GUViCS: The GALEX UltraViolet Virgo Cluster Survey

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Introduction: the general context

Which are the main driver of galaxy evolution ?

Galaxies are distributed within the Universe in a non homogeneous way (voids, groups, superclusters, clusters..)

In high density environments both gravitational interactions and interactions with the cluster IGM can heavily affect the physical properties of galaxies

Which is the role of the environment on galaxy evolution?

Introduction: the Virgo cluster

1) The closest rich cluster of galaxies ⇒ perfect target to study the effect of the environment on galaxy evolution (dwarf galaxy population, angular resolution, multifrequency data…)

2) Unrelaxed, spiral rich cluster ⇒ example of ongoing formation process

3) Different ongoing blind/pointed surveys (NGVS, HeViCS, ALFALFA, SMAKCED…) ⇒ complete multifrequency coverage

Introduction: the importance of UV data

1) Directly related to the young stellar population in star forming galaxies ⇒ tracer of SFR, SFH (SED fitting)

2) Directly related to the oldest stellar population in early type galaxies (UV upturn) ⇒ tracer of the SFH (SED fitting)

3) UV radiation principal heater of the dust component (equilibrium of the ISM) ⇒ tracer of the dust attenuation (FIR/UV)

4) Tracer of the scattered light from Galactic cirri ⇒ important in the study of the diffuse IGM

UV surveys of the Virgo cluster

1) (2421 A), Smith & Cornett 1982
2) FAUST experiment (1650 A), Deharveng et al 1994
3) FOCA experiment (2000 A), Donas et al unpublished

Problems: sky coverage, sensitivity, red leakage, photometric calibration..

Detection ~ 100-200 objects

GUViCS: a complete GALEX survey of the Virgo cluster (cycle 6)

Sky area: ~ 120 sq.deg. NUV (2316 A) and ~ 40 sq.deg. FUV (1539 A) survey of the Virgo cluster (**94 sq.deg. covered by the present survey in the NUV band**)

Exp. Time: ~ 1 orbit (1500 sec)

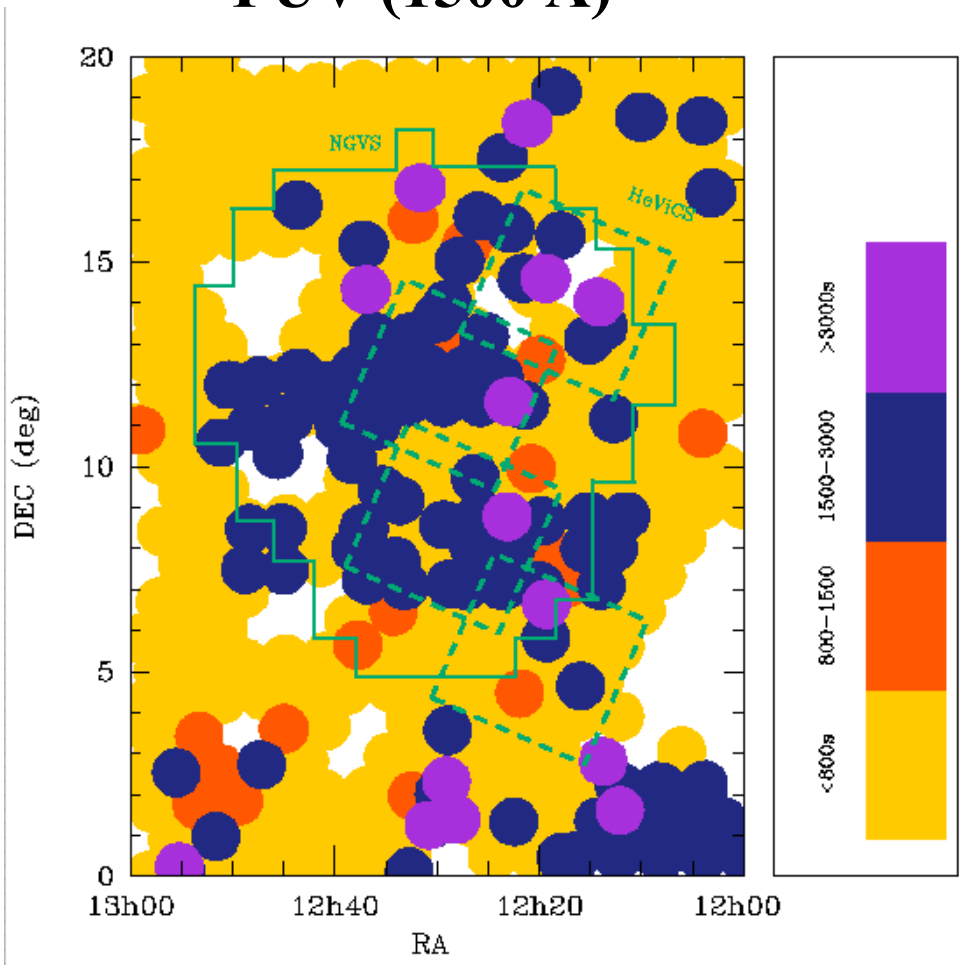
Completness: ~ 21.5 AB mag; ~27.5 AB mag arcsec^{-2}

Detection rate: NUV ~ 10000 sources/field; FUV ~ 1500 sources/field

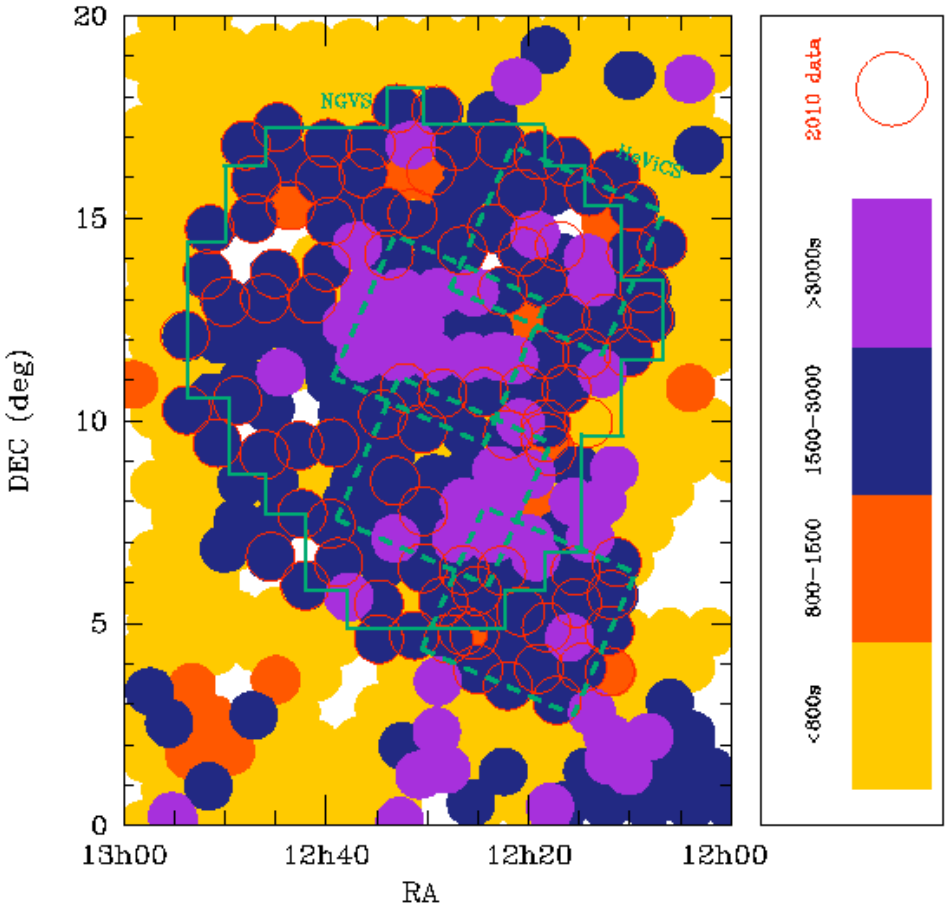
Angular resolution: 4-5 arcsec

The GALEX UV Virgo cluster survey: GUViCS

FUV (1500 A)

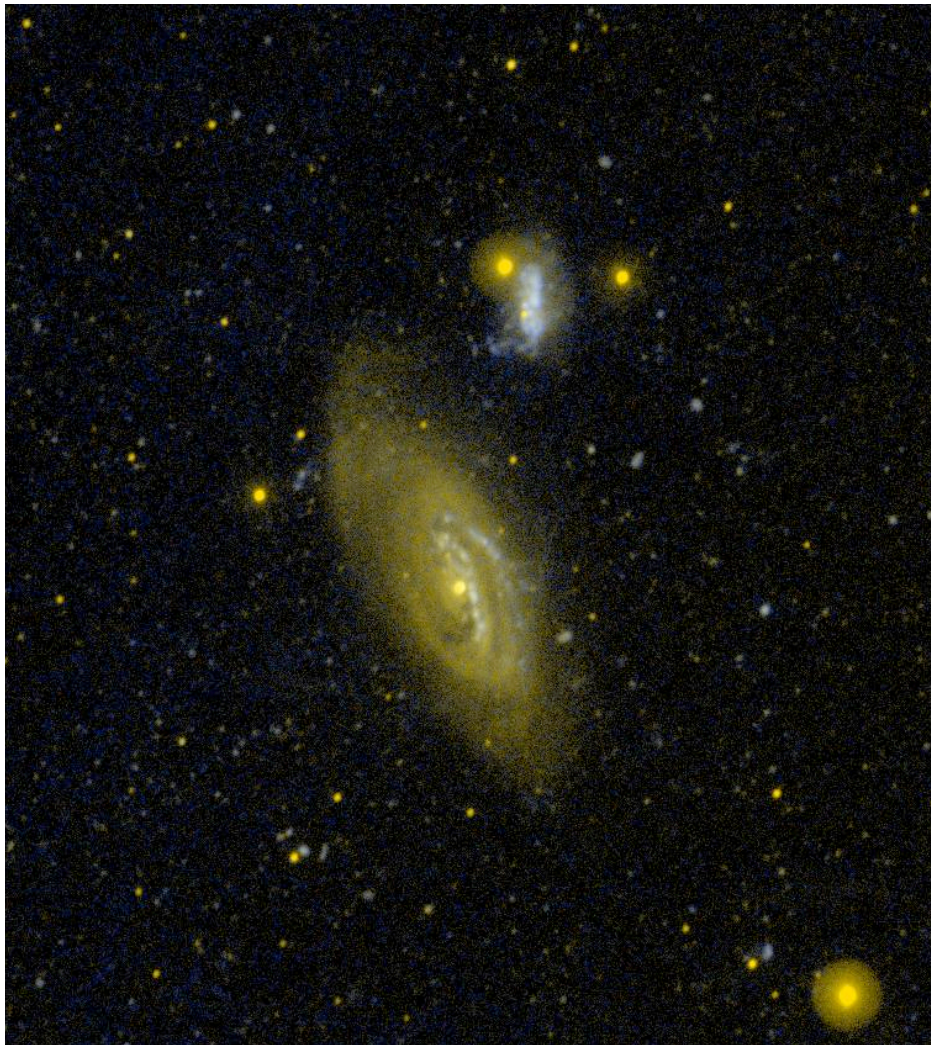


NUV (2300 A)

