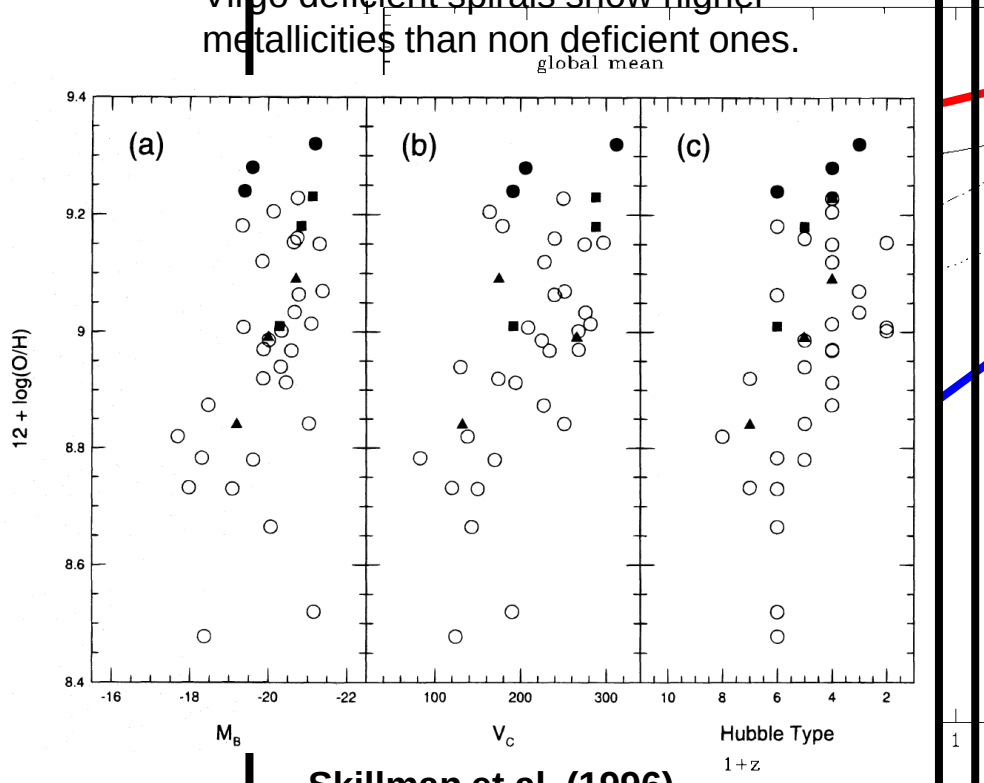
Kenney et al. (2004)



Koopman & Kenney (2004)

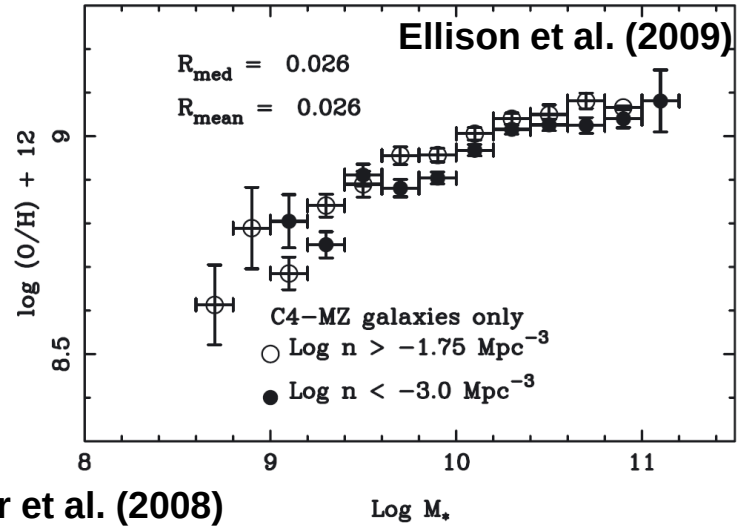
The effect of the cluster environment on metallicity

Virgo deficient spirals show higher metallicities than non deficient ones.

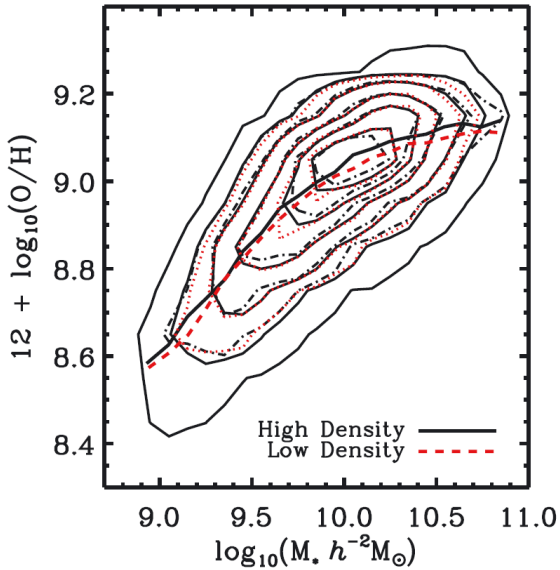


Skillman et al. (1996)

Numer
& Ostri
high de
epochs



Cooper et al. (2008)



Galaxies in high local density environments show higher metallicity than expected for their masses.

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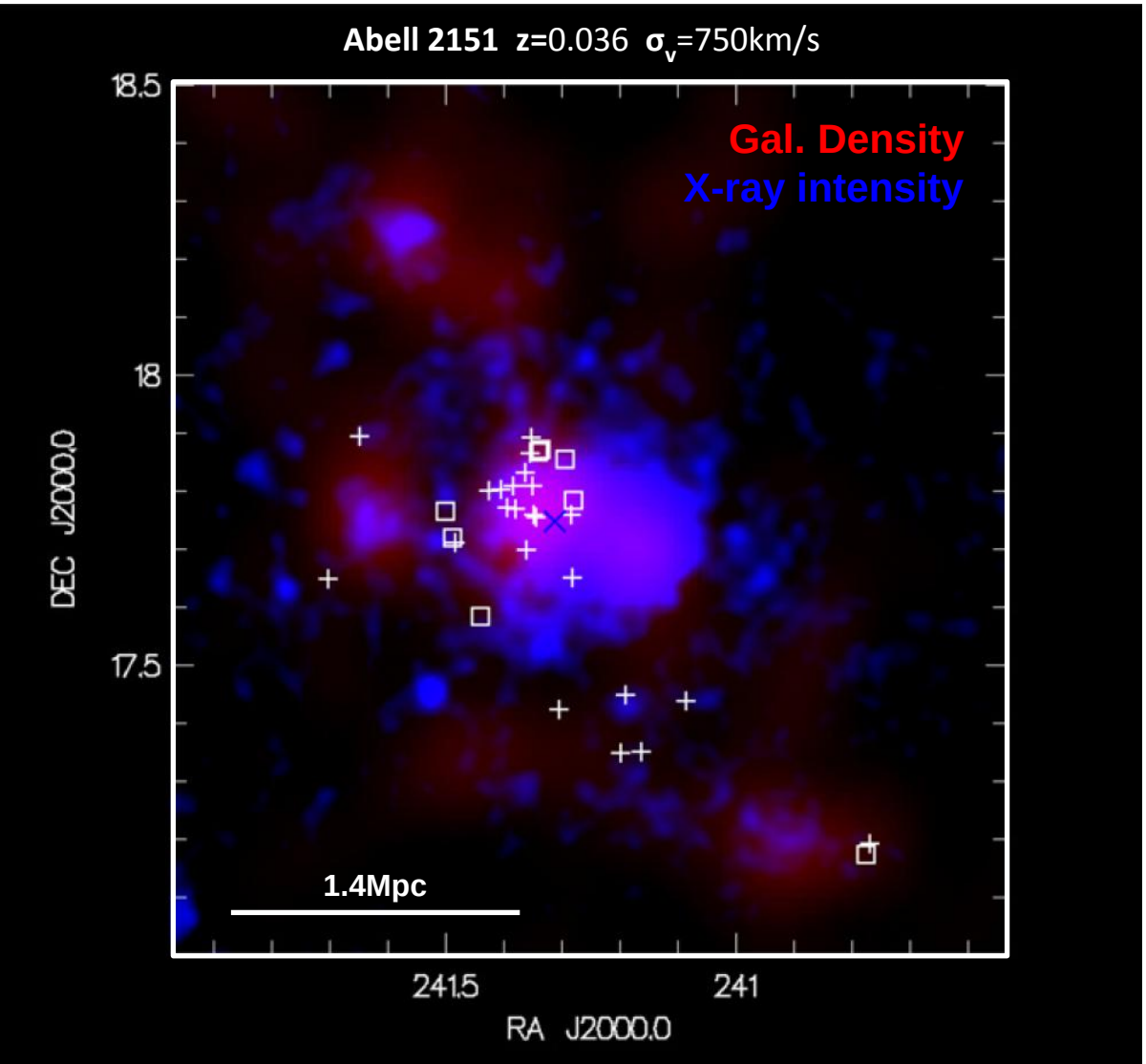
Spatially resolved spectroscopy of star-forming galaxies in the Hercules cluster

