$H\alpha^3$ ($H\alpha$ follow-up of ALFALFA)

An $H\alpha$ imaging survey of 21 cm selected galaxies from ALFALFA in the Virgo cluster and surroundings

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& The ALFALFA collaboration

San Pedro Martir (Mx) (2006 - 2009)

narrow-band Imaging.

Arecibo-ALFALFA (2005 - 2007)

Garching, June 27, 2011

M100

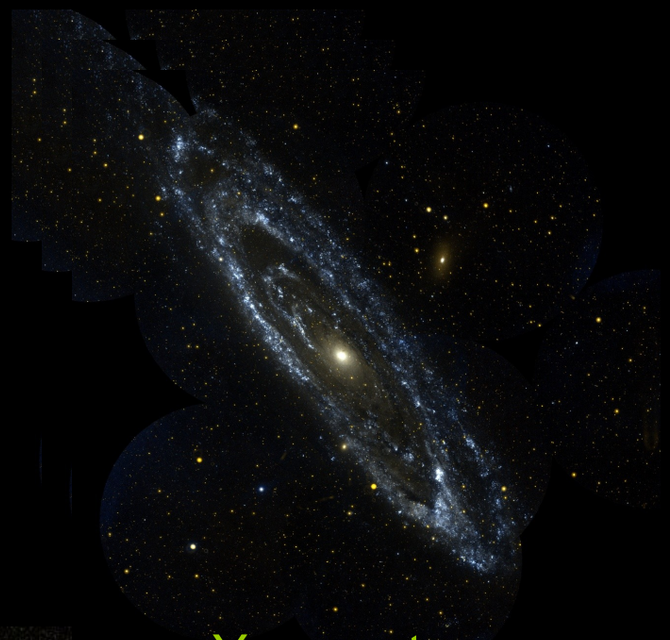
M100

HI

Hα

The HI selection biases in favor of spirals and against ellipticals

gas



Young stars

Old stars

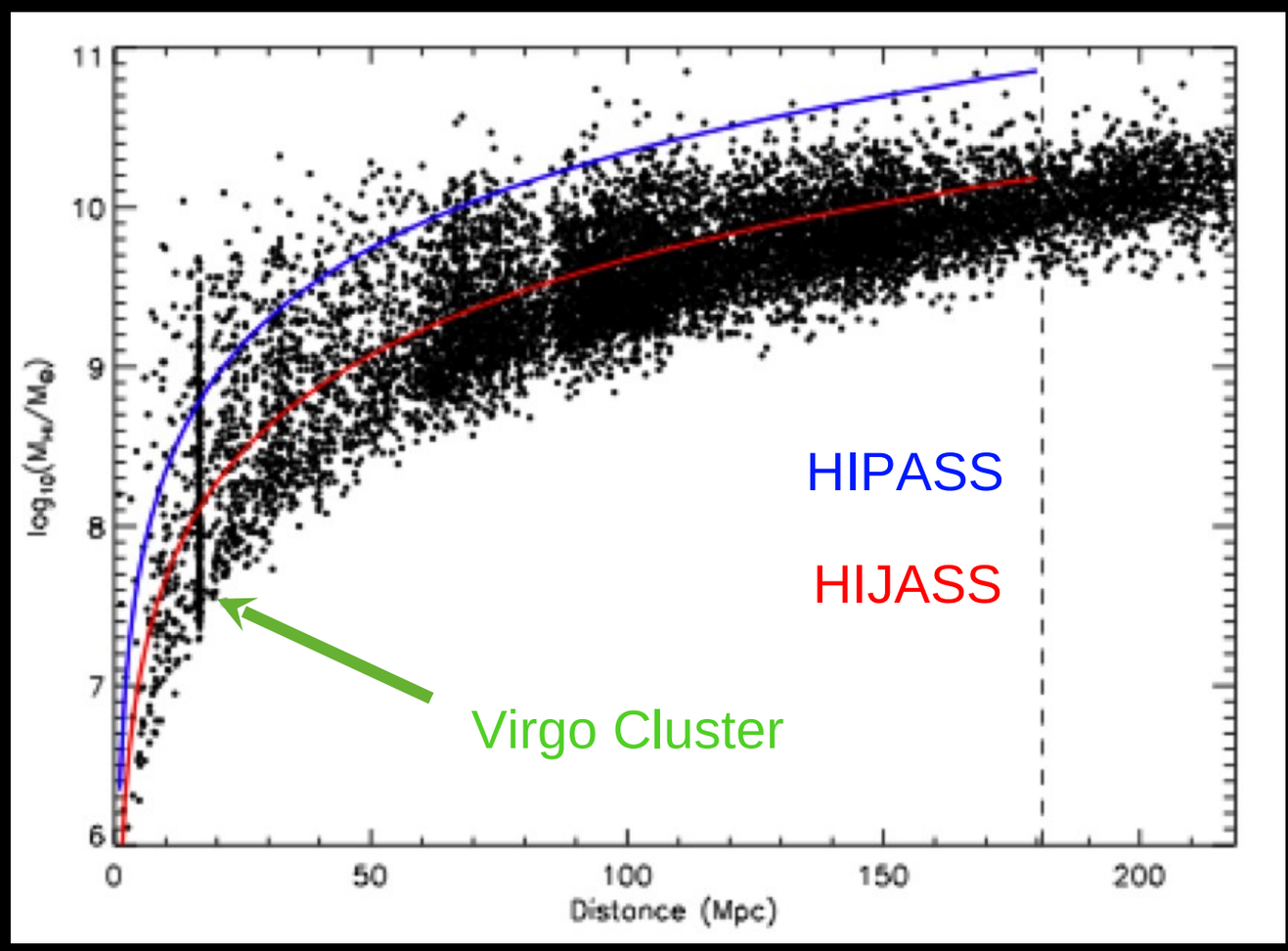
M31

X

M87

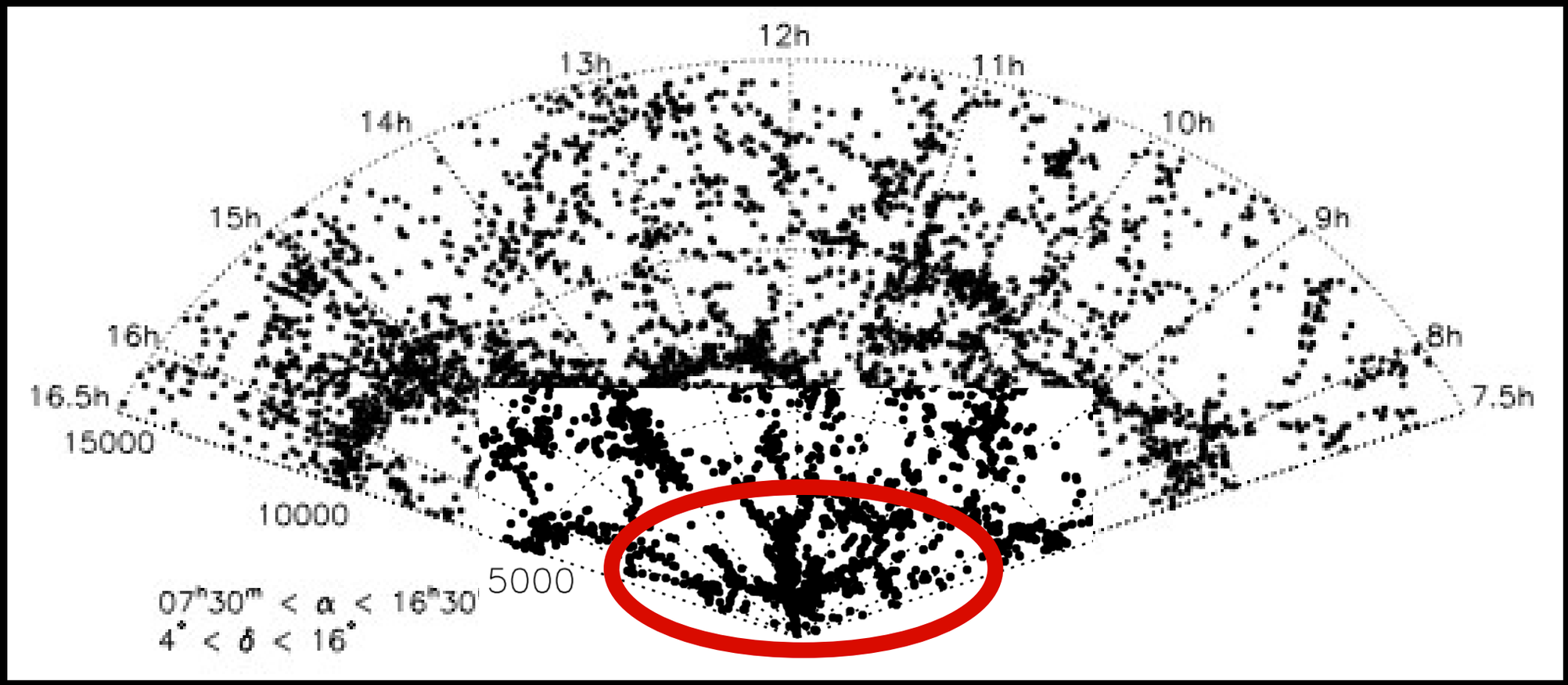
Arecibo Legacy Fast ALFA (ALFALFA)

