ASTRON

Netherlands Institute for Radio Astronomy

Galaxies in isolation: an HI perspective

Paolo Serra

ASTRON is part of the Netherlands Organisation for Scientific Research (NWO)

Outline

- Early-type galaxies and the Atlas^{3D} survey
- HI in ETGs and their environment
- An isolated, HI-rich dwarf galaxy
- Conclusions

Early-type galaxies

Early-type galaxies appear as a very homogeneous family:
tight scaling relations, relaxed morphology, strong clustering, old stellar populations, gas-poor (thus passively evolving)

However:

- KDCs, internal discs
- morphological fine structure (shells, ...)
- residual star formation (more recent in the field?) and associated CO
- extended regions with ionised-gas (LINER-like line ratios)
- neutral hydrogen (in the field)

The Atlas^{3D} survey

A volume-limited multi-wavelength survey of 263 early-type galaxies within ~40 Mpc

Optical integral-field spectroscopy (WHT/SAURON)
Optical imaging (INT+SDSS)
CO (IRAM+CARMA)
HI (WSRT)
archival 2MASS, GALEX, XMM-Newton, Chandra
semi-analytic models
N-body simulations

PIs: Cappellari and Kranjovic (Oxford), Emsellem (ESO), McDermid (Gemini)

Bacon and Bois (Lyon), Blitz and Alatalo (Berkeley), Bournaud (SACLAY), Bureau, Davies and Kochfar (Oxford), de Zeeuw and Kuntschner (ESO), Falcon-Barroso (IAC), Morganti, Oosterloo and Serra (ASTRON), Sarzi (Univ. Hertfordshire), van den Bosch and Weijmans (Leiden), Verdoes Kleijn (Kapteyn), Van de Ven (Institute Advanced Studies) , Young (New Mexico Tech), Naab (Muenchen)

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Atlas^{3D} sample selection

M_K <-21.5 (K<11.6 @ $dist_{max}$)

dist<42 Mpc mostly SBF

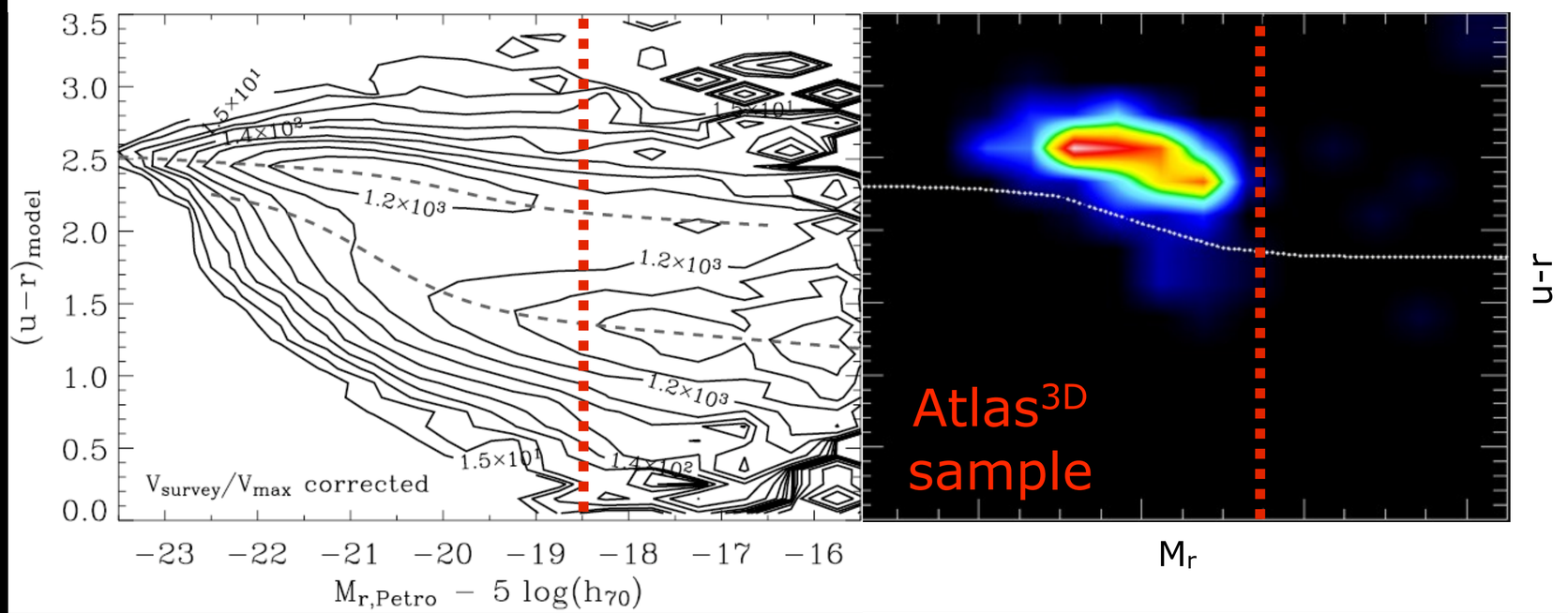
|δ-29|<35°

|b|>15°

Morphological classification by eye
(82% SDSS, else DSS2-blue)
Main criterion: no spiral arm

263 ETGs (Virgo included)

Baldry et al. (2004)



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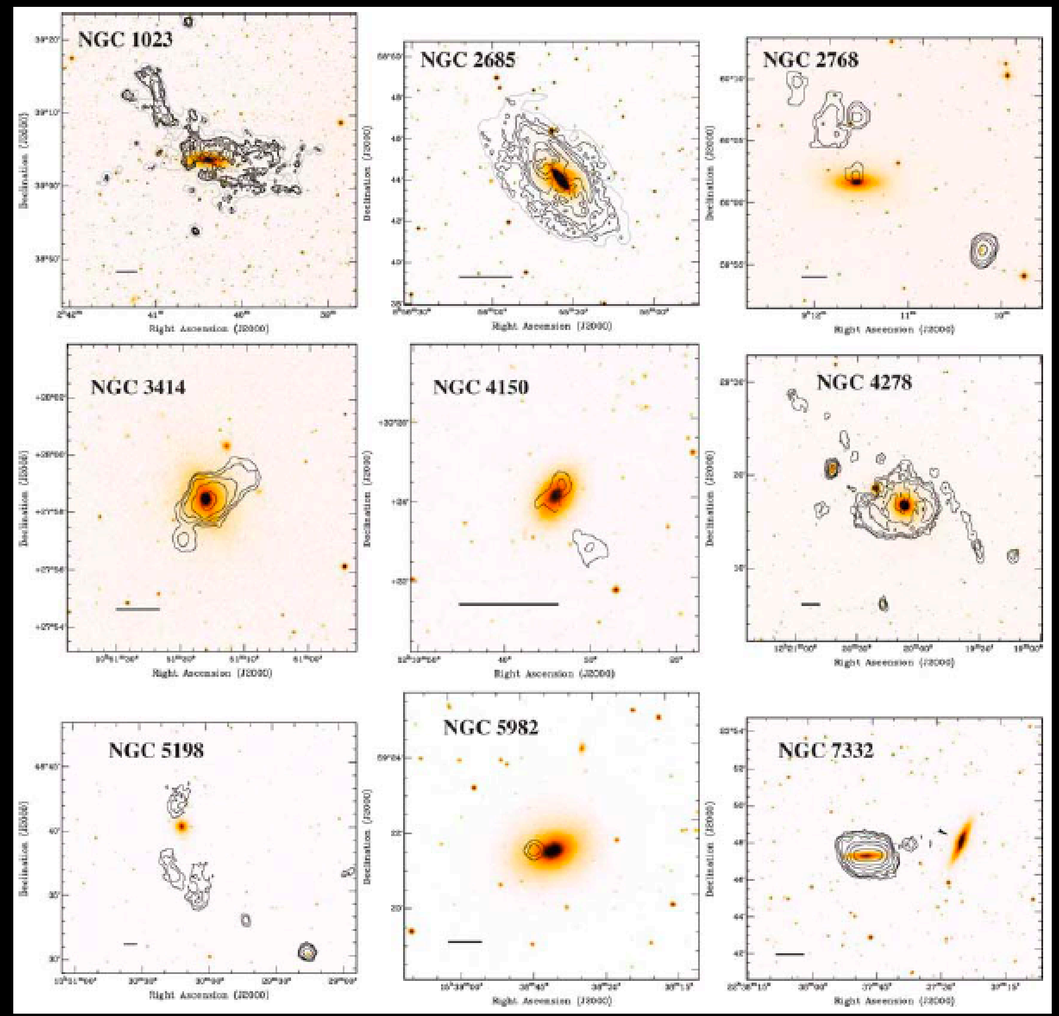
HI in ETGs