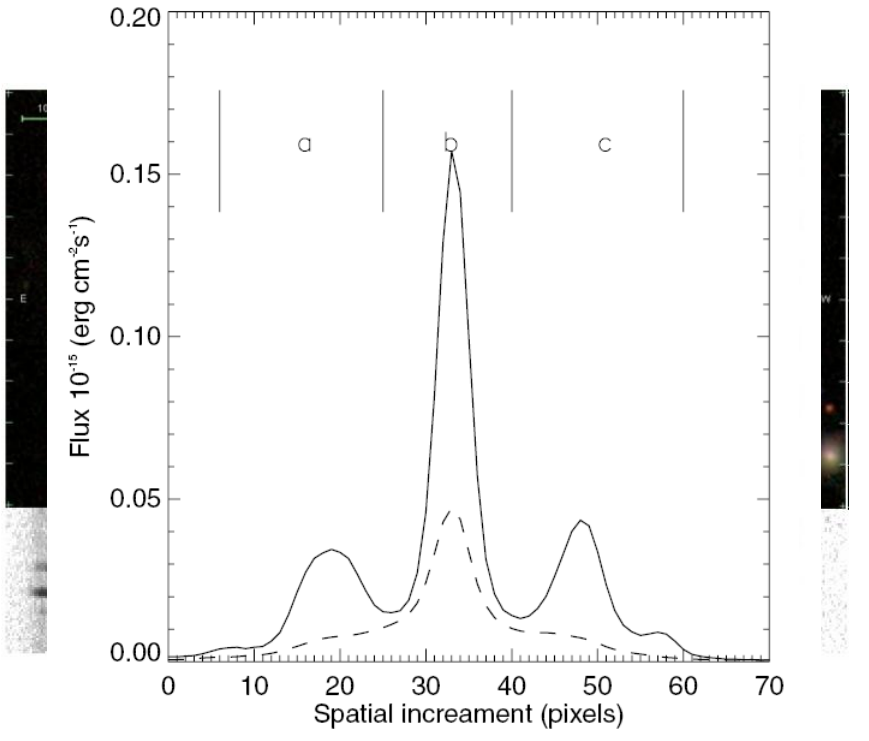
(Petropoulou et al. 2011, ApJ, 734, 32)



Spectroscopic follow-up: 31 Hα emitting galaxies from Cedrés et al. (2009)
15 luminous M_B<-19 and 16 dwarf/Irr M_B>-19

Observations with:

- ISIS @ WHT4.2m (~0.8Å/pix)
- IDS @ INT2.5m (~1.8Å/pix)



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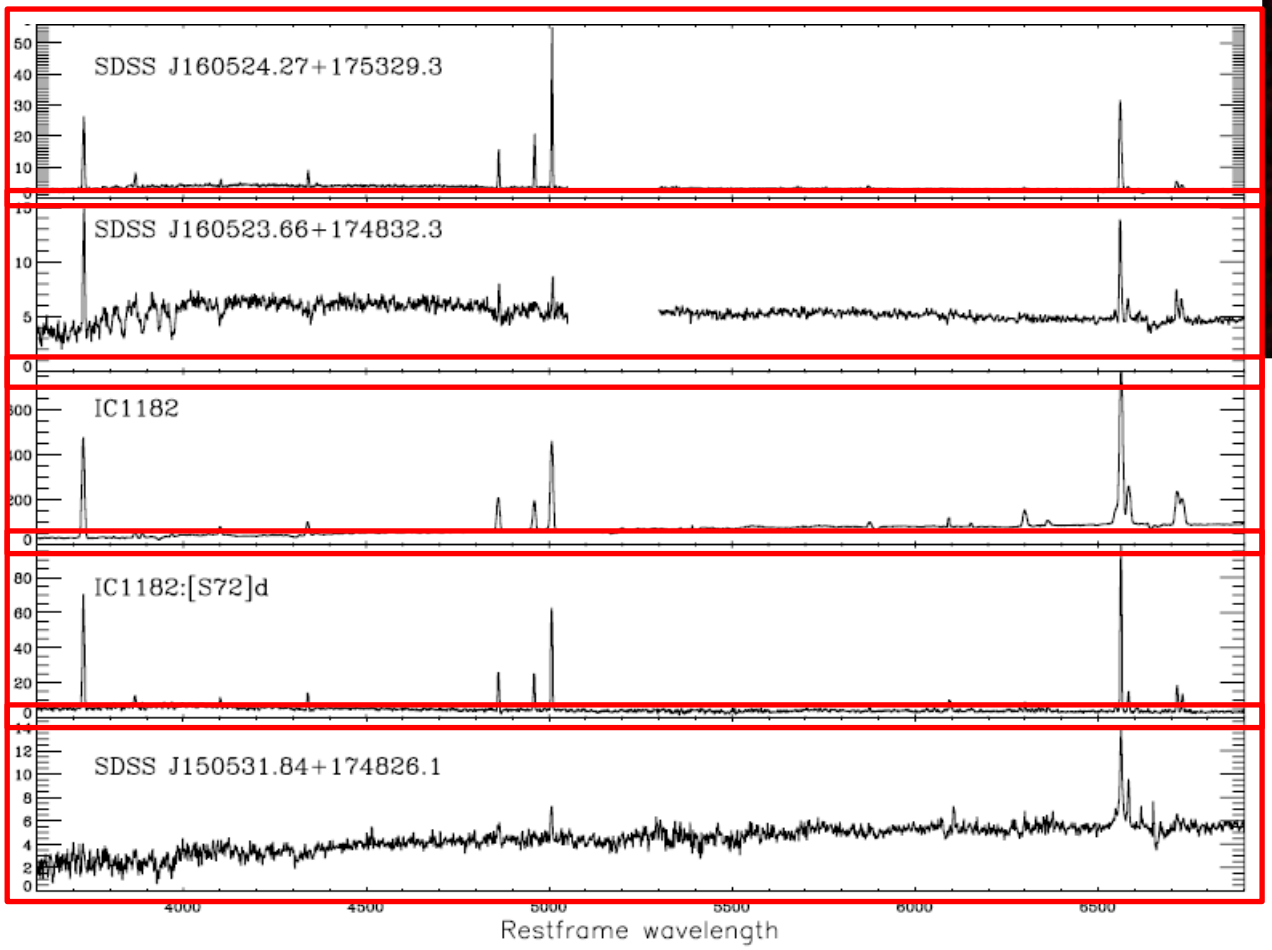