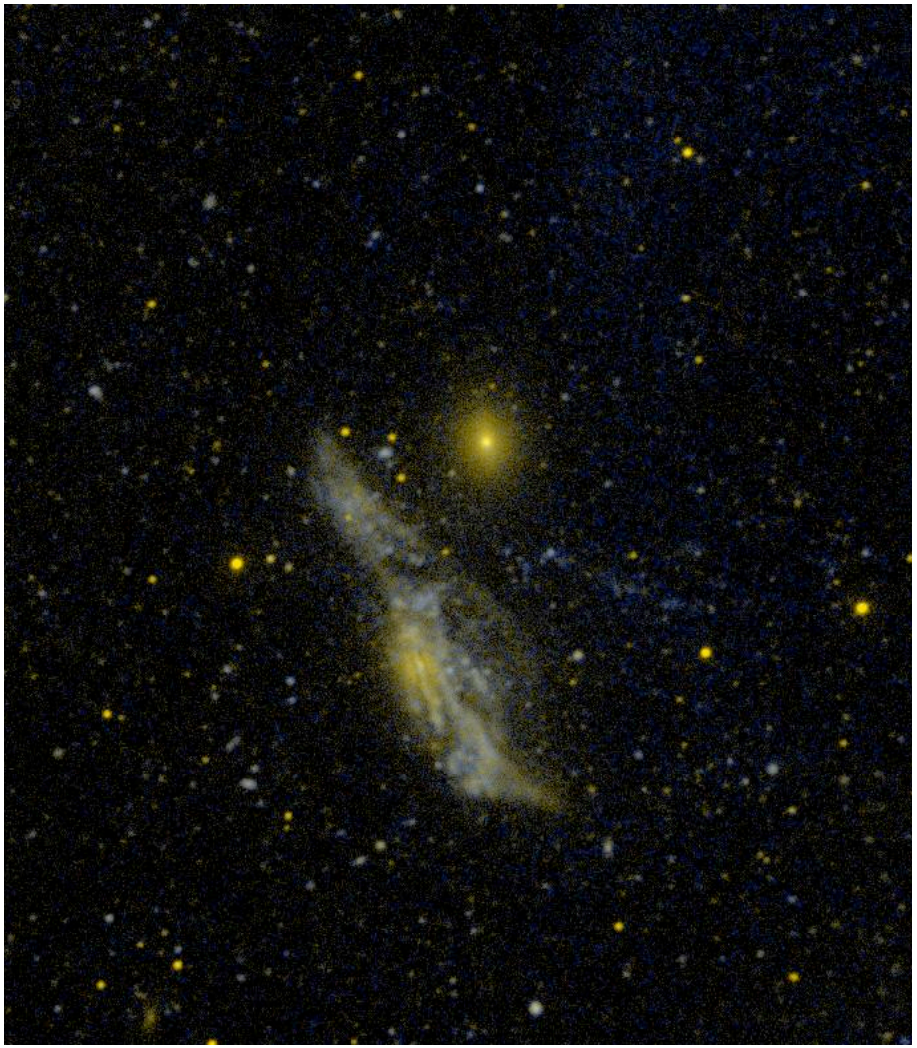


The GALEX UV Virgo cluster survey: GUViCS

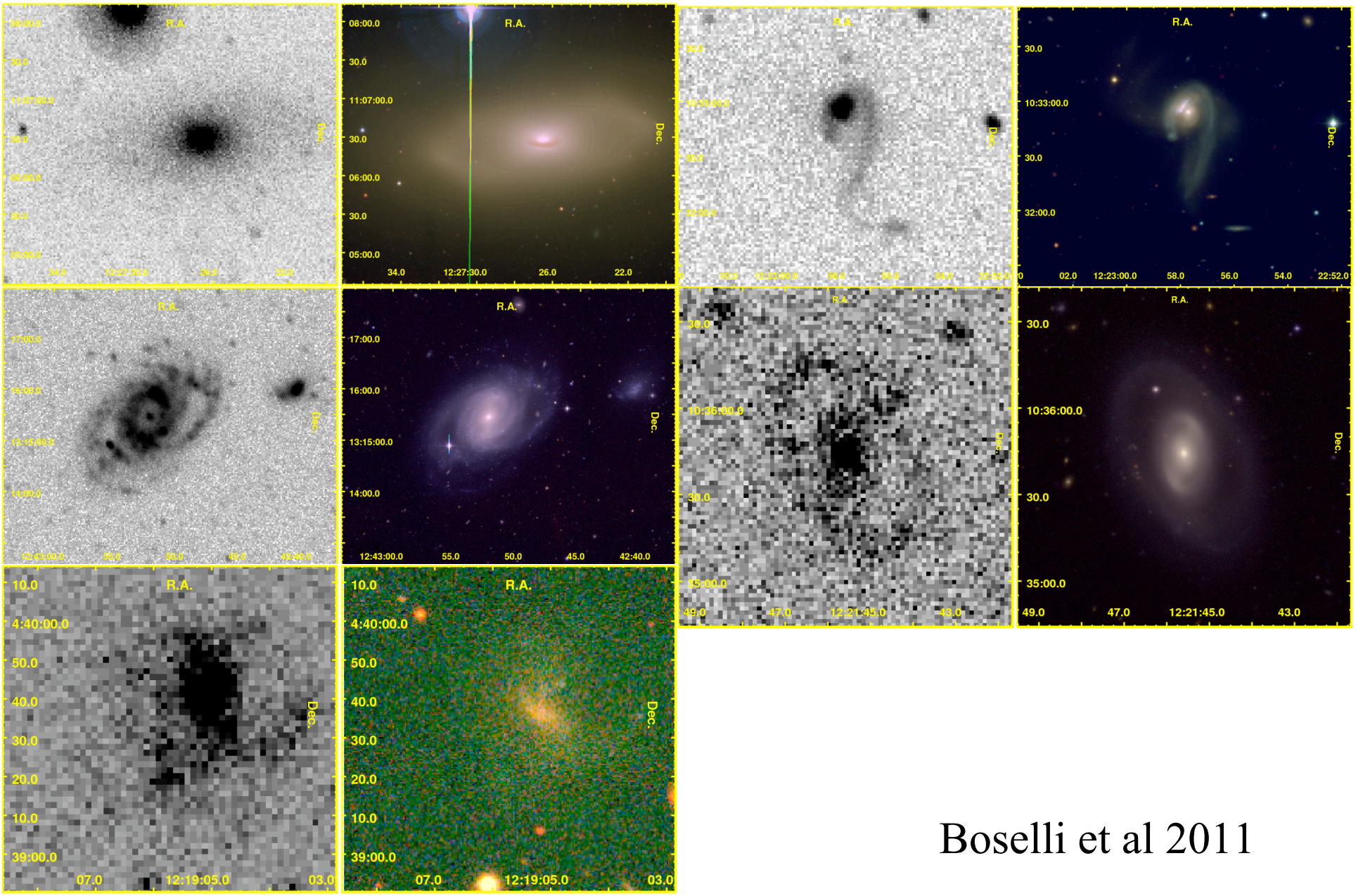
NGC 4569 - IC 3583



NGC 4438-4435



GUViCS



Boselli et al 2011

Science: obtained results

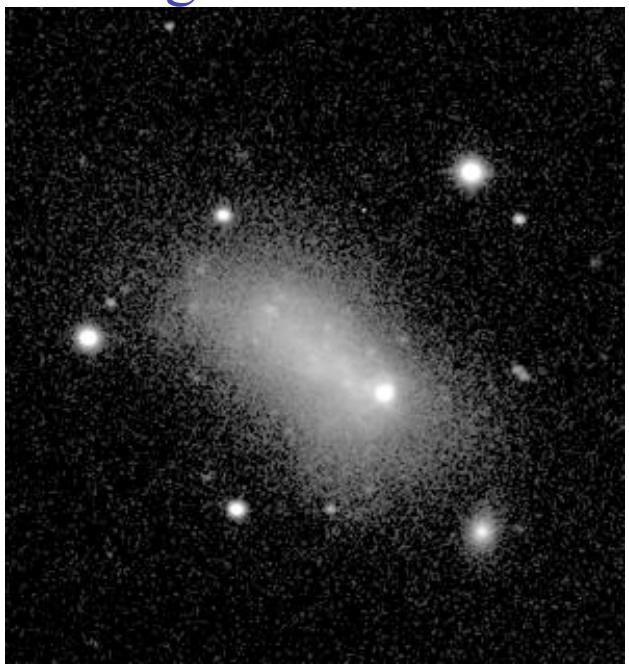
Environment:

1) The origin of dE galaxies in clusters (Boselli et al. 2008)
2) Study of peculiar objects (NGC 4569, 4438…Boselli et al 2005, 2006; Cortese et al 2010a,b)
3) The UV properties of early-type galaxies (Boselli et al 2005)
4) The role of AGN feedback and environment on the formation of the red sequence (Hughes & Cortese 2009, Cortese & Hughes 2009)
5) The UV luminosity function of the Virgo cluster (Boselli et al 2011)

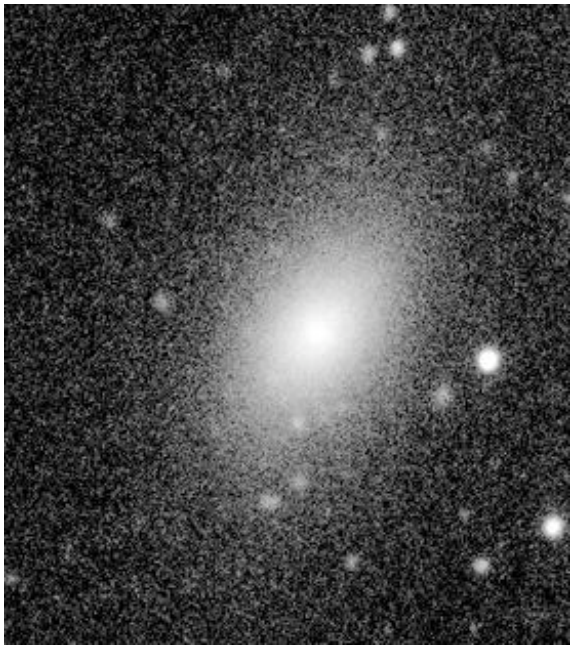
General results: dust attenuation, IMF, UV scaling relations …

The origin of dwarf ellipticals in clusters

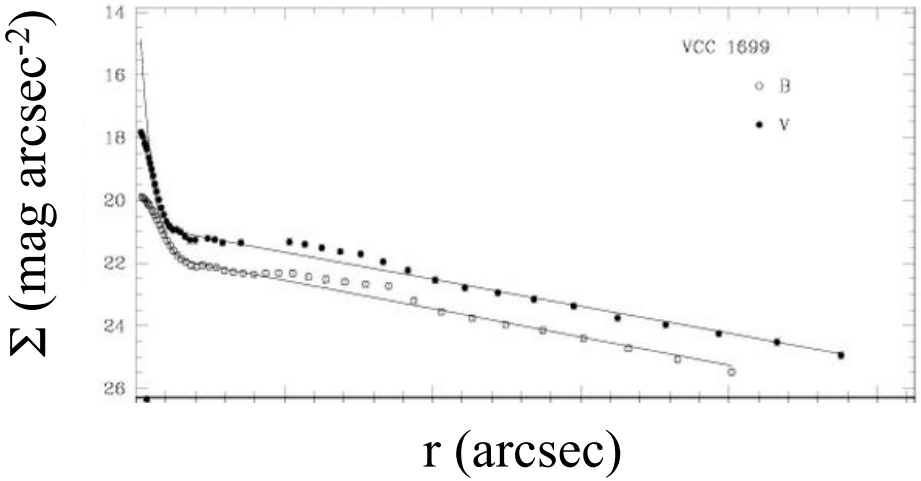
Structural and morphological similarities suggest that dE might results from gas removal and successive suppression of star formation in Im