Significant fraction of the ISM

Detection rate:
30-70% in the field
~1% in the cluster

$M(HI)=10^{6}$-$10^{10}\ M_{\odot}$
spread over tens of kpc
$n_{HI} < 10^{20}\ cm^{-2}$

(Morganti +06, Oosterloo +07, Grossi +09)



So far, no relation with stellar properties (luminosity, stellar age, kinematics), BUT poor statistics

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WSRT HI survey of the Atlas^{3D} sample (ongoing)

dec>10 deg:

all non-Virgo galaxies => 127 ETGs (full synthesis)

Virgo galaxies detected in Alfalfa (7/44)

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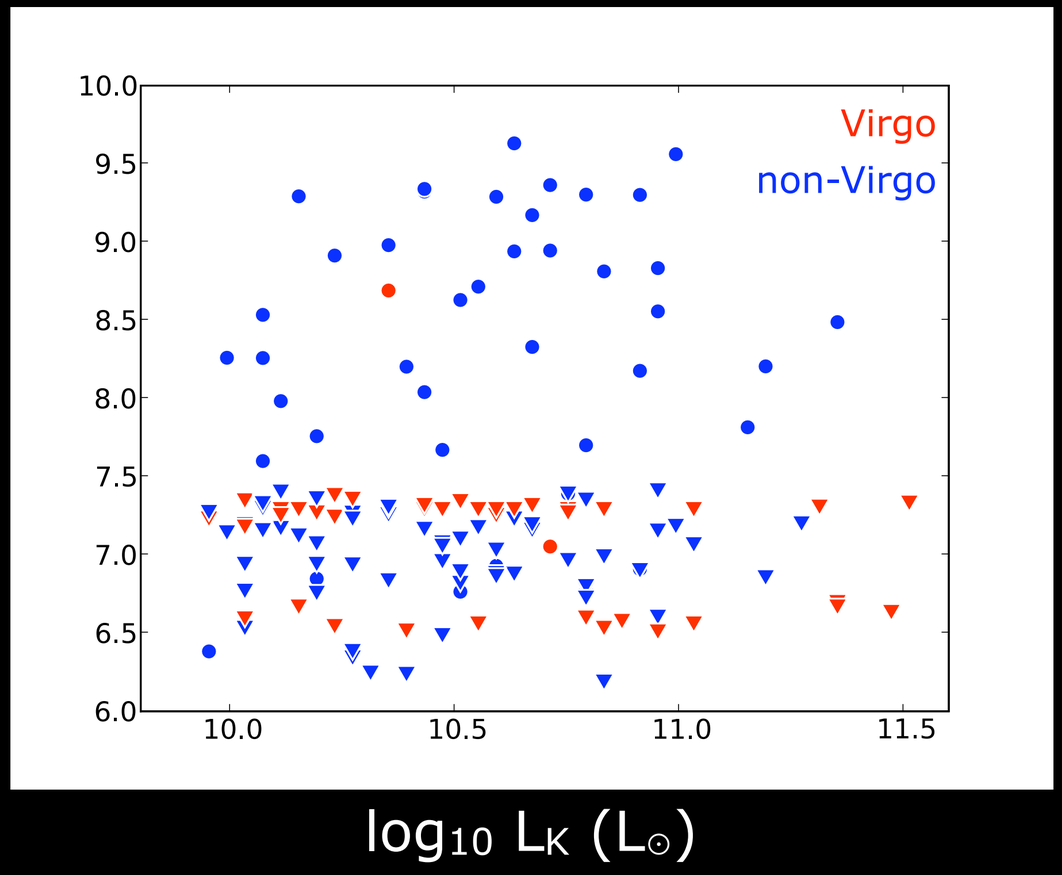

Detection rate: ~40% outside Virgo

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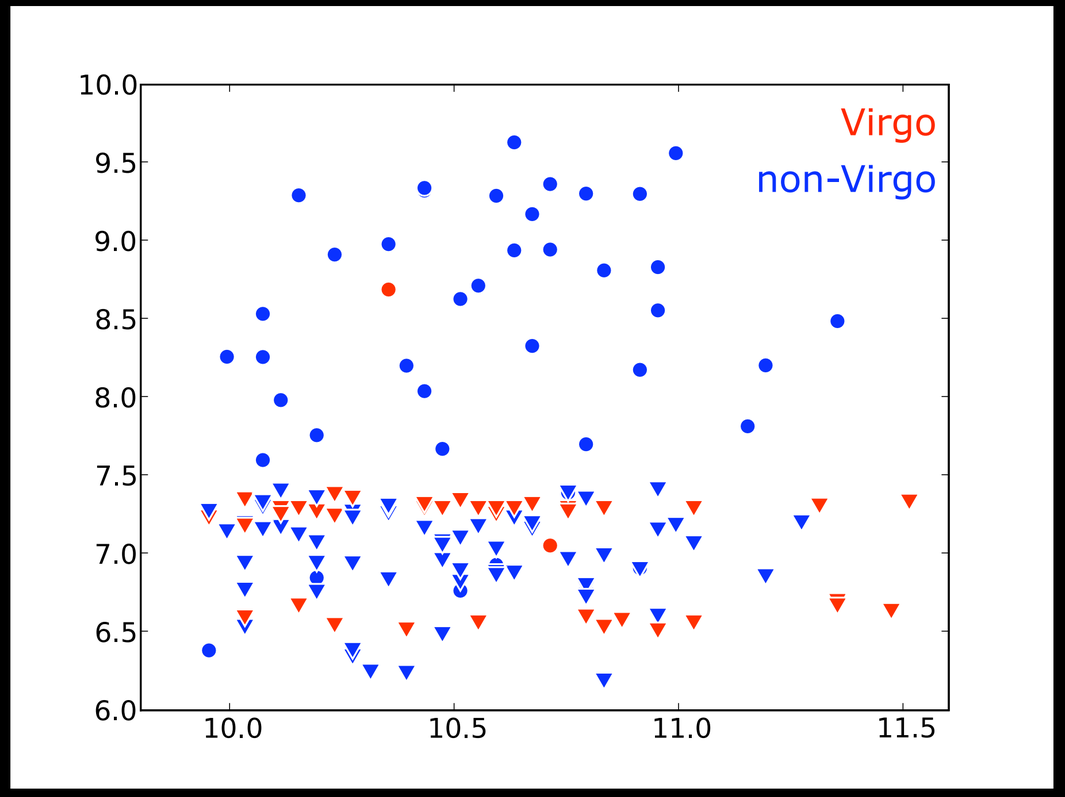