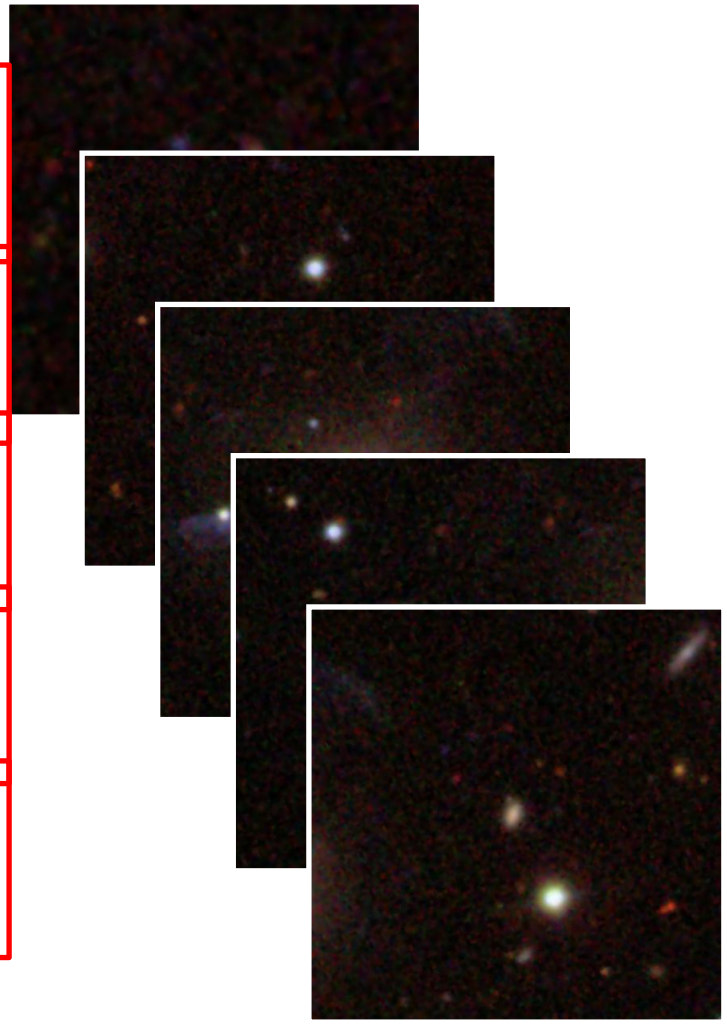

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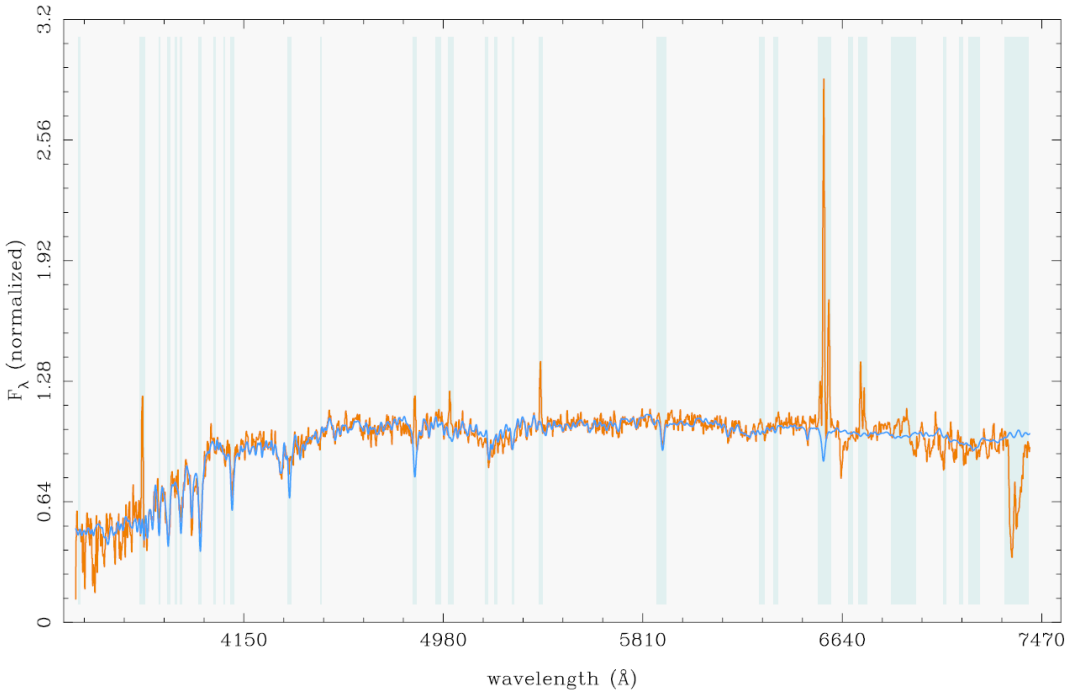