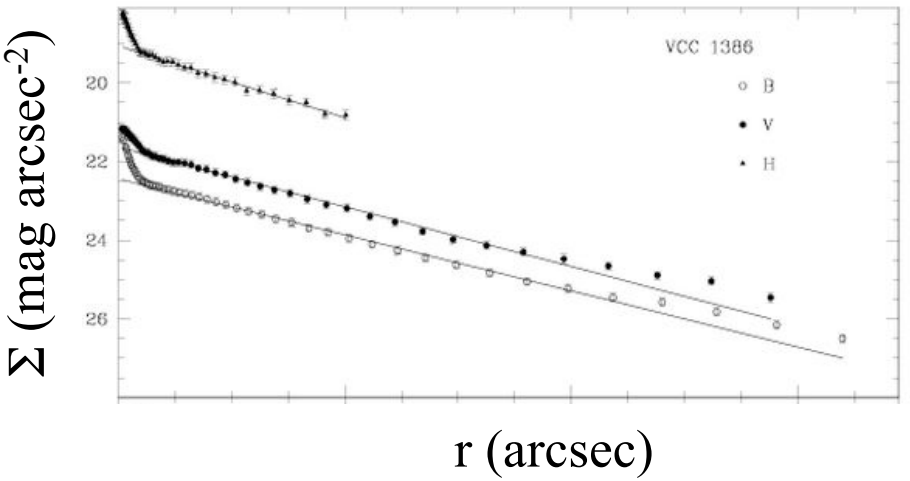


VCC 1699
Sm



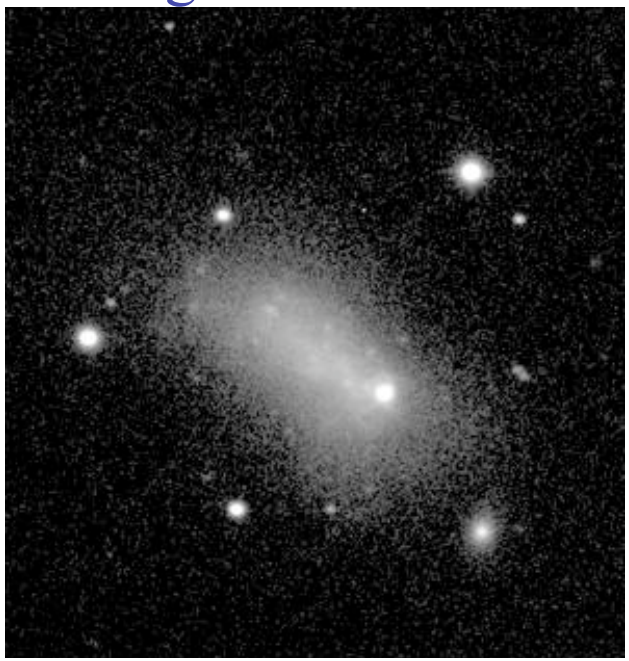
VCC 1386
dE





The origin of dE in clusters

Structural and morphological similarities suggest that dE might results from gas removal and successive suppression of star formation in Im



VCC 1699
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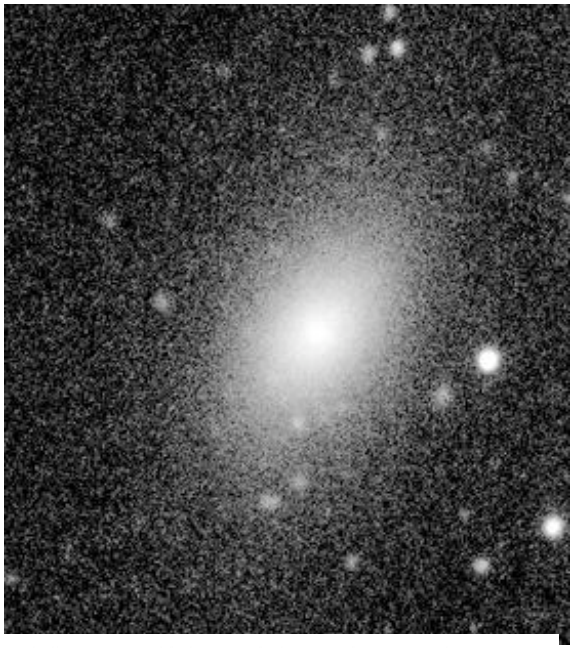
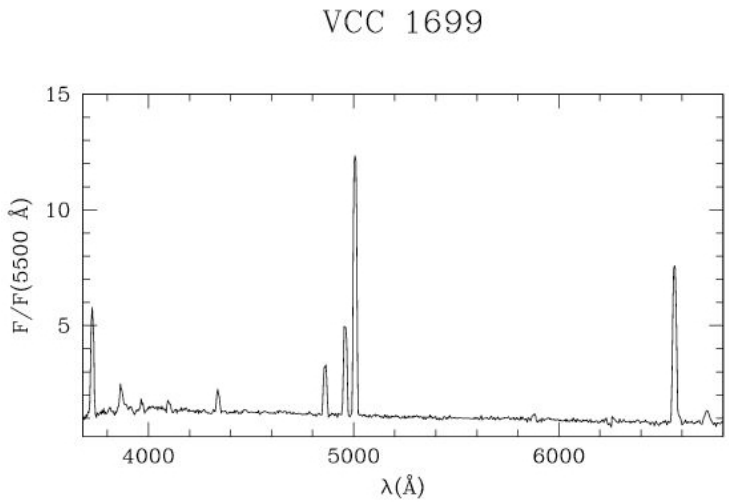
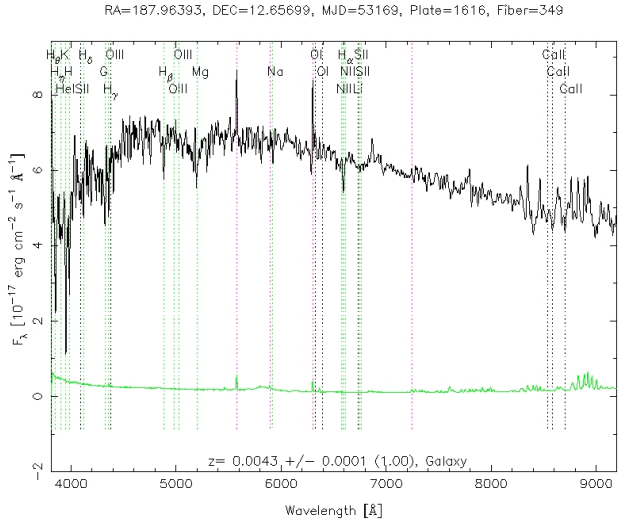


VCC 1386
dE





Chemo-spectrophotometric multizone model of galaxy evolution

Boissier & Prantzos 2000

- disc with an exponentially declining surface density profile formed from a halo of mass given by the CDM models of Mo et al (1998).

- SFR: rotation modulated Schmidt law (Boissier et al 2003)

$$SFR(R,t) = \alpha\, \Sigma_{gas}(R,t)^{1.5}\, V(R) R^{-1}$$

- infall rate exponentially decreasing with time

- calibrated on the Milky Way: the resulting free parameters are λ (spin parameter) and *Vrot* (rotational velocity)

-

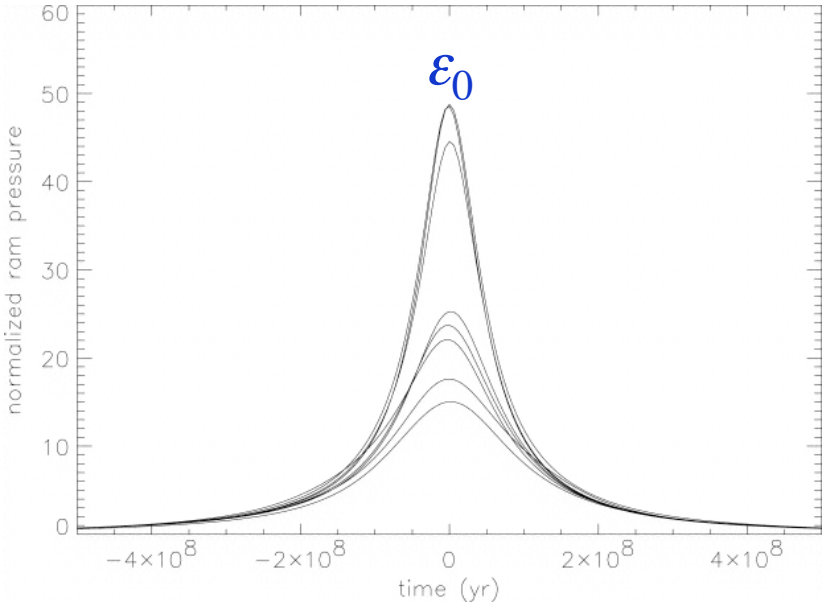
Modelling the interaction

1) Starvation ----> stopping infall

2) Ram pressure $\rho_{IGM} V^2_{gal} > 2\ G\ \Sigma_{star}\ \Sigma_{gas}$

Vollmer et al. 2001

$\varepsilon(t)$



time

Gas loss rate = ε *Σgas / Σpotential*

$\varepsilon(t)$ = efficiency (ε_0 free parameter)

Σgas = gas column density

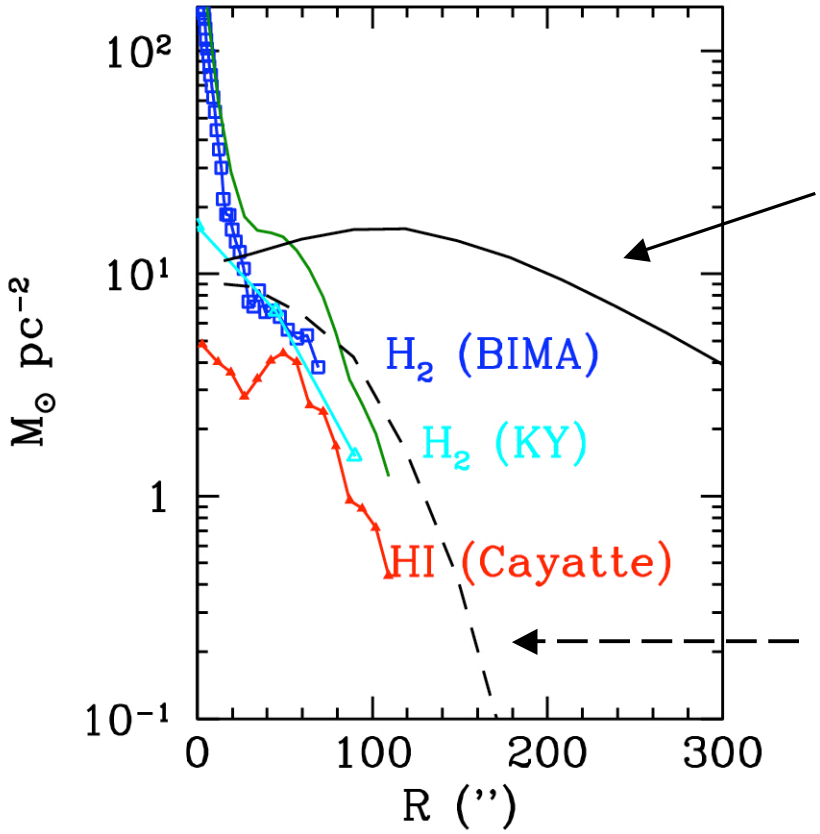
Σpotential = total local density (potential of the galaxy)

t = age of the interaction (free parameter)