- blind survey of ~ 7000 deg^2 0^o + 36^0 at 21 cm (Giovanelli et al. 2005)
- Velocity range: -1600 ÷ 18000 [km s^{-1}]
- approx 20000 galaxies detected
- **sensitivity (typical 2 mJy/10km/s channel) 8 times HIJASS and HIPASS**
- **signal-to-noise limited survey - (not flux limited)**



Martin et al. (2010)

Hα[3]: follow-up of ALFALFA



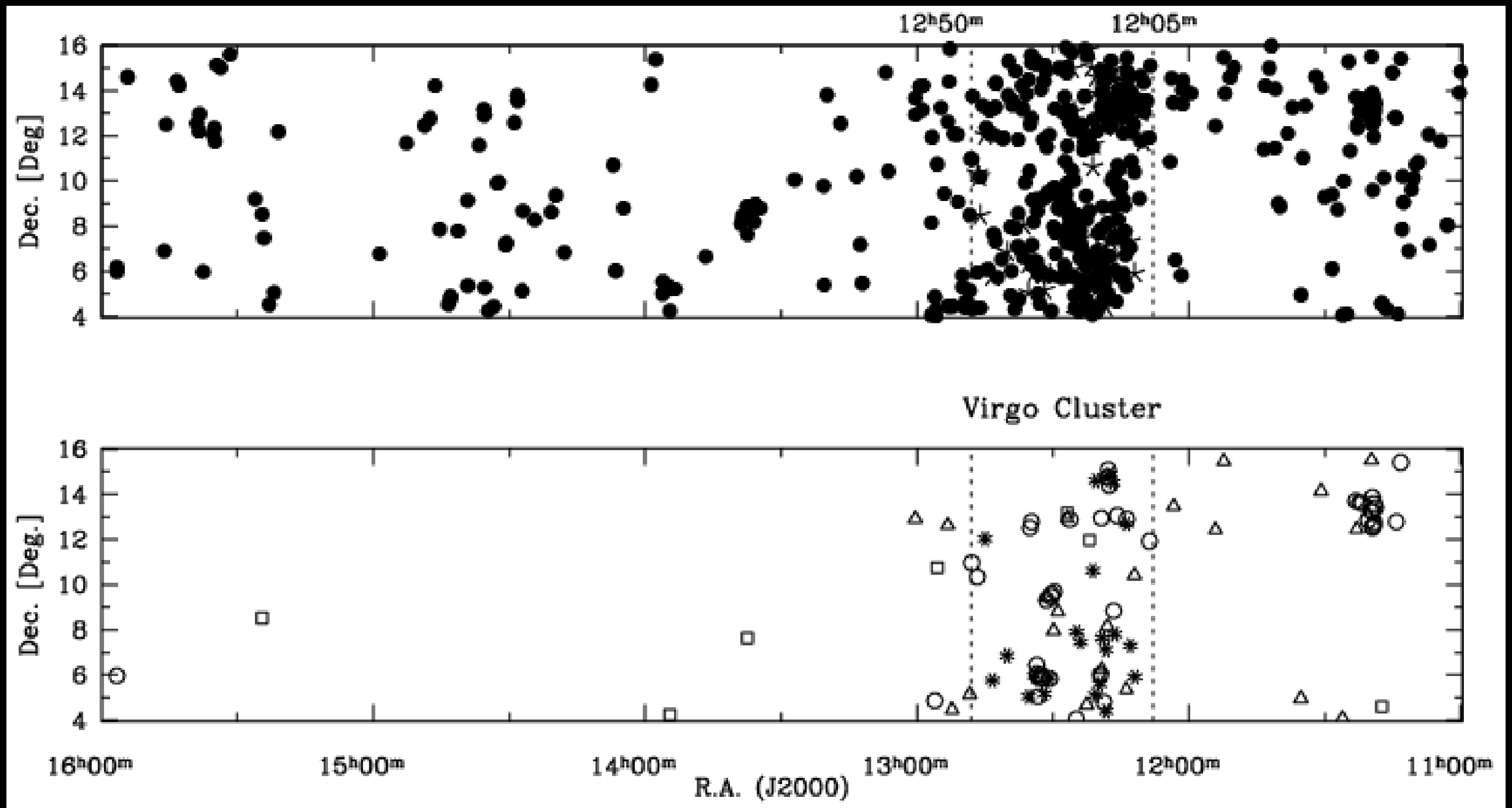
Martin et al. (2010)

Hα[3] maps ~ 900 deg[2] of the N spring sky containing 509 HI objects in:

- $11^h00^m \leq$ R.A. $\leq 16^h00^m$; $04^o \leq$ DEC $\leq 16^o$ (including Virgo)
- $350 \leq zc \leq 2000$ km s^{-1} outside Virgo < 3000 km s^{-1} in Virgo
- SintP > 0.7 mJy km s^{-1}

Hα[3]: follow-up of ALFALFA

411/509 observed (~