STARLIGHT

Bruzual & Charlot (2003) models

Metallicities: Z⊙/5, Z⊙/2.5, Z⊙

59 ages: 0.25-13 Myr

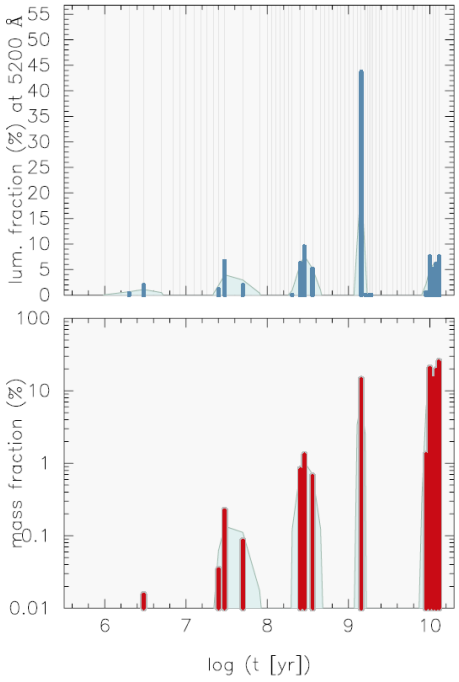
Stellar population properties

Light-weighted stellar age $\tau_{*,L}$

Light-weighted stellar metallicity $Z_{*,L}$

Mass-weighted stellar age $\tau_{*,M}$

Mass-weighted stellar metallicity $Z_{*,M}$



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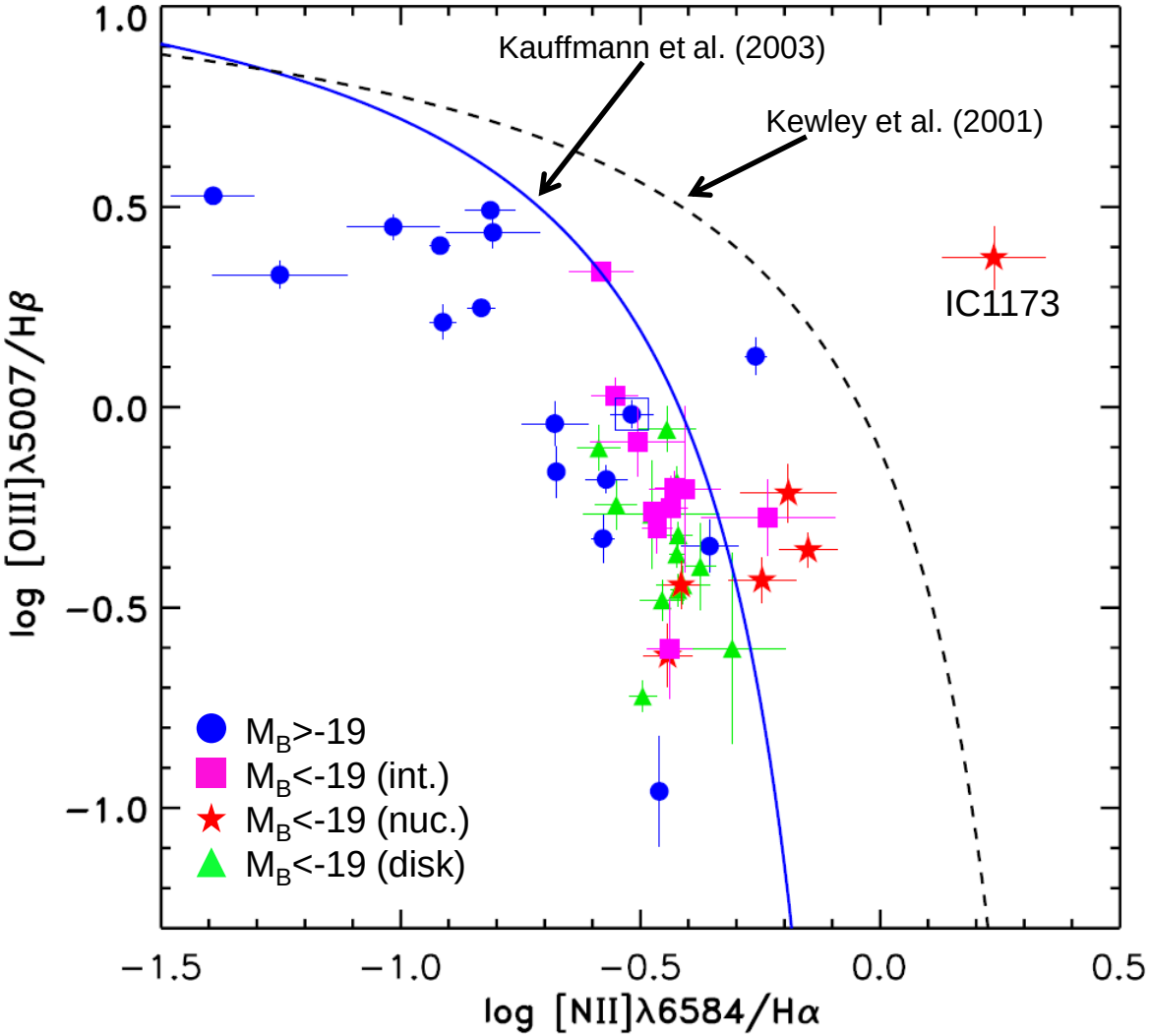


BPT diagram

Most HII emission in the photoionization regime.

IC1173 (nucleus) clearly in the AGN regime.

Abundance derivation

Balmer emission lines: Hα, Hβ, Hγ, Hδ (when possible) and collisionally excited lines: [OII]λ3727, [OIII]λ5007, [NII]λ6584, [SII]λλ6717,6731

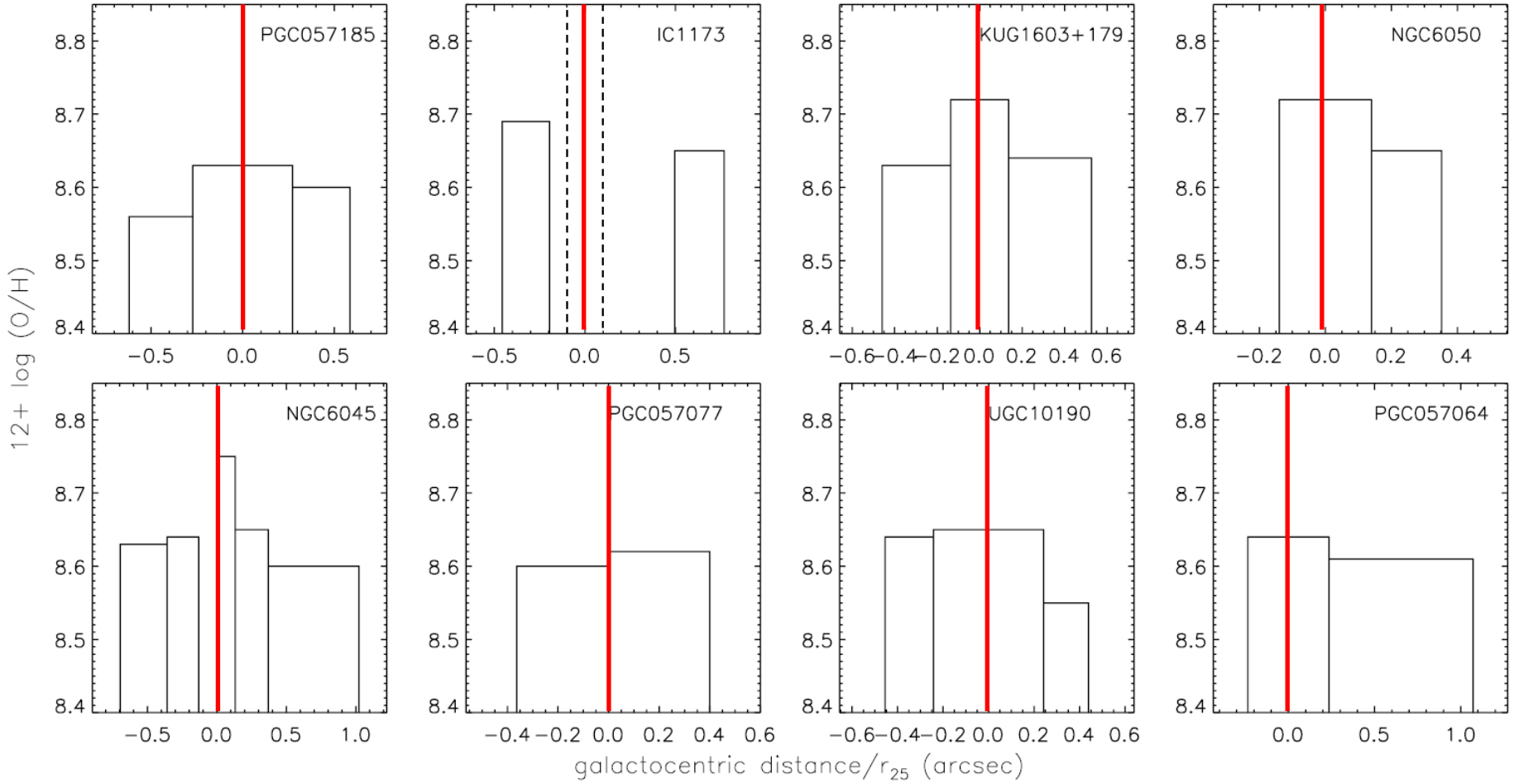
We compute the c(Hβ) and correct our spectra from extinction

Chemical abundances (O/H and N/O) using the empirical calibrations of Pilyugin et al. (2010) and Perez-Montero & Contini (2009)

Spatially resolved spectroscopy of star-forming galaxies in the Hercules cluster

(Petropoulou et al. 2011, ApJ, 734, 32)

Still some signatures of abundance gradient in disks of spirals (although ionized emission in disks is truncated).