Δt = duration of the interaction ($9\ 10^7$ years)

Model calibration on the Virgo cluster anemic galaxy NGC 4569

Model calibration (Boissier & Prantzos 2000): constrain of the free parameters λ (spin parameter) and *Vrot* (rotational velocity)



Continuum line: unperturbed model

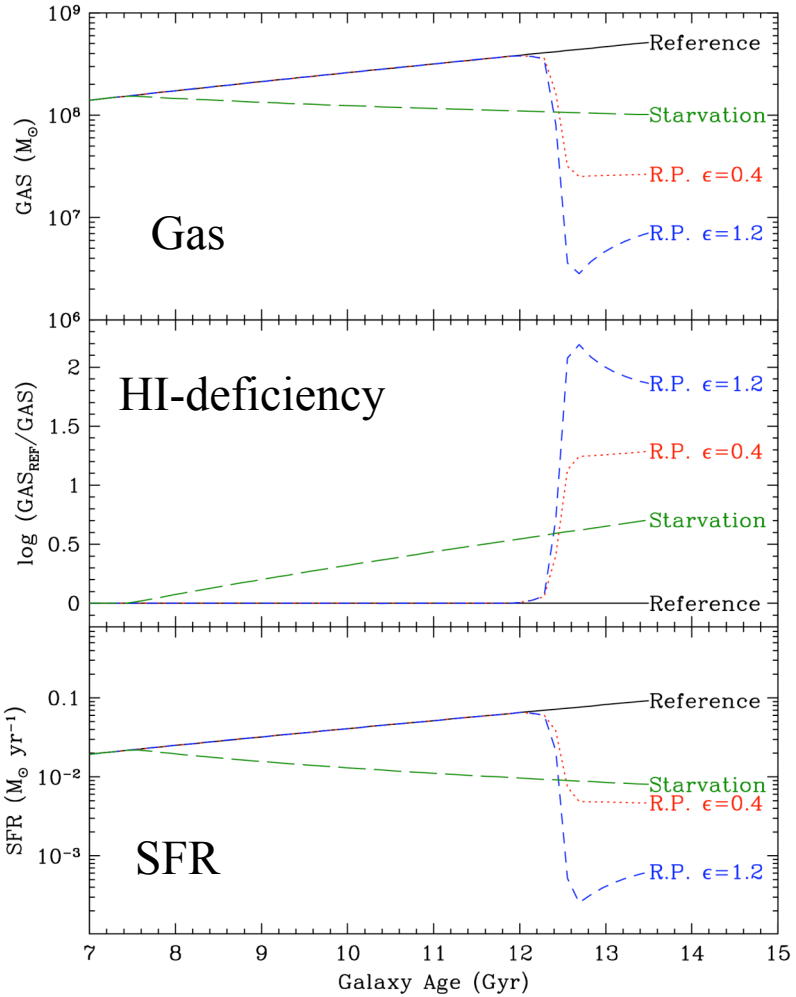
Dashed line: ram pressure model

Total gas (HI+H_2+He) profile

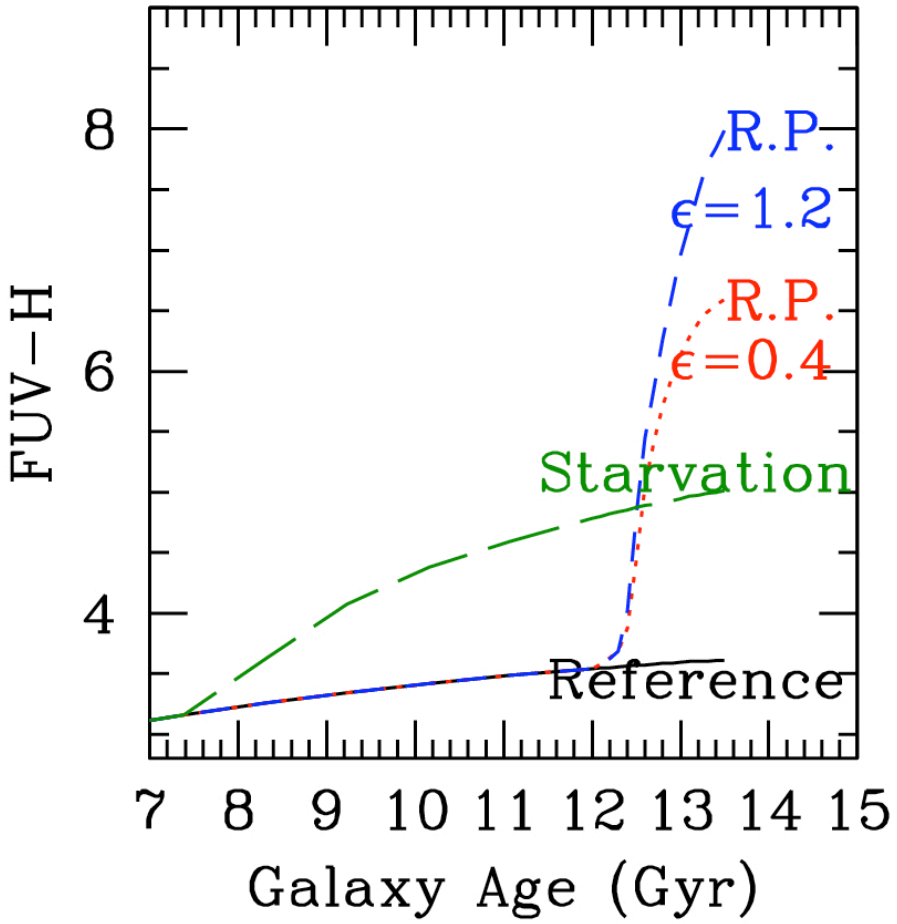
Boselli et al 2006

The origin of dE in clusters

Continuum line: unperturbed model



Age



Age

ε_0 *(NGC4569)*$= 3\varepsilon_0$

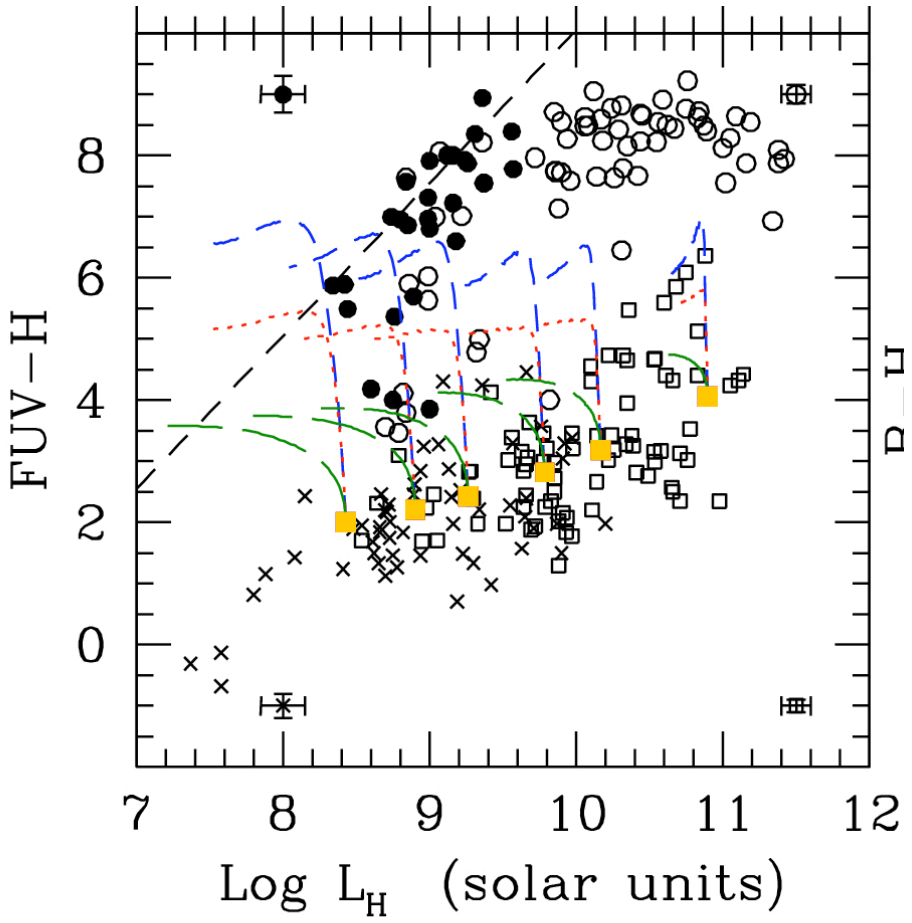
The origin of dE in clusters

Open squares: Sa-Scd
Crosses: Sd-Im-BCD
Filled circles: dE-dS0
Opne cirlces:E-S0-S0a

Ram pressure ε_0 *(NGC4569)*
Ram pressure ε_0
Starvation
Yellow square: unperturbed model