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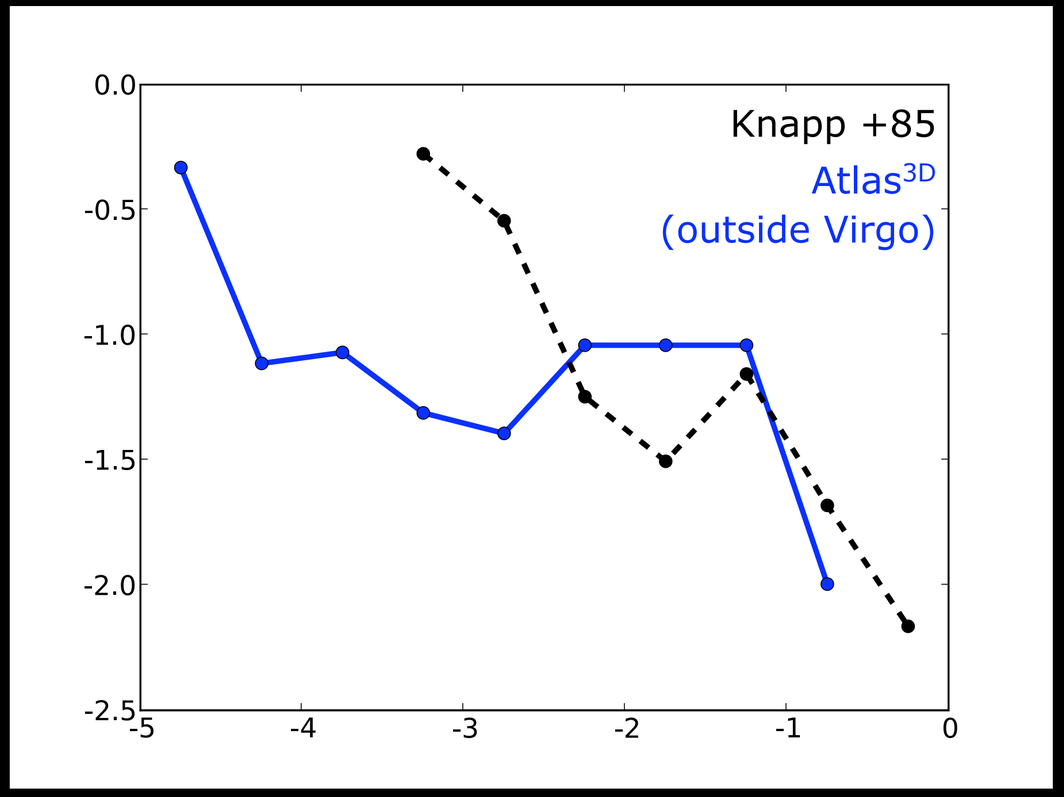

HI external origin?

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HI in ETG's and environment: gas mass

Environment = all galaxies within 2 Mpc, ±300 km/s, and with M_K <-21.5

Isolated galaxies: L_{gal}/L_{env}~1

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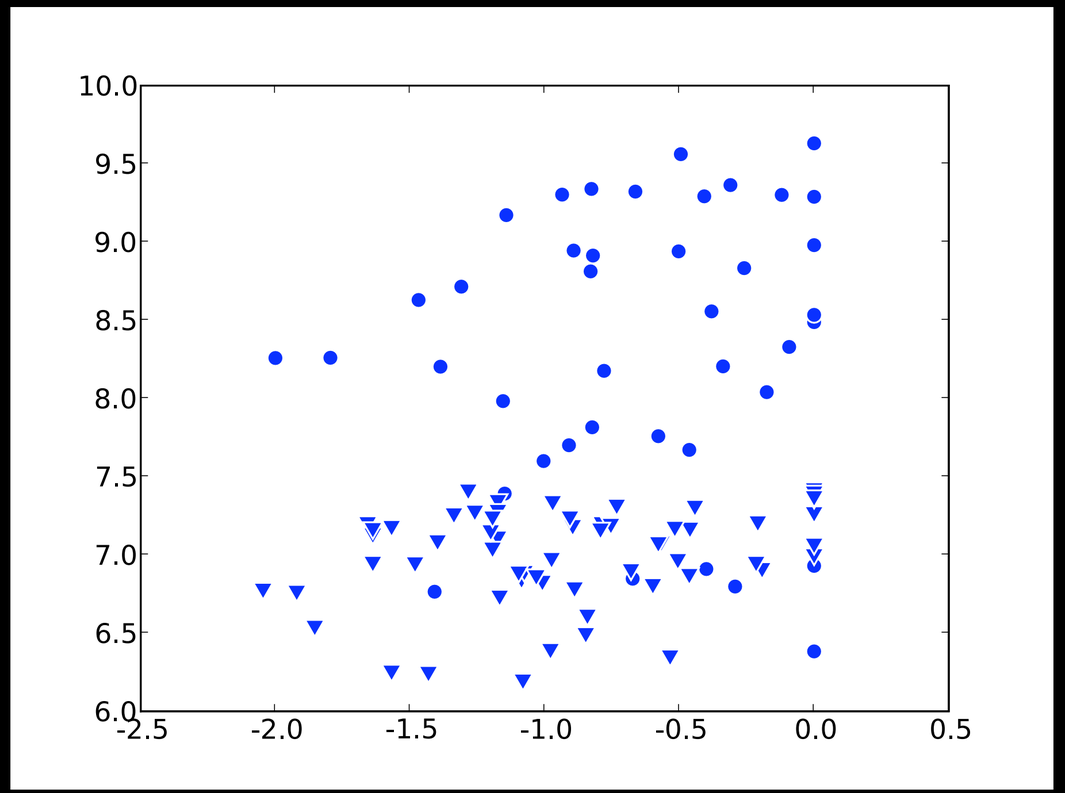