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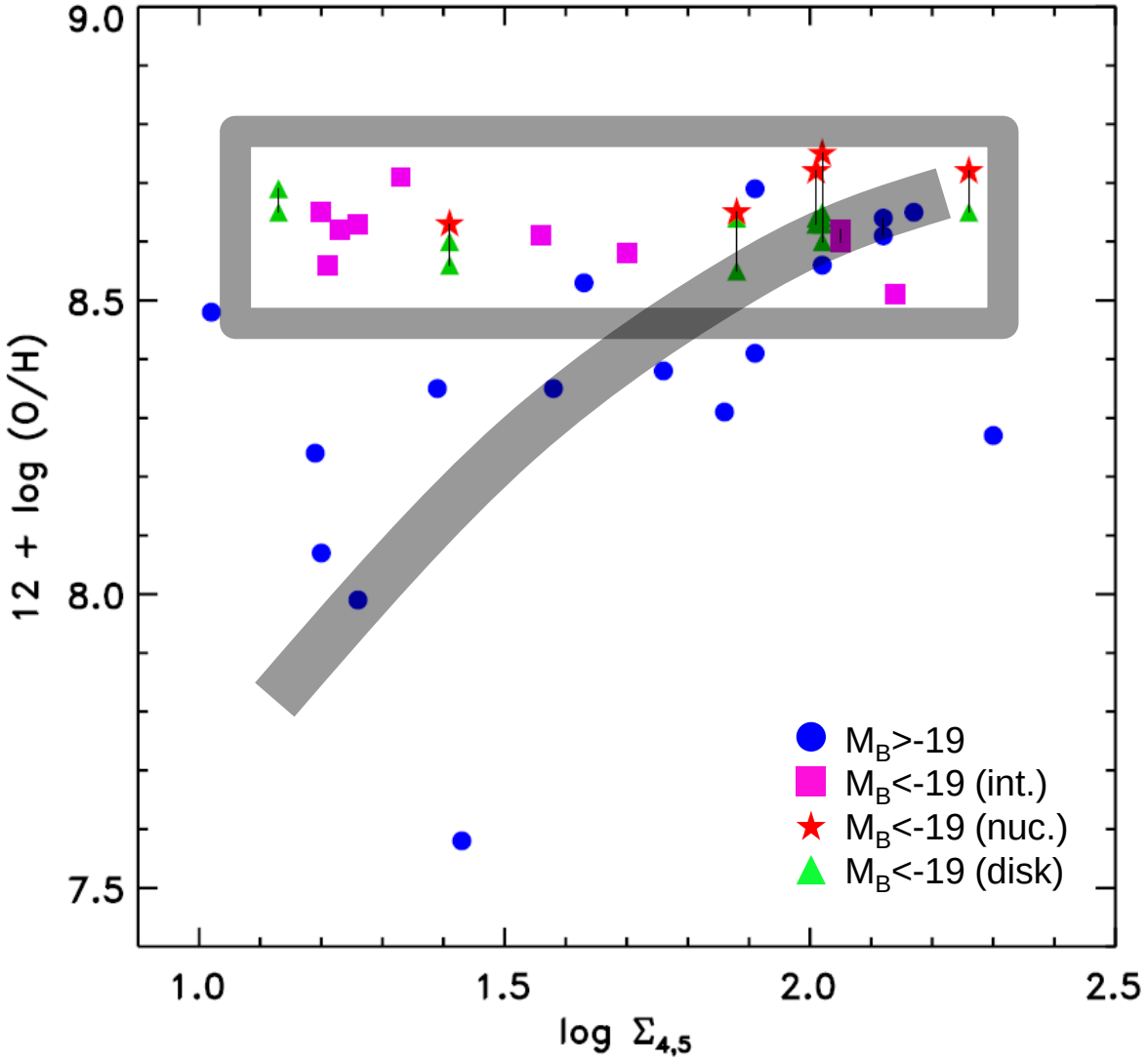

Metallicity vs. Local Density

Bright galaxies show constant metallicity with density.

Faint galaxies at higher densities show more metals.

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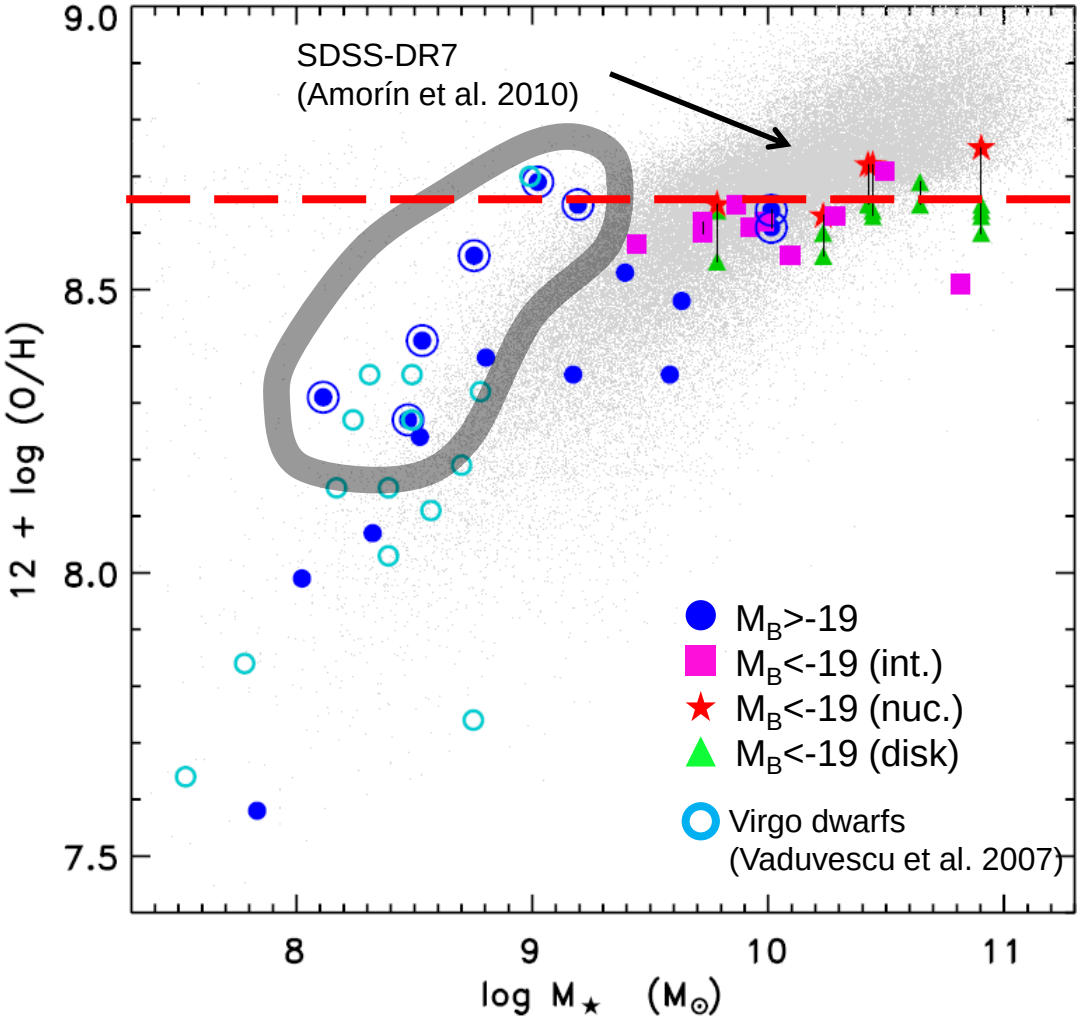


Physical mechanisms underlying the MZR

Ejection of enriched gas by momentum driven gas outflows or galactic winds (Finlator & Davé 2008, Spitoni 2008).