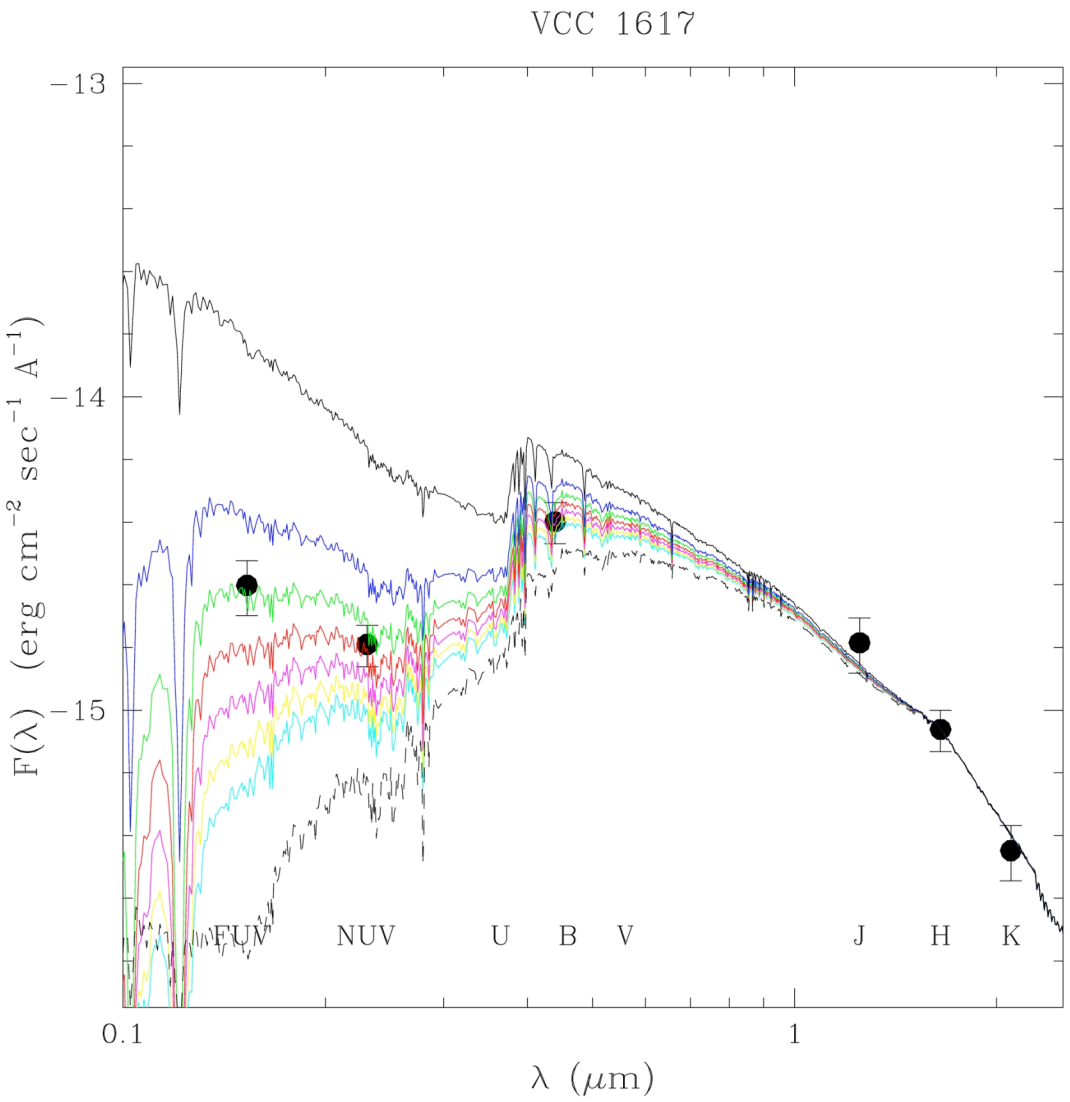
Dashed line: GALEX detection limit

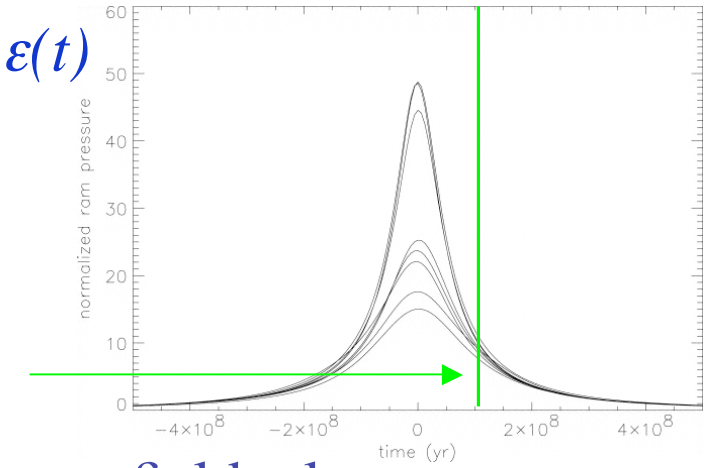
Galaxies get redder



Boselli et al 2008a

The origin of dE in clusters

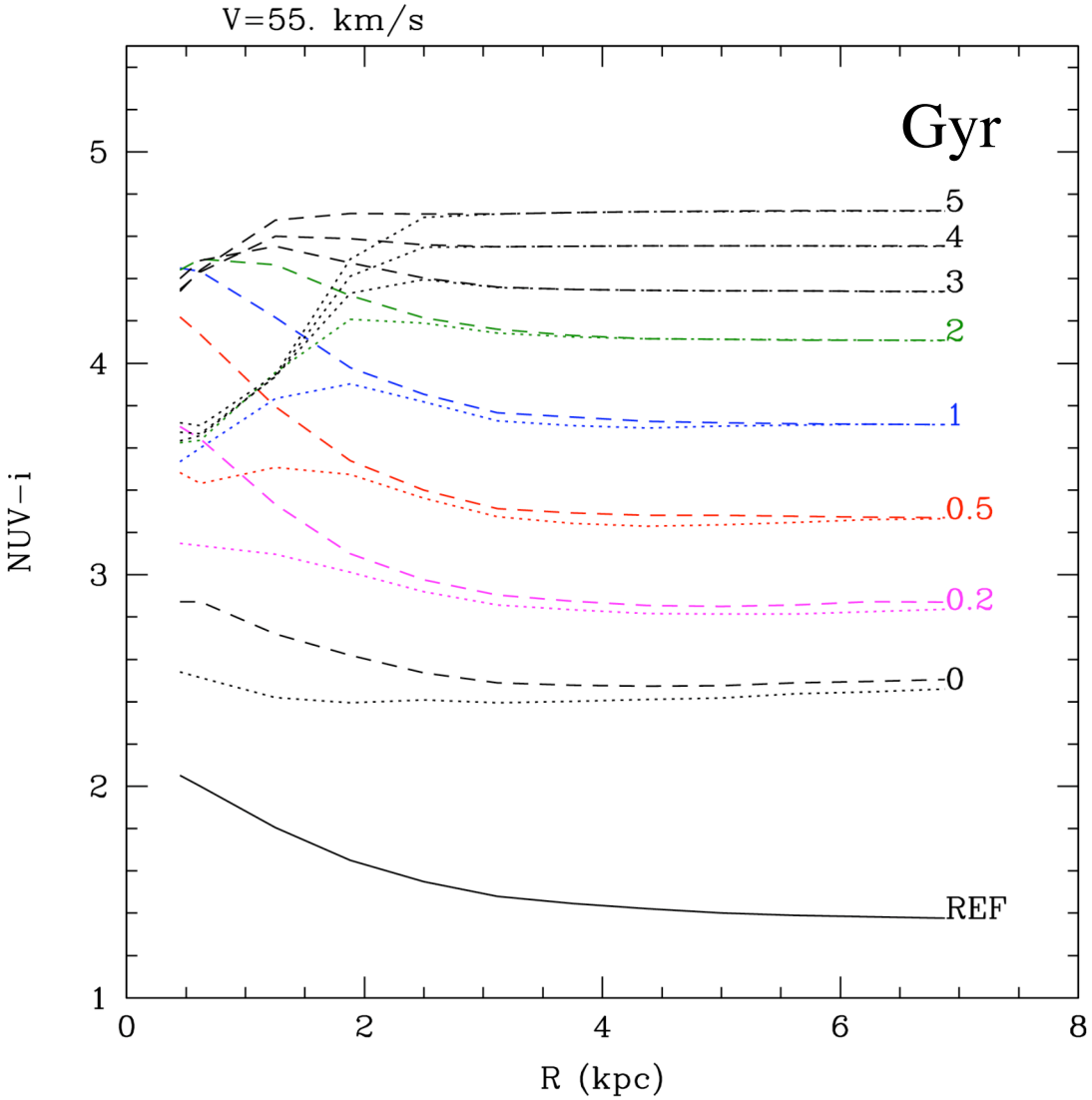




field cluster-core

Continuum Black=without interaction Blue:t=0 green:t=100 red t=200
magenta:t=300 yellow:t=400 cyan:t=500 Dashed black=1300 Myr

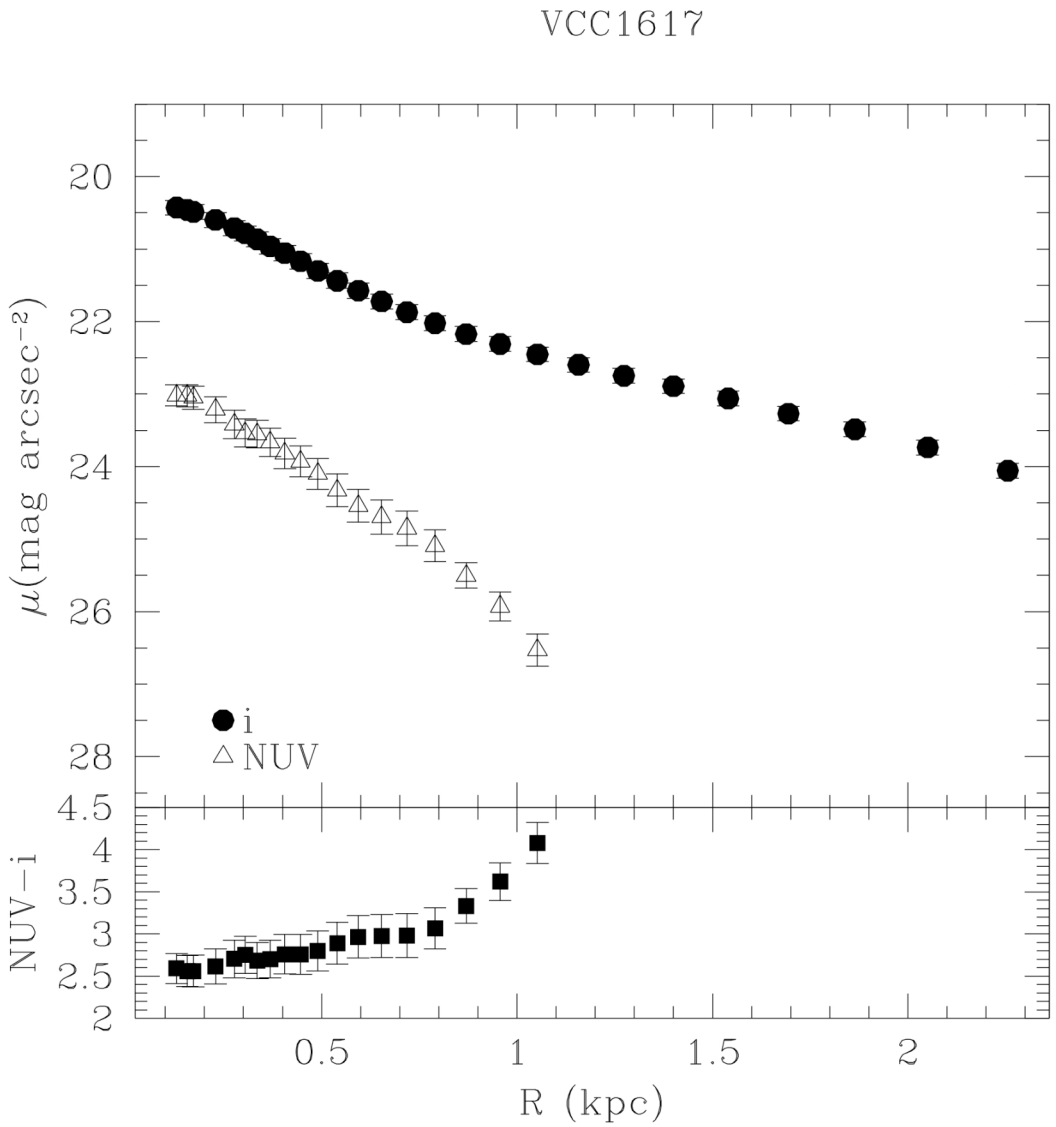
The origin of dE in clusters

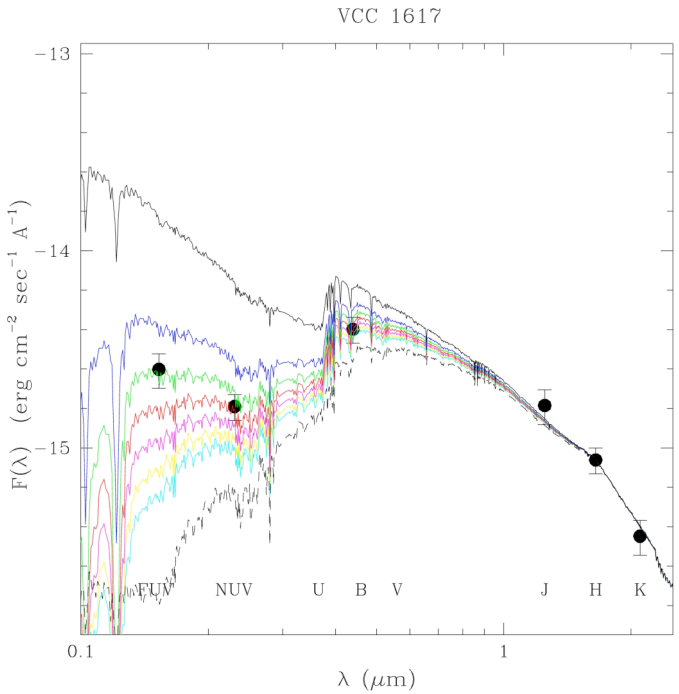


Dotted line: ε_0 *(NGC4569)/3*
Dashed line: ε_0 *(NGC4569)*

Inversion of the central colour gradients: after the interaction galaxies bluer in the center