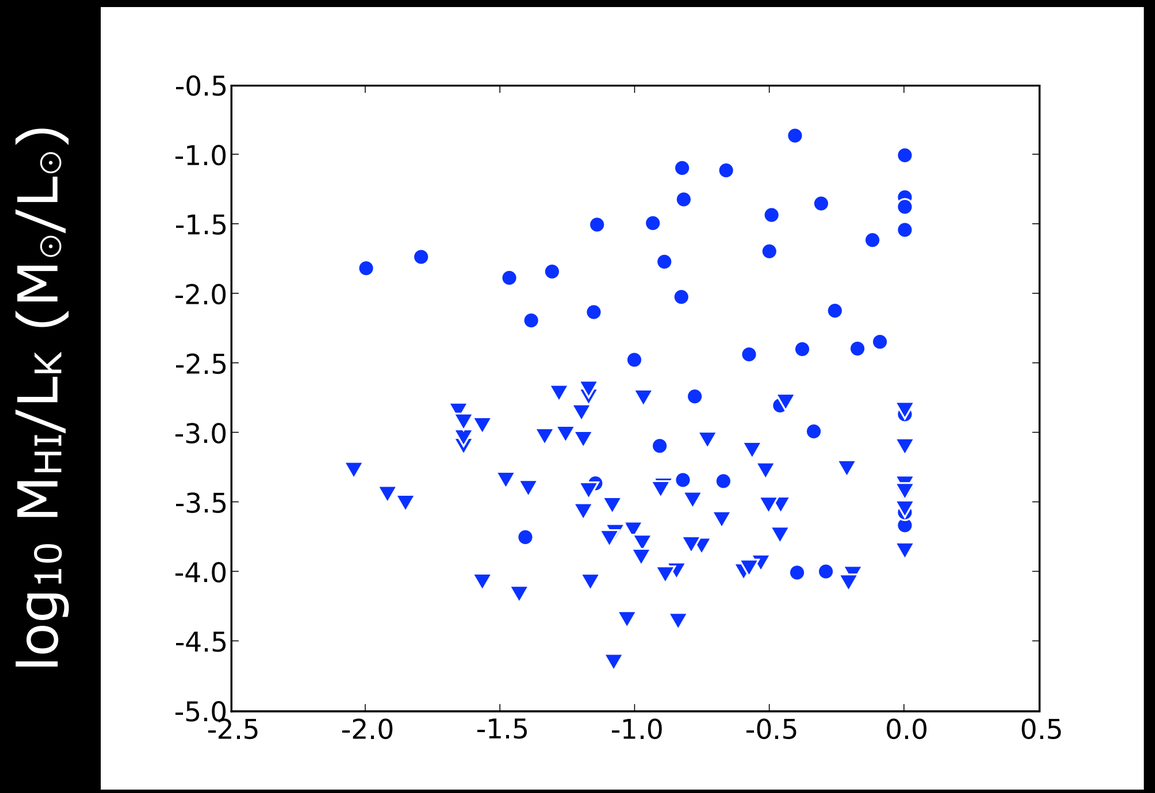

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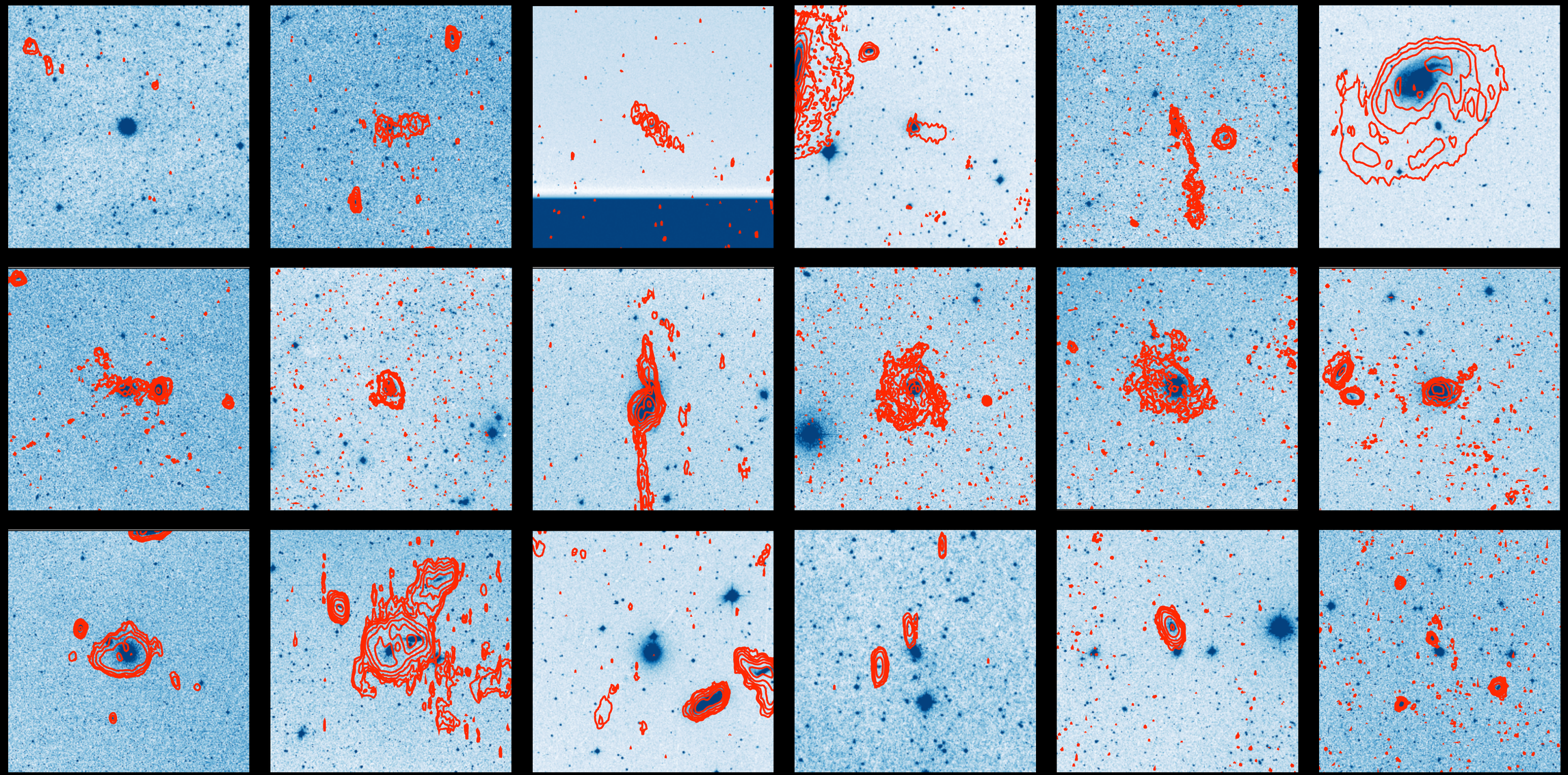
HI in ETG's and environment: gas morphology

$L_{galaxy}/L_{environment}$

n_{HI} > 1.5 x10^{19} cm^{-2}



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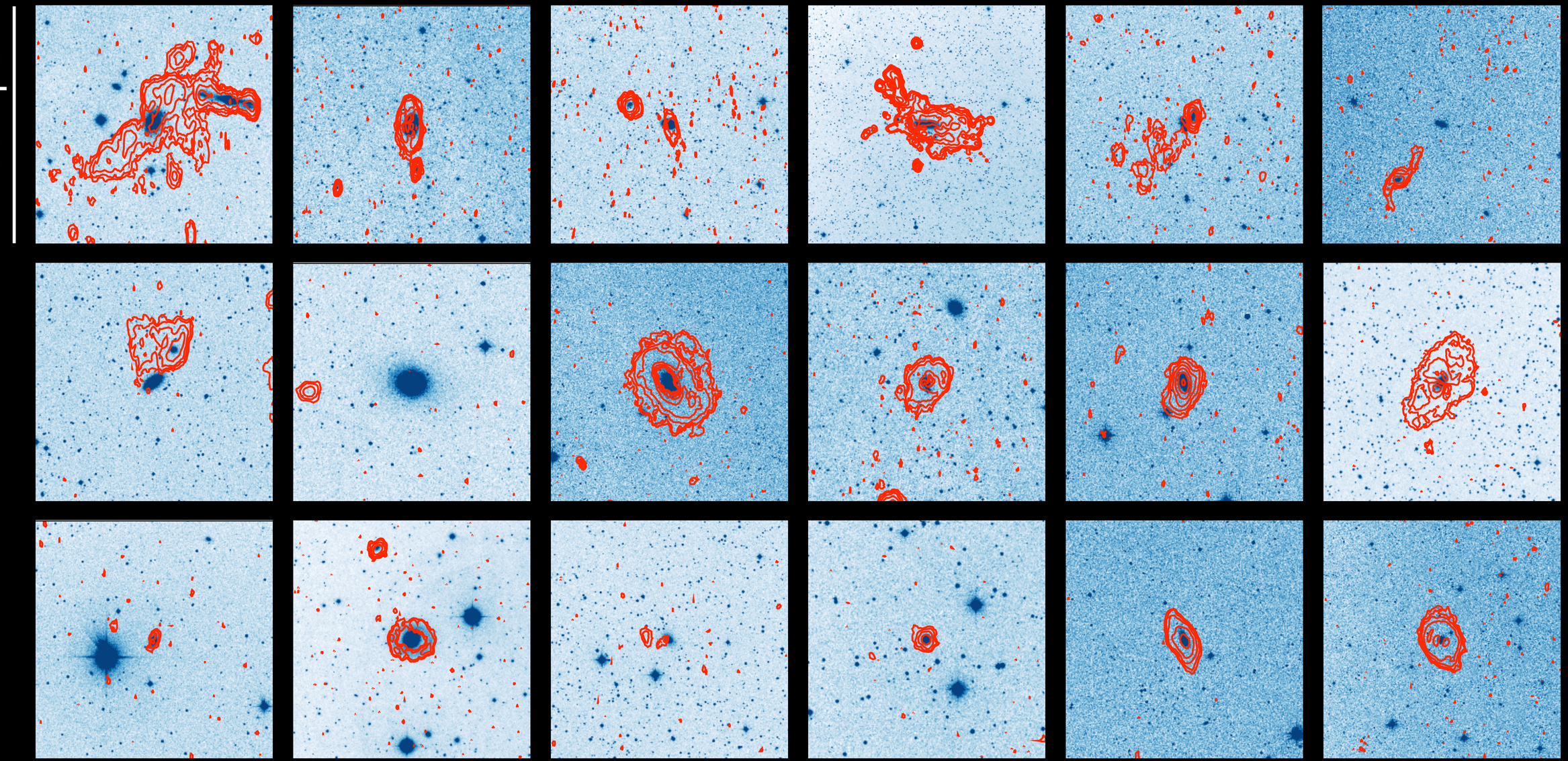