Variation of the IMF with mass (Koppen et al. 2007)

Downsizing (Brooks et al. 2007, Calura et al. 2009)

Inflows (smooth or via satellites) (Dalcanton et al. 2007, Davé 2010)

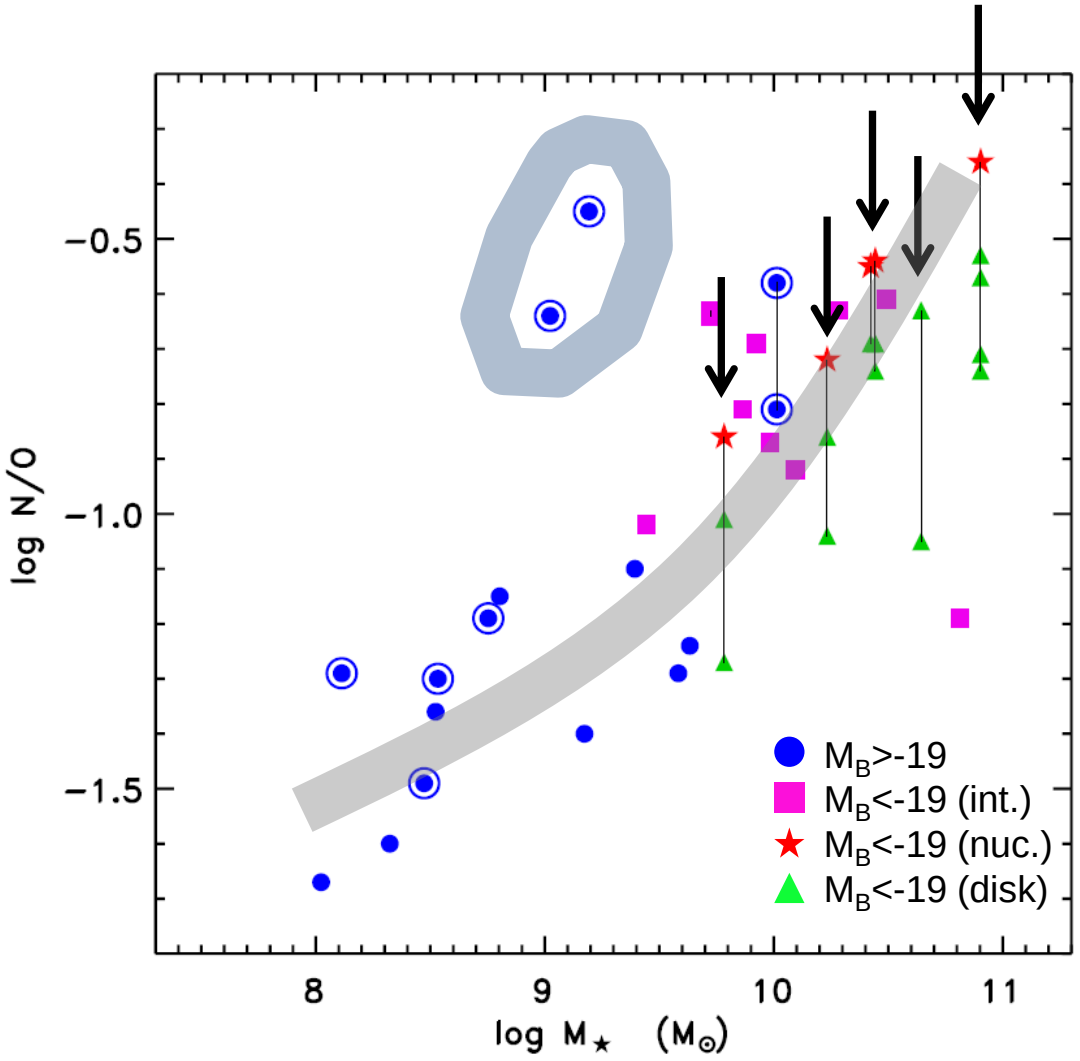
Stellar mass vs. Metallicity

Consistent with other works, but flattened at high masses at around the solar value.

Low luminosity galaxies at high densities show high abundance for their masses.

Spatially resolved spectroscopy of star-forming galaxies in the Hercules cluster

(Petropoulou et al. 2011, ApJ, 734, 32)



Stellar mass vs. N/O

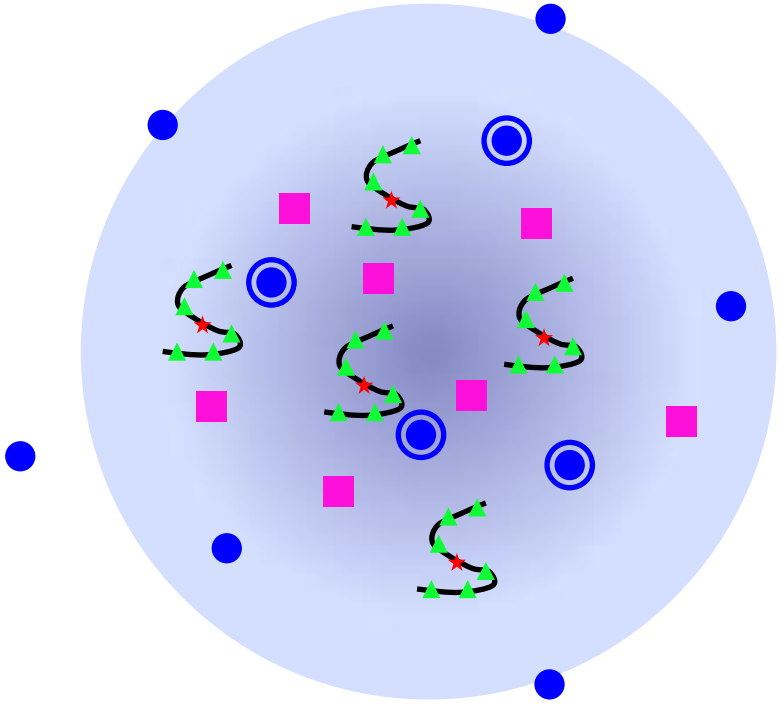
Positive correlation between both quantities: high mass galaxies more evolved chemically.

No clear relation between the environment and the N/O (but see latter).

O/N gradients much stronger than O/H ones (nuclear inflows of stripped material or interaction driven?).

Spatially resolved spectroscopy of star-forming galaxies in the Hercules cluster

(Petropoulou et al. 2011, ApJ, 734, 32)



Three groups of galaxies:

Luminous galaxies: affected by ram pressure stripping. Follow the normal MZR. Interactions? Inflow of stripped gas?

"Robust" low luminosity galaxies: found at high densities. HI deficient and overabundant for their masses. Chemically evolved. Some of them affected by tidal interactions.

"Newcomers" low luminosity galaxies: found at low densities. Normal HI content and metallicity for their mass. Experiencing a ram-pressure triggered starburst previous to stripping of gas?

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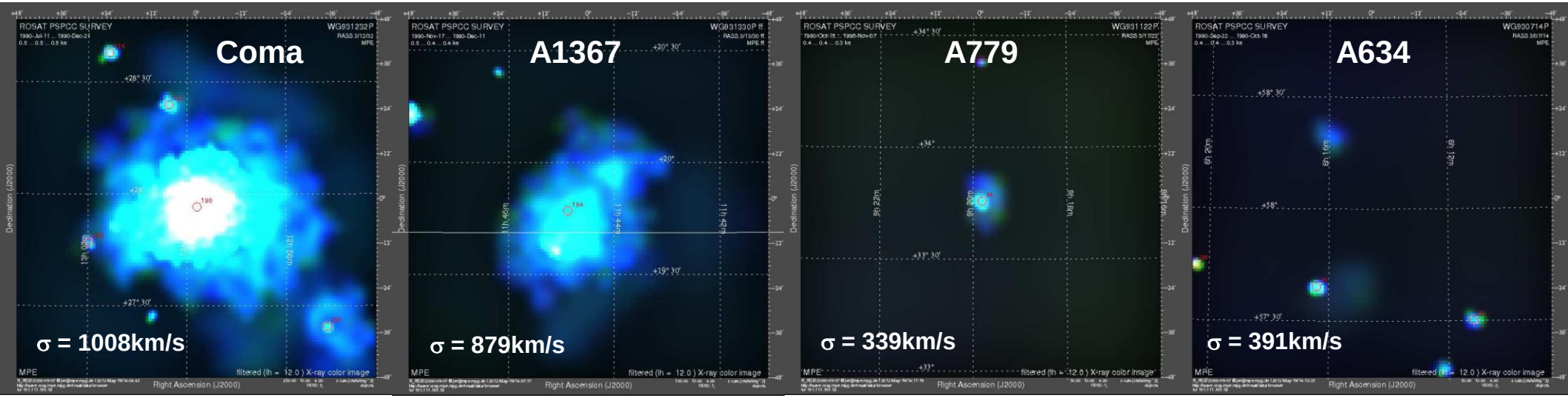
Chemical history of low-mass galaxies in 4 nearby clusters