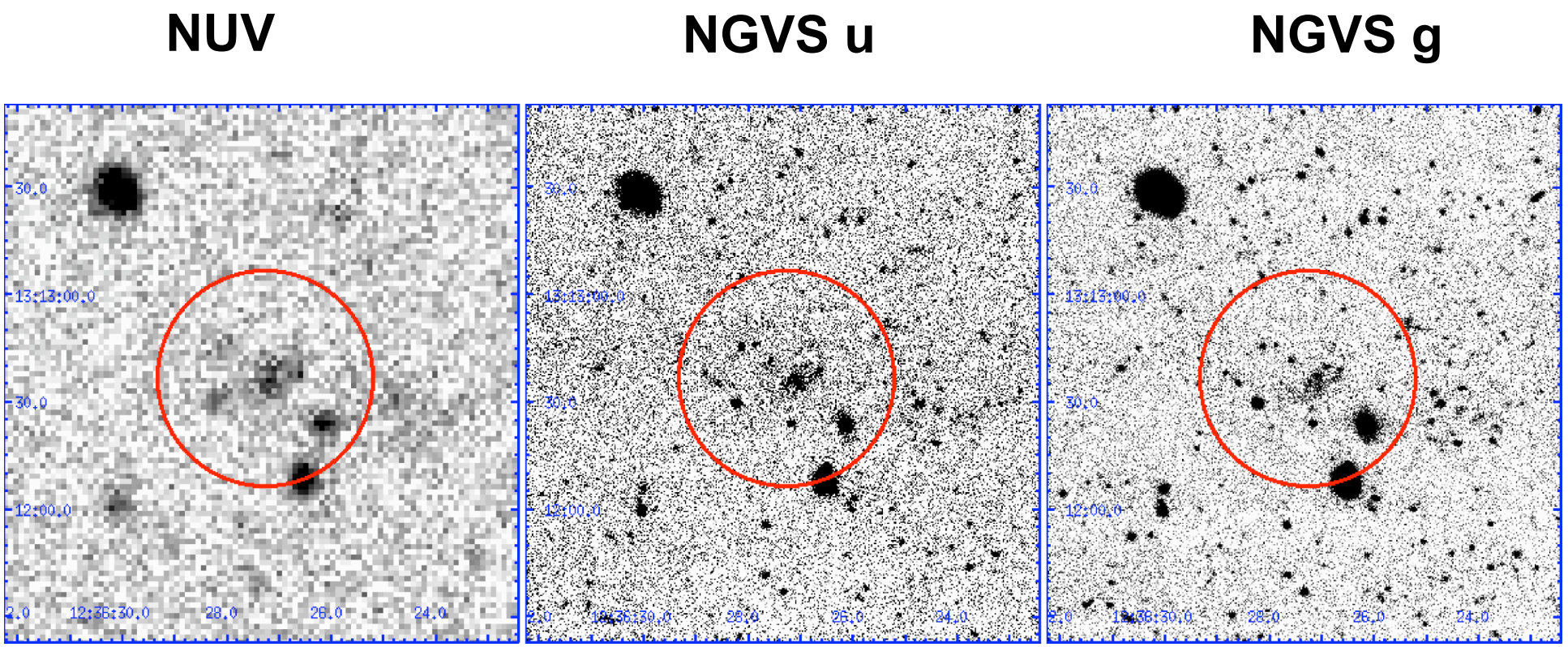
The origin of dE in clusters





Inversion of the central colour gradients: after the interaction galaxies bluer in the center

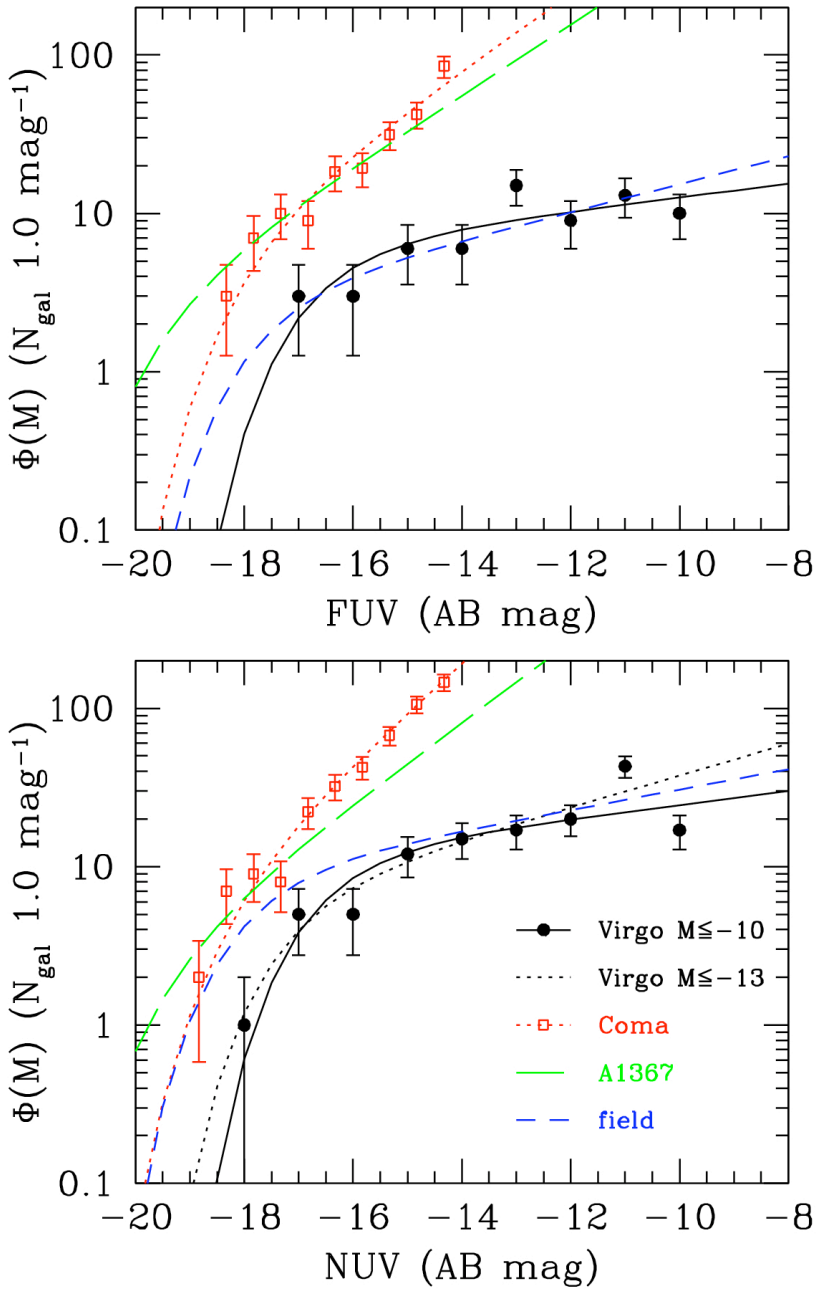
The UV luminosity function of the central 12 sq.deg



GALEX detection without SDSS counterpart

Boselli et al 2011

The UV luminosity function of the central 12 sq.deg



Boselli et al 2011

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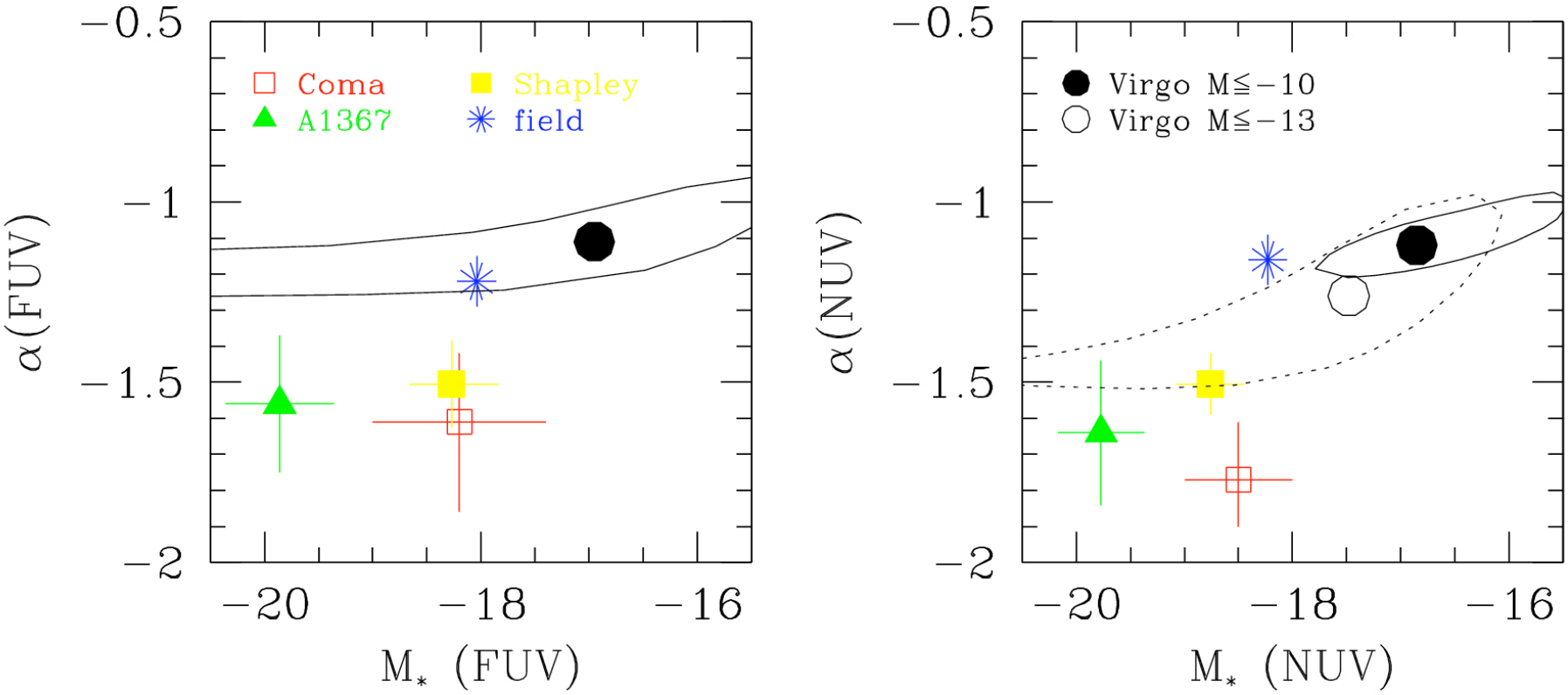