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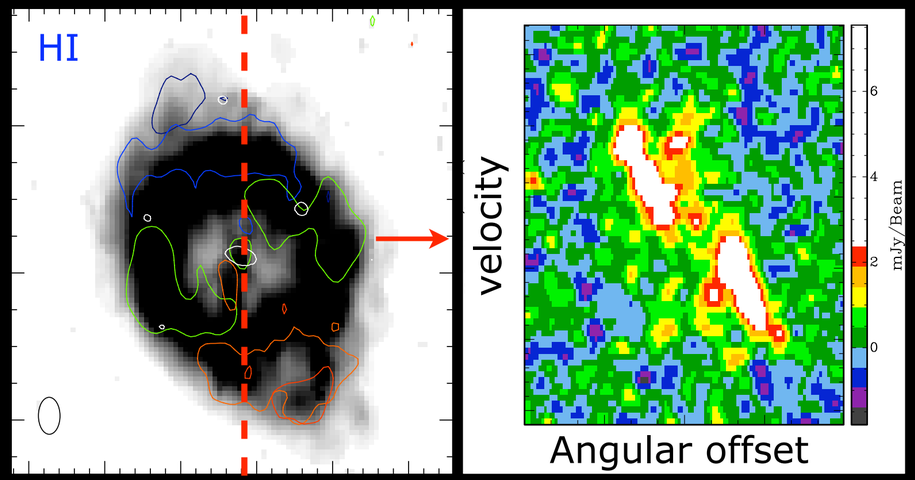
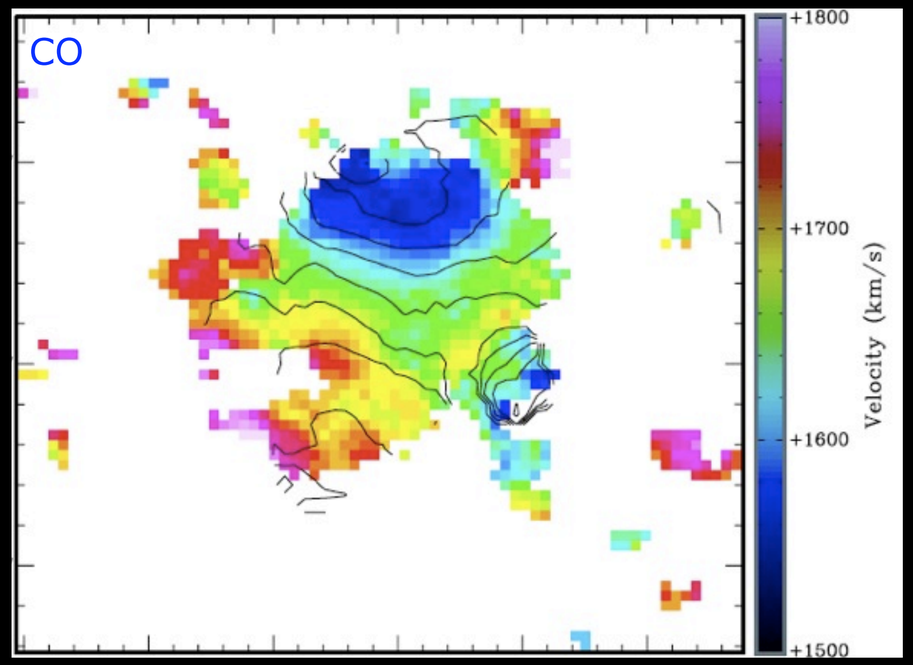
The role of HI: fuelling inner star formation?





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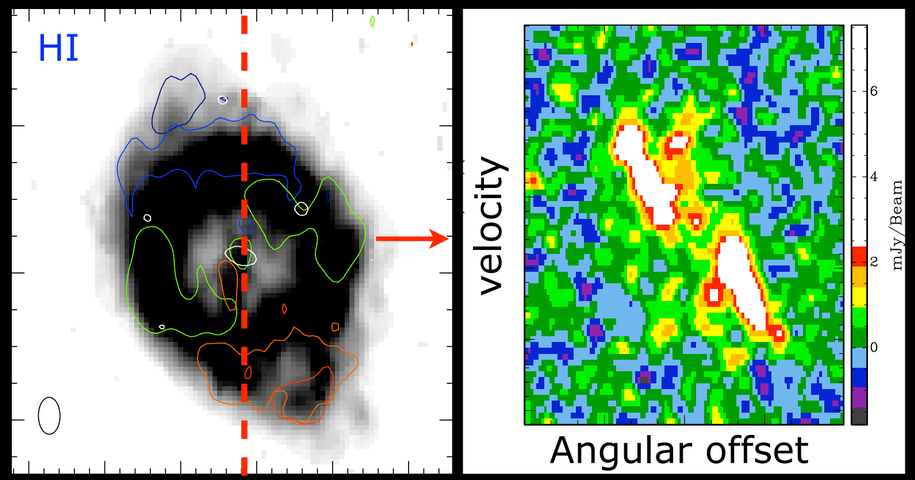

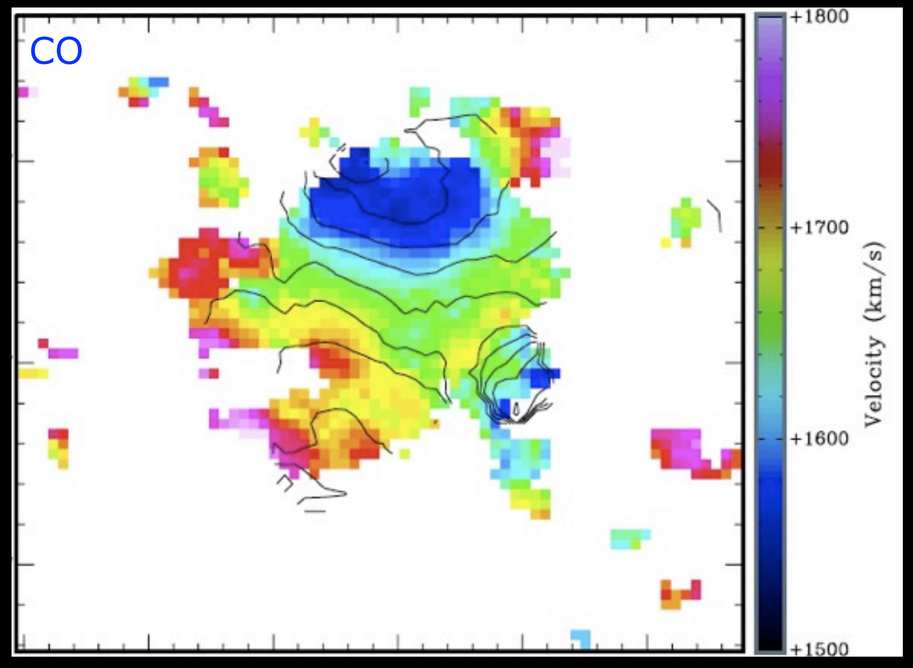

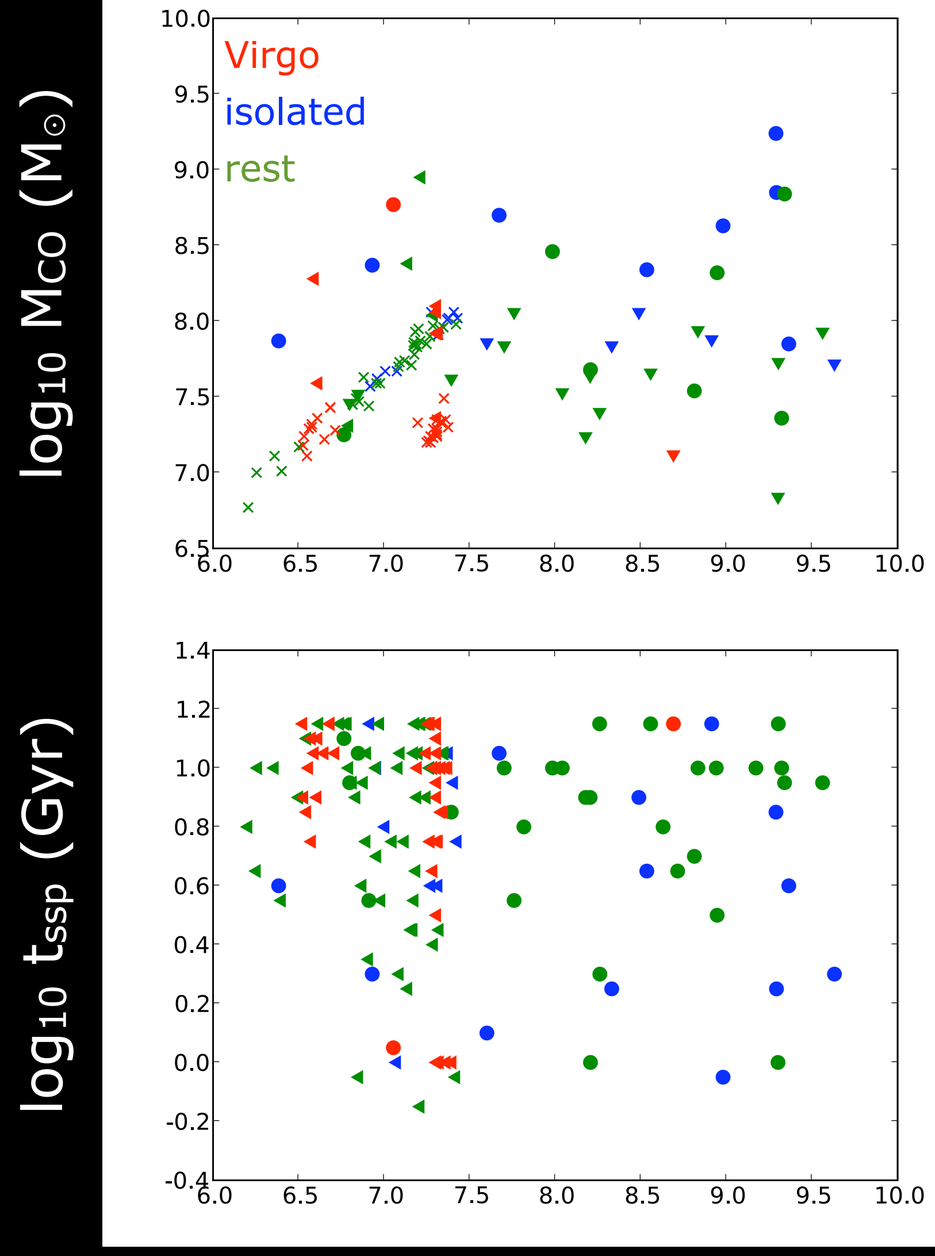

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A bright future: APERTIF

The current front-end will be replaced by focal plane arrays on the WSRT dishes:

- FOV will increase by a factor ~25
- Instantaneous bandwidth 300-400 GHz, i.e., z=0-0.3 for HI

Ideal for ~all-sky surveys out to z~0.3 (same survey speed as SKA precursors ASKAP and MeerKat)

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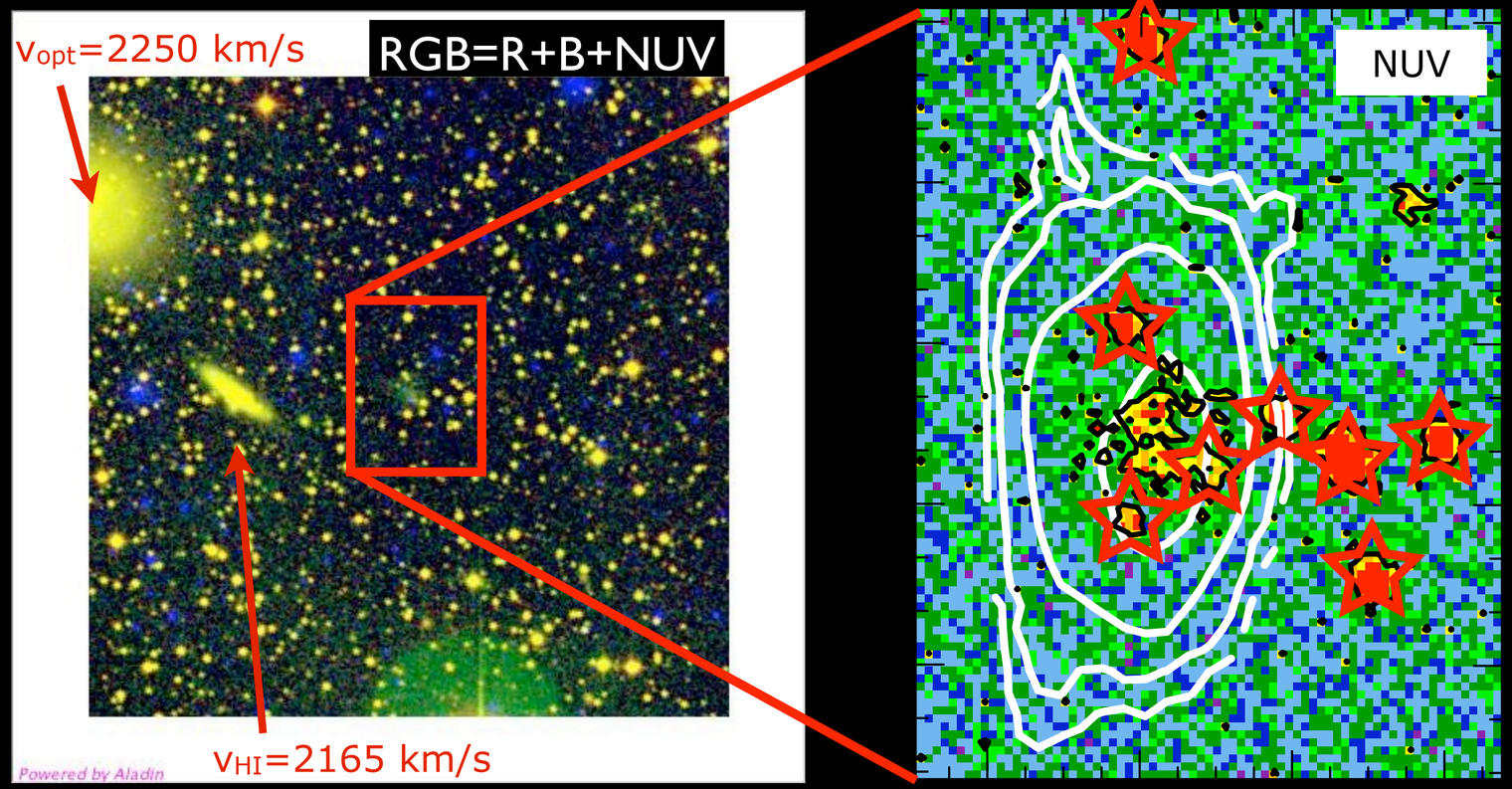
Serendipitous discovery of a dwarf galaxy