(Petropoulou et al. 2012, ApJ, 749, 133)

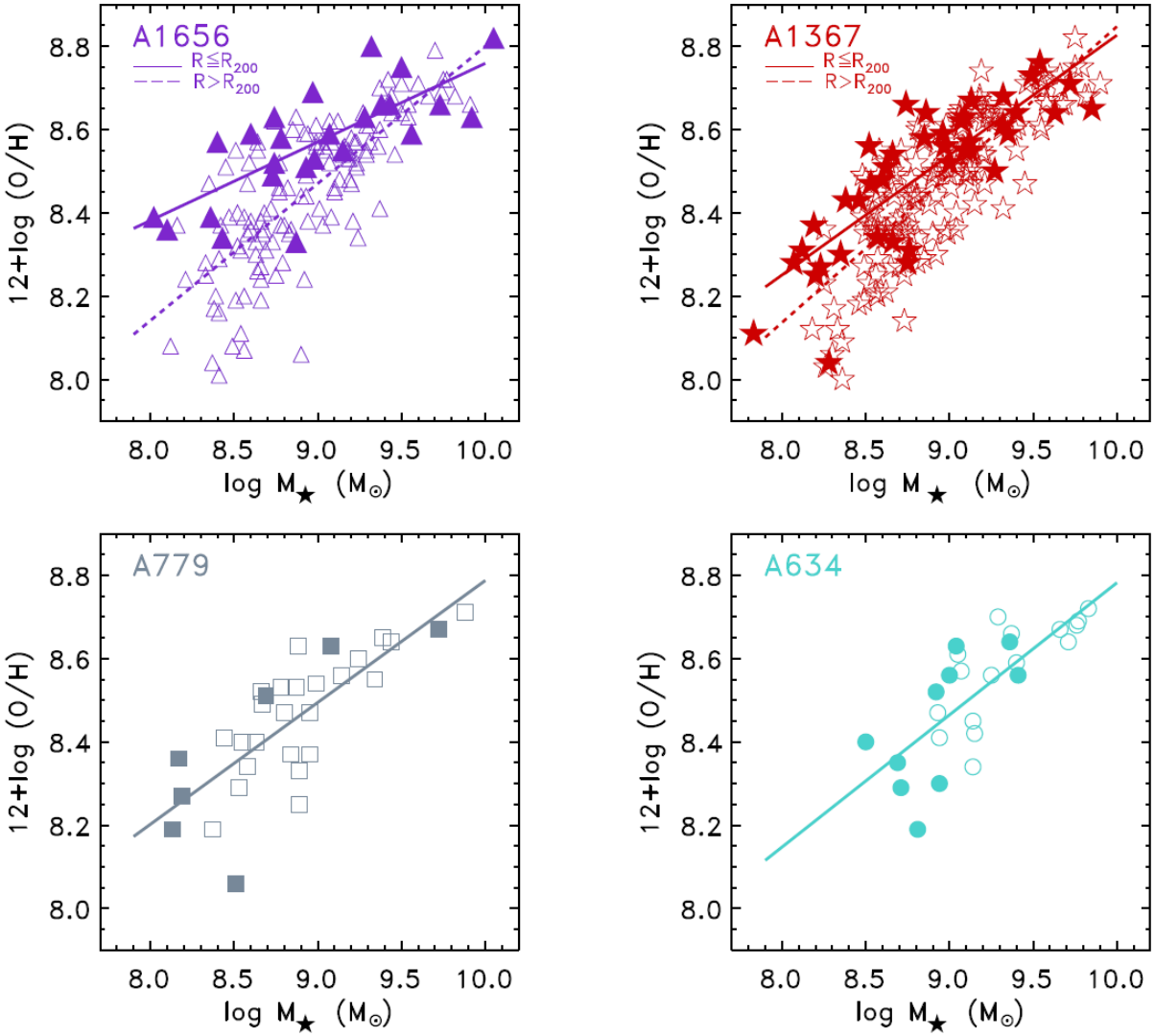


- Coma, A1367, A779, A634 (M =4x10^{13}-10^{15} $M\odot$, z~0.02)
- Galaxies: low-mass (M =10^{8}-10^{10} $M\odot$) star-forming
- Data: SDSS DR8 spectroscopy of 396 galaxies in a region of $3R_{200}$ radius around each cluster

- Derive c(Hβ) and correct emission lines for extinction
- Chemical abundances (O/H and N/O) using N2 calibrations of Pérez-Montero & Contini (2009), which is consistent with the O3N2 calibration of Pettini & Pagel (2004).
(lack of [OII]λ3727 for part of our sample of galaxies)

Chemical history of low-mass galaxies in 4 nearby clusters

(Petropoulou et al. 2012, ApJ, 749, 133)



Stellar mass vs. Metallicity

Galaxies within the virial radius show enhanced metallicities for their stellar masses in Coma and A1367.

This effect is stronger for low mass galaxies.

Mass matters!!!!

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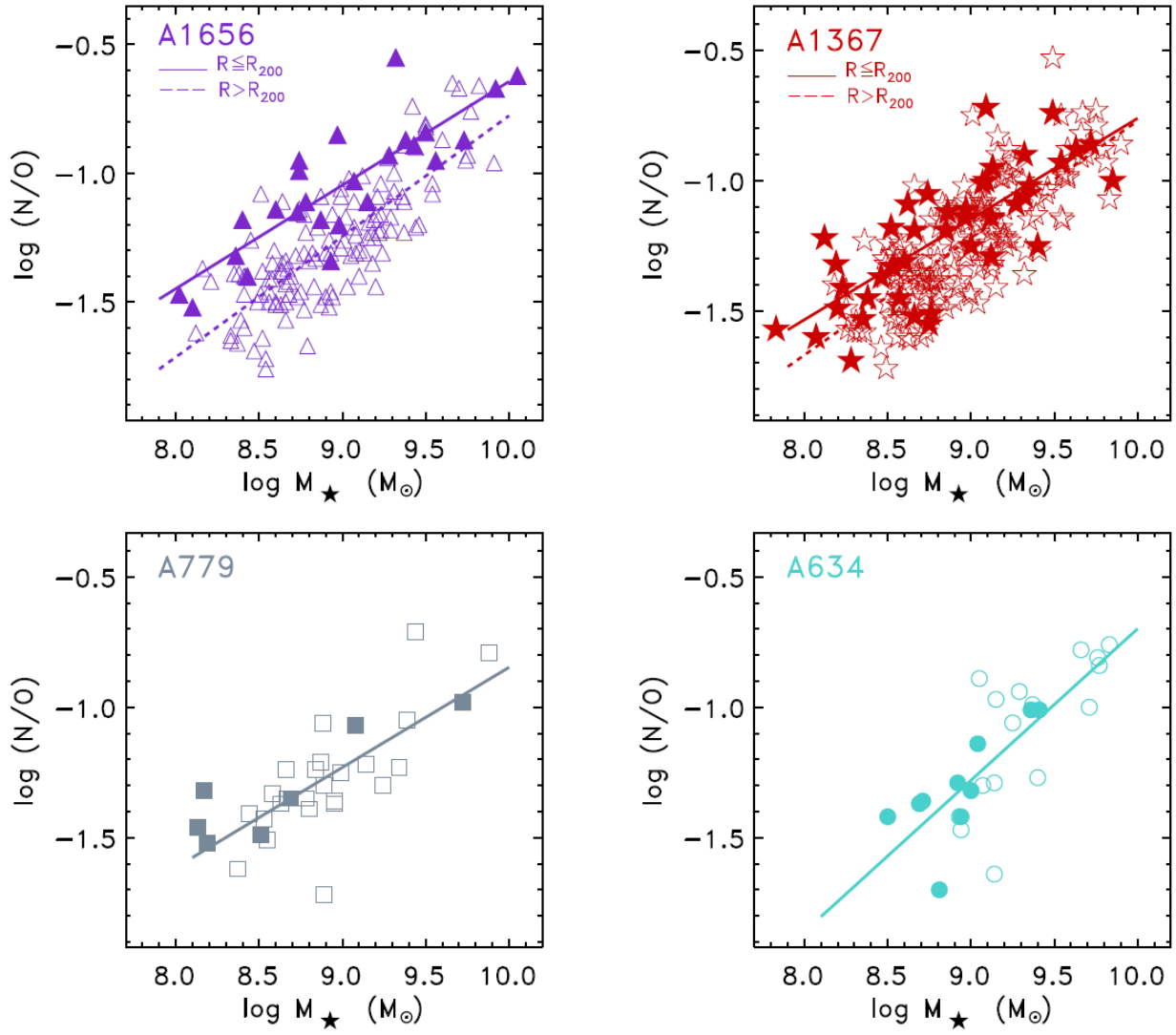