Boselli et al 2011

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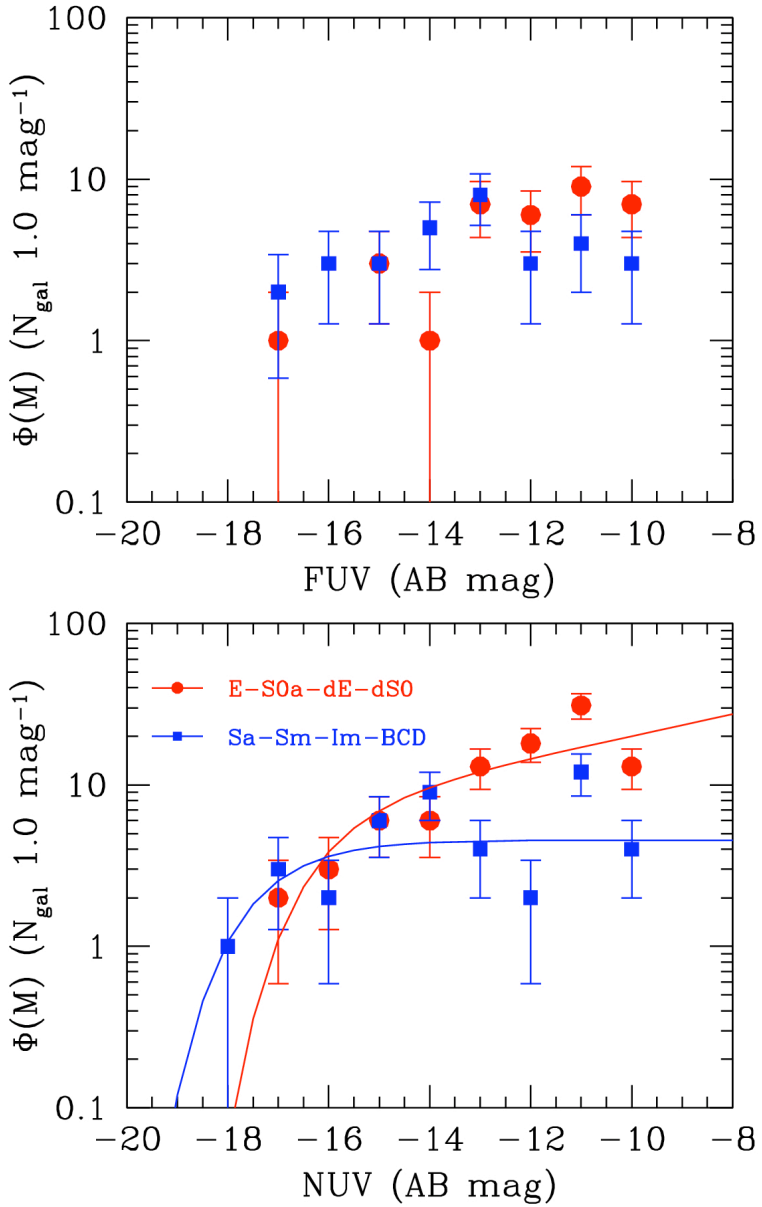
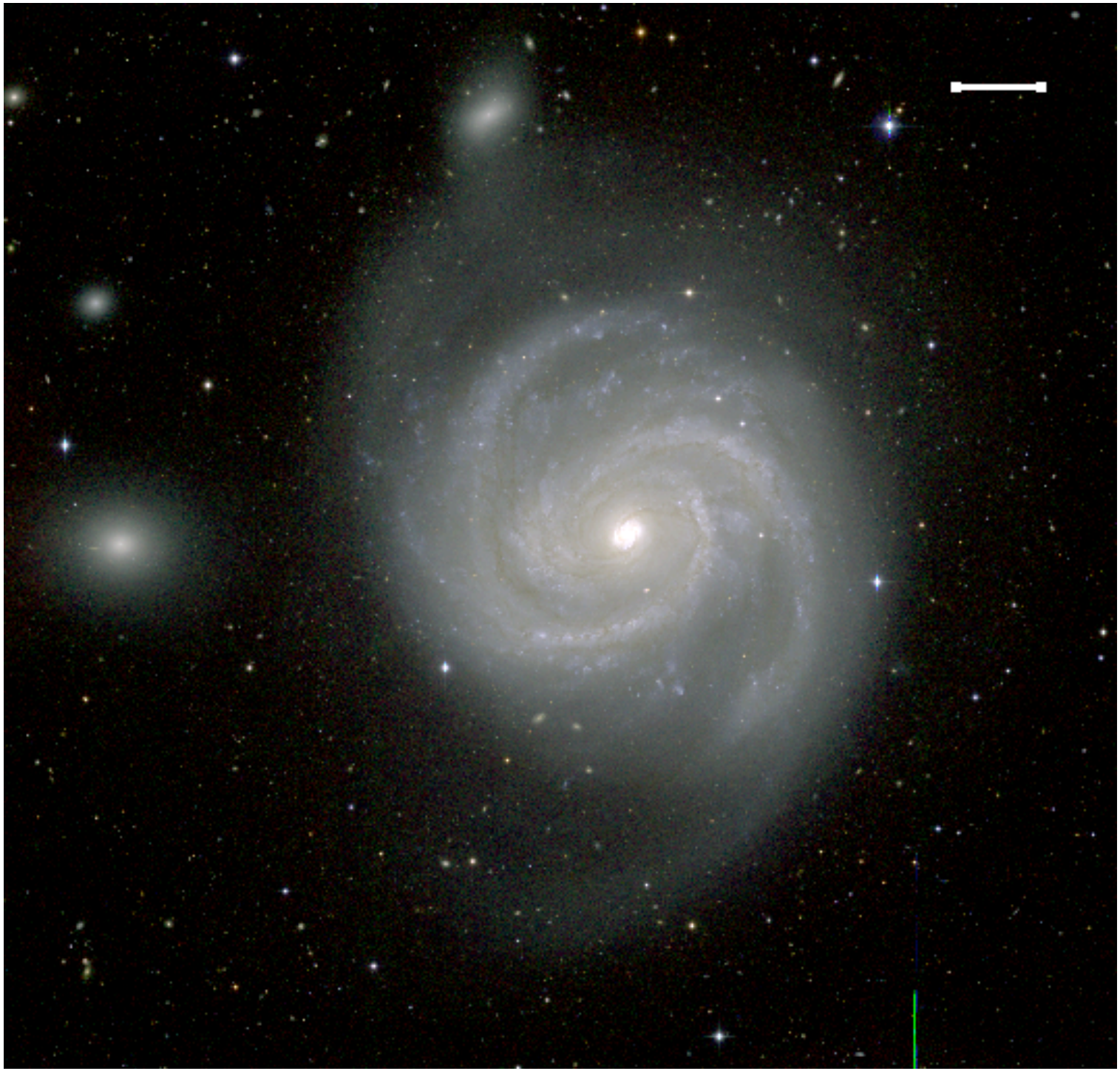


Boselli et al 2011

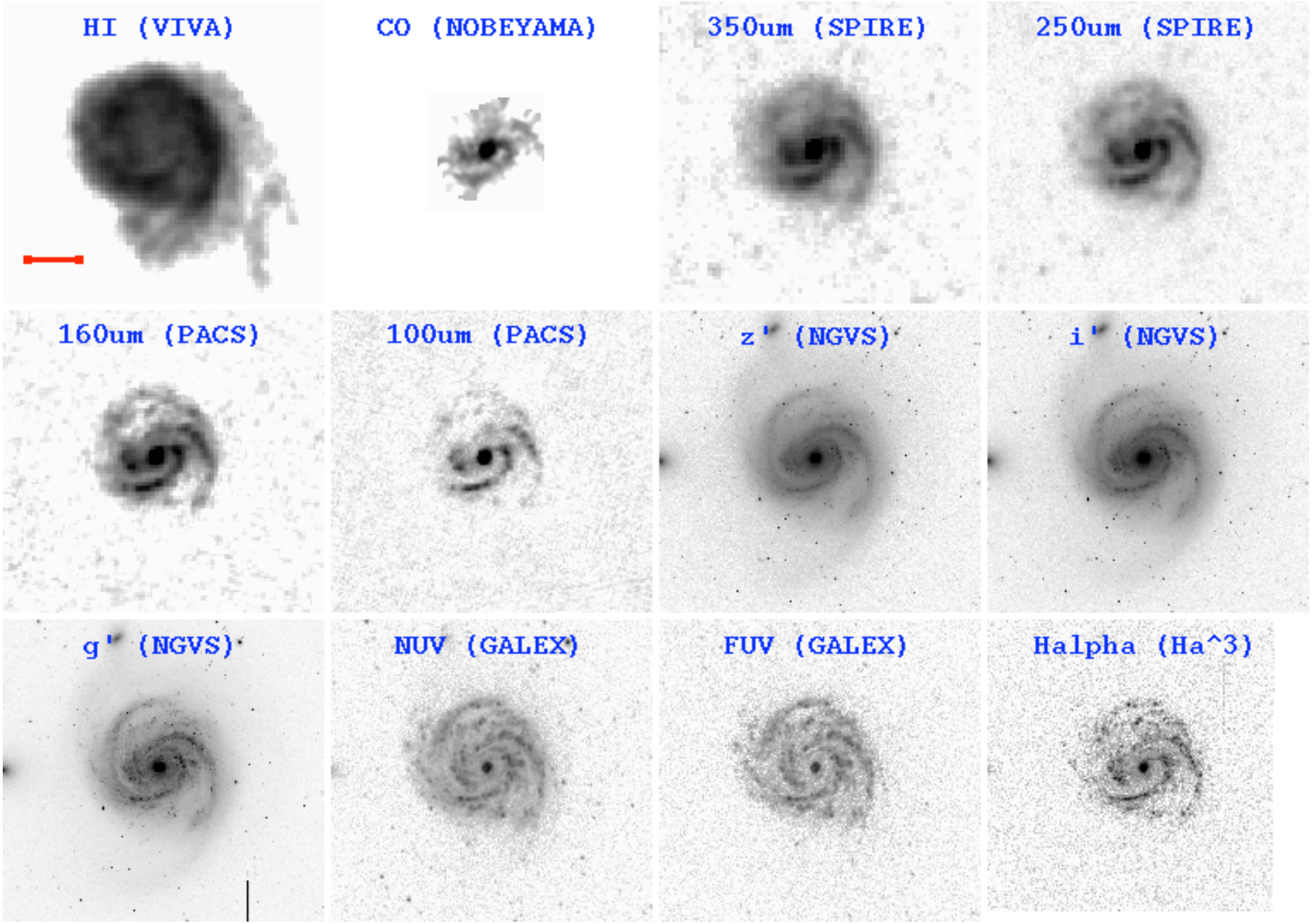
Science: ongoing projects

1) Star formation in the ram pressure stripped gas (see Boissier et al poster at this conference)
2) Multifrequency radial profiles of star forming galaxies in Virgo (Arrigoni Battaia, Gavazzi et al)
3) Study of peculiar objects: the interacting system VCC1249/M49 (see Arrigoni Battaia et al poster); the dust rich dE galaxy IC 3303 (in collaboration with the SMAKCED team)
4) Cirrus emission vs. the study of the diffuse light of the IGM (joint GUViCS, NGVS, HeViCS, ALFALFA project; Cortese, Mihos et al)
5) Galactic extinction towards Virgo (Brosch et al)
6) Virgo globular clusters in UV (Lambas, Valotto et al)
7) UV colours of background galaxies and the evolution of the UV upturn with redshift (Cucciati, Mei et al)