M_B=-16

μ_B=26.5 mag/arcsec^2

M_{HI}=2x10^8 $M_\odot$

SFR_{NUV}=10^{-3} $M_\odot$/yr

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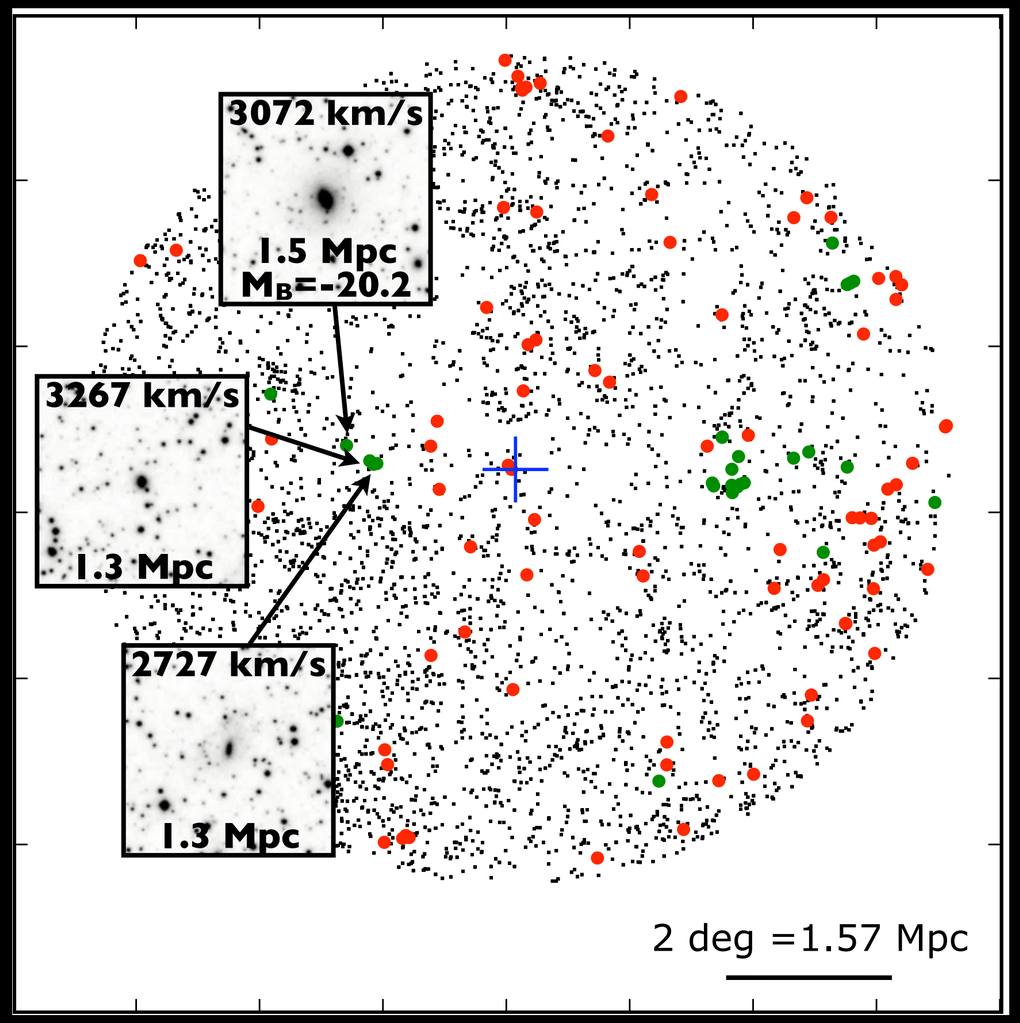
Dwarf galaxy environment



- z outside +/- 500 km/s window
- z inside +/- 500 km/s window
- no redshift

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Conclusions

Atlas^{3D} survey first results:

- 40% of early-type galaxies outside Virgo contain HI
- flat M_{HI}/L_{stars} between 10^{-4} and 10^{-1} $M_\odot/L_\odot$

HI and environment of ETGs

- strong dependence of HI mass on environment (Virgo vs. non-Virgo)
- strong dependence of HI morphology on environment (groups vs. more isolated galaxies)
- unclear role of HI

Future: APERTIF and SKA precursors

Isolated, HI-rich dwarf galaxy discovered

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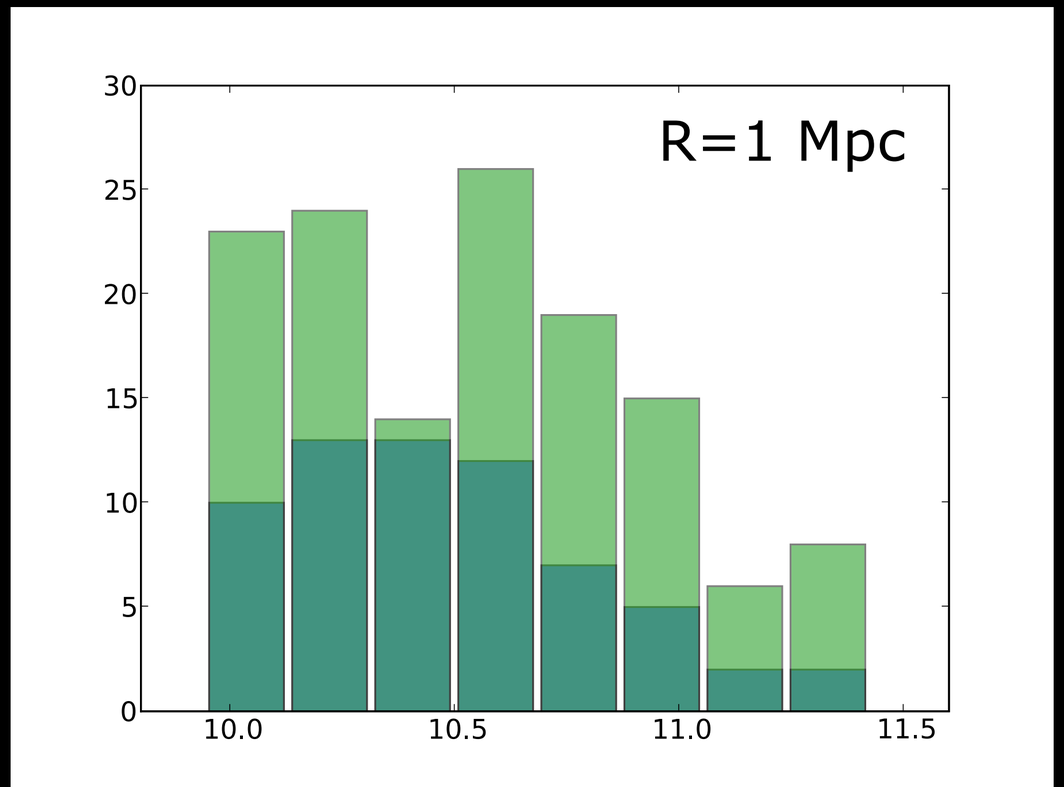
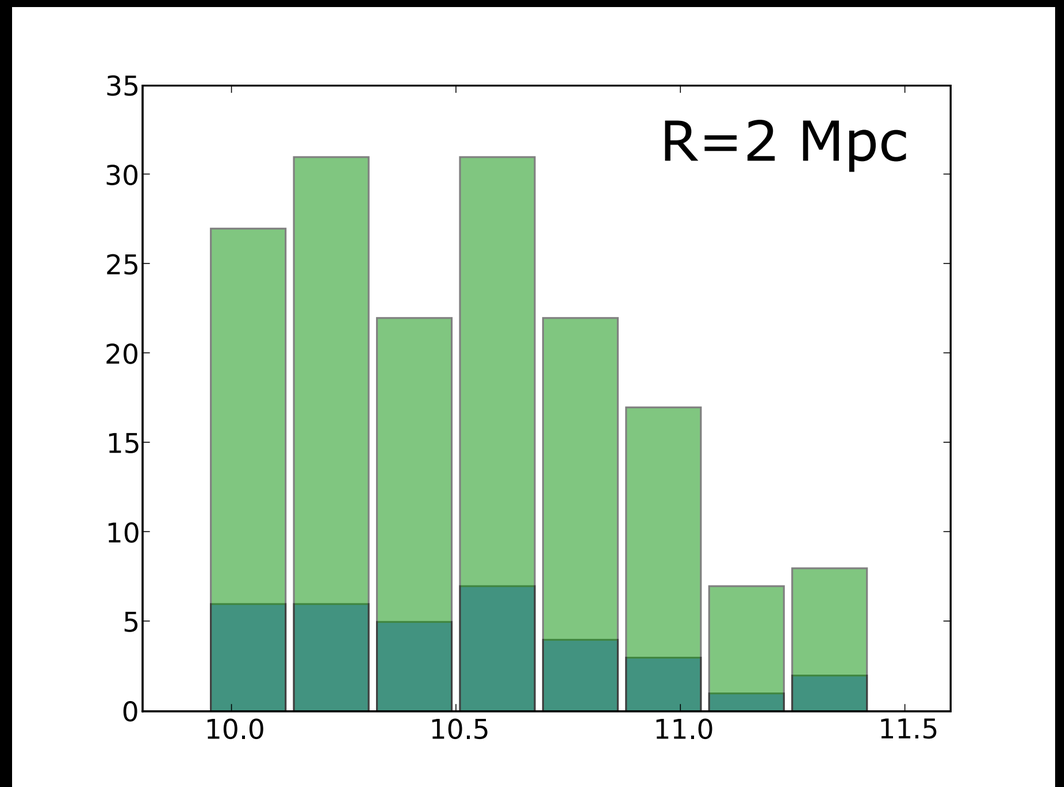
Luminosity distribution of (non) isolated ETGs





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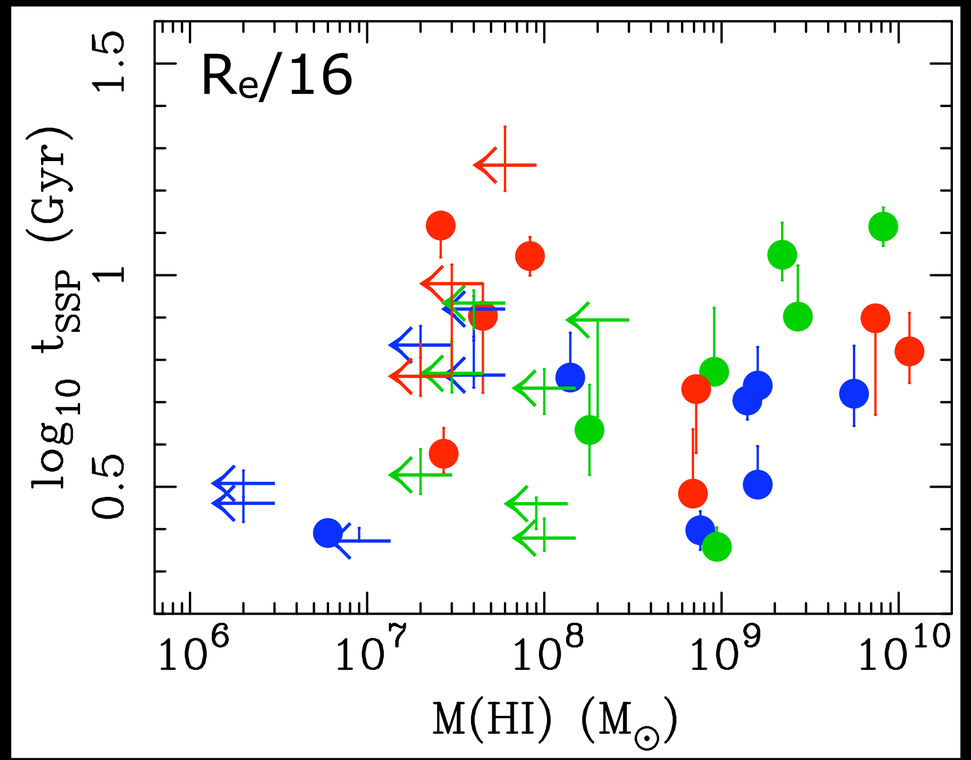
HI and stellar properties



Serra +08

- $\sigma_{km/s}$ <180
- 180< $\sigma_{km/s}$ <240
- $\sigma_{km/s}$ >240

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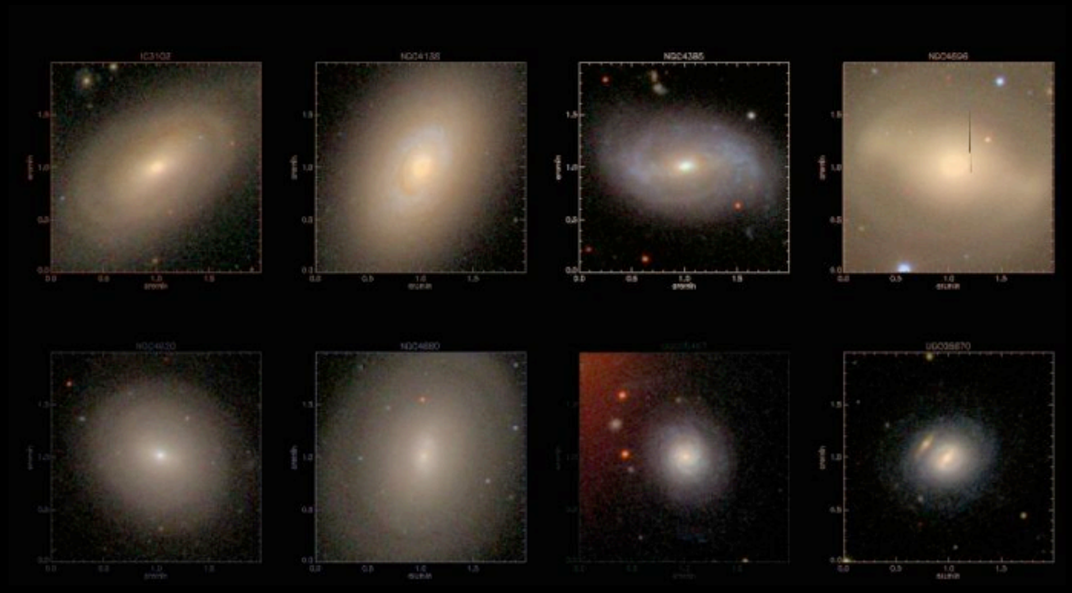
Visual classification of Atlas^{3D} galaxies

LEDA E/S0 removed from sample



LEDA S0/a added to sample

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