Stellar mass vs. N/O

N/O enhancement for galaxies within the virial radius of Coma and A1367 (milder than for O/H).

Also stronger for low mass galaxies.

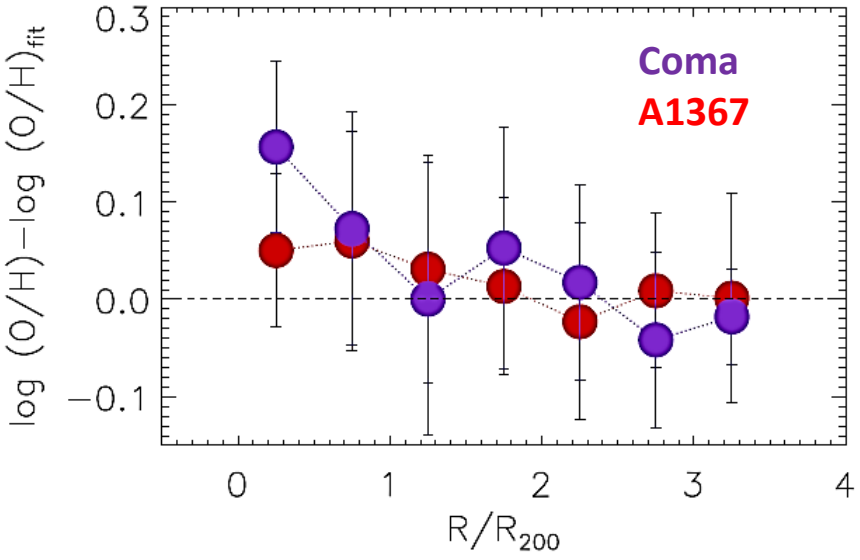
O is released after ~10Myr
N is released after >250Myr

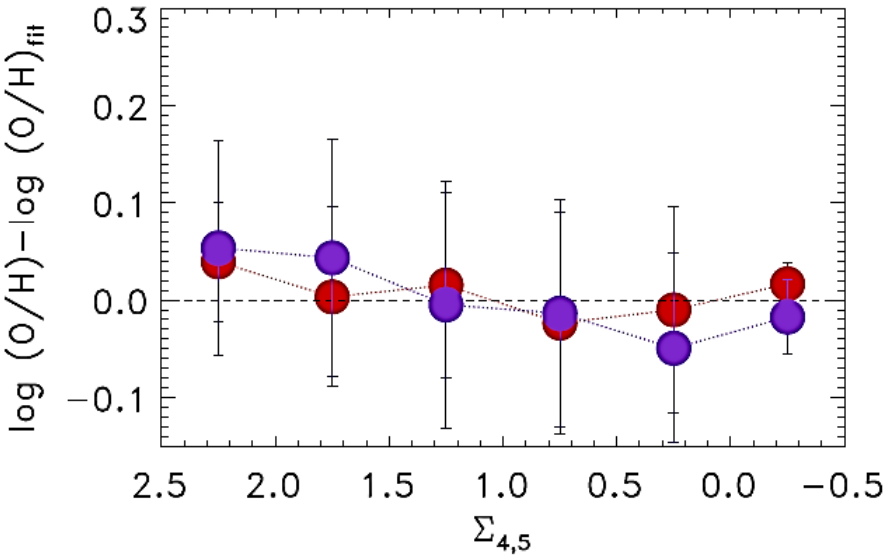
Whatever the mechanism acting on galaxies must have started at least 250Myr ago.

Chemical history of low-mass galaxies in 4 nearby clusters

(Petropoulou et al. 2012, ApJ, 749, 133)

The observed chemical enhancement in O/H (and in N/O) of Coma low-mass star-forming galaxies correlates mainly with cluster-centric distance rather than with local density.





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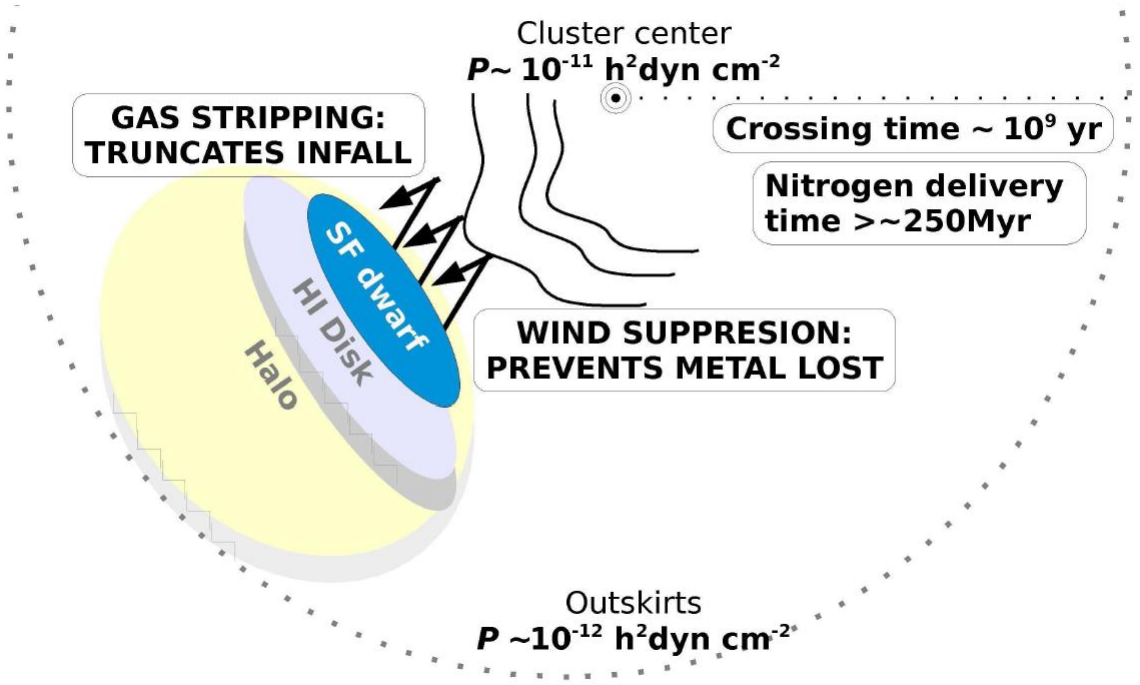

Starvation: eliminates infall of non enriched halo gas

Triggered SF (ram pressure compression? Interactions?): creates new metals

Ram pressure stripping: truncates SF

Wind suppresion (due to pressure confinement by the ICM): prevents metals loss.

Result: differential O/H enrichment stronger for low mass galaxies (and N/O enrichment if complete gas stripping takes more than 250Myr).

Equilibrium model & momentum driven winds

Finlator & Dave (2008), Dave et al (2011)

with outflow rate $\eta \propto M^{-1/3}$