F.Arrigoni Battaia
G. Gavazzi et al

M 100 - NGC 4321



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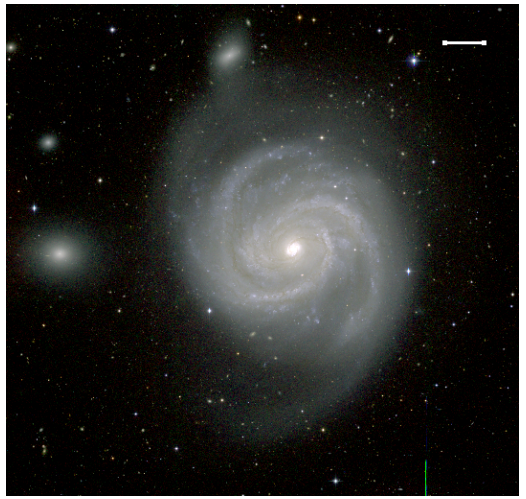
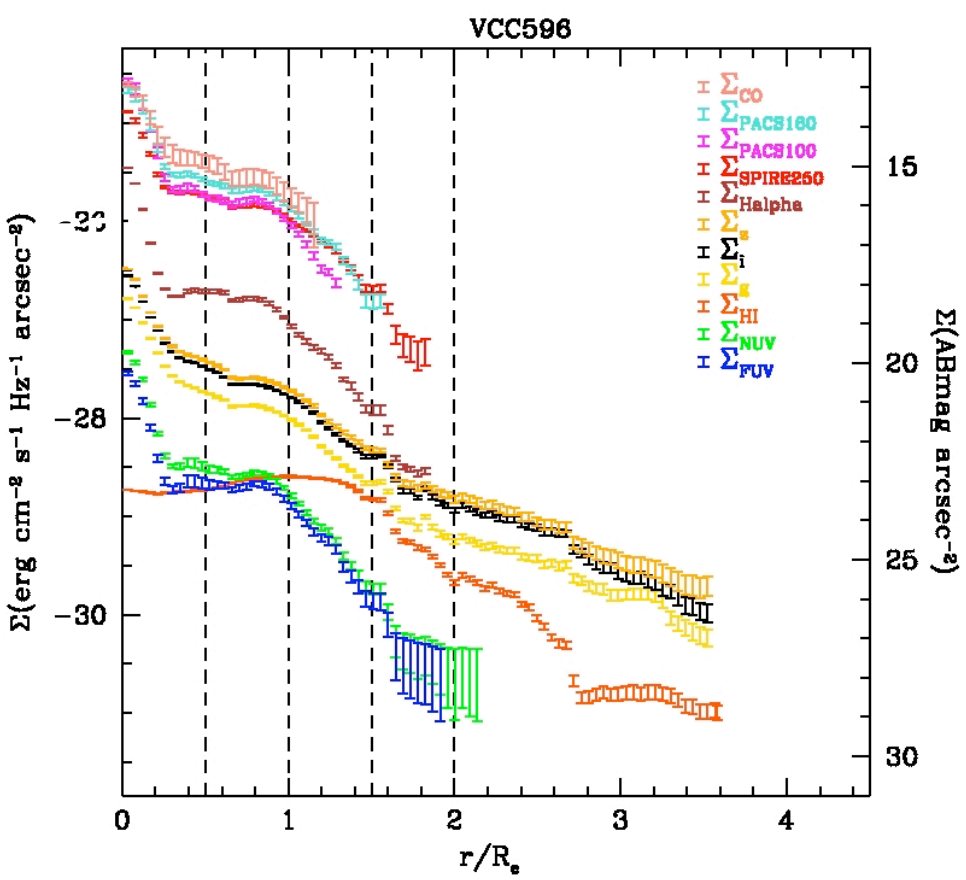
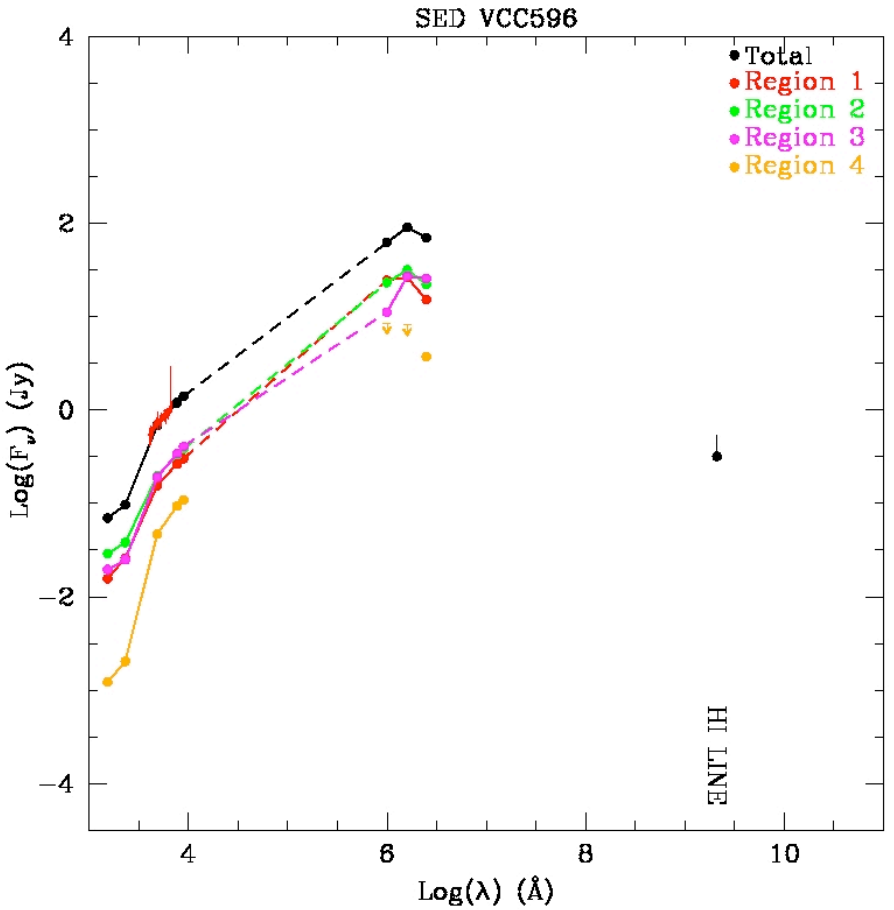
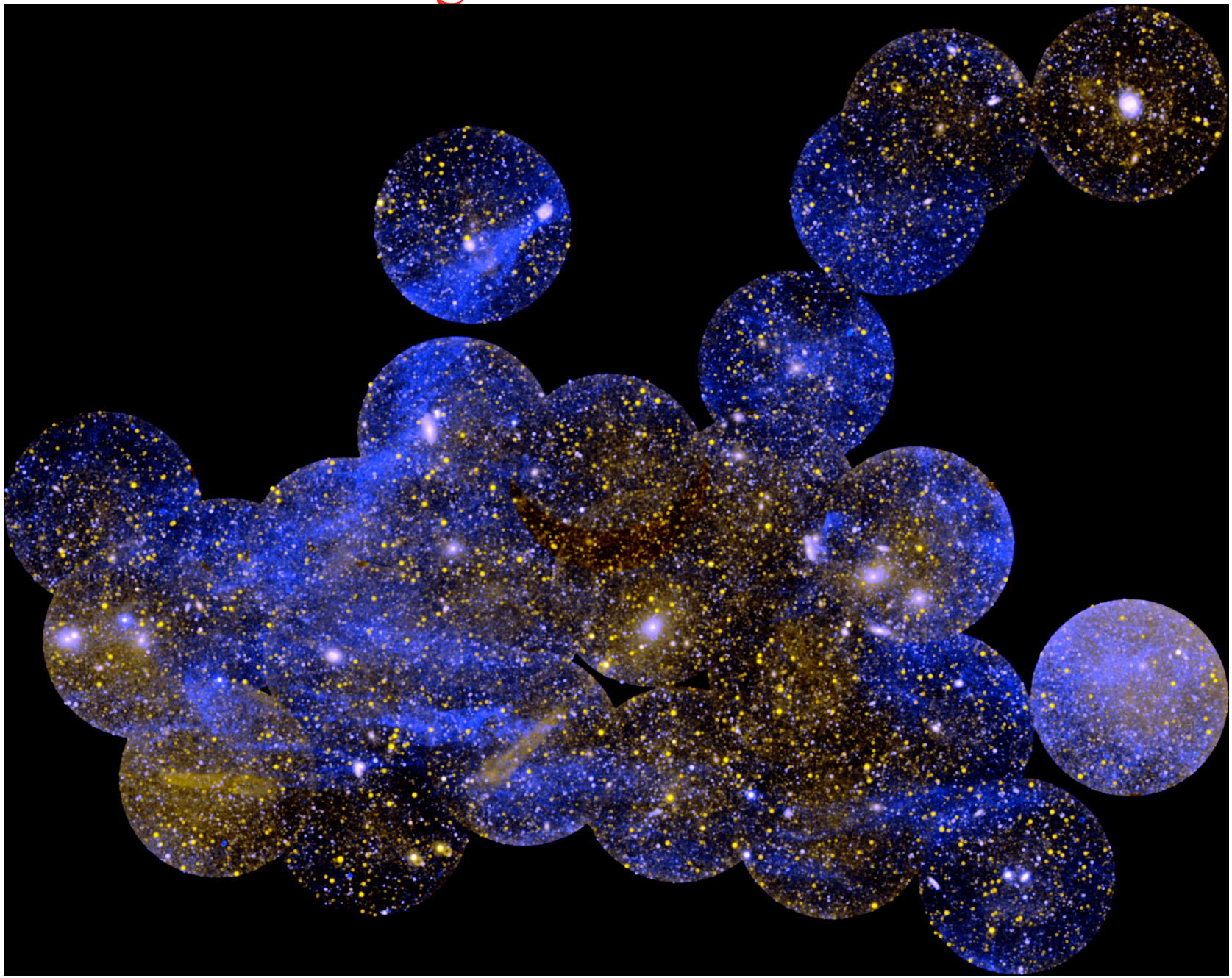






Scattered light from the Galactic cirrus



The GALEX UV Virgo cluster survey: *GUViCS*

The survey has been completed

Description of the survey available on a dedicated webpage (S. Boissier)

http://galex.oamp.fr/guvics/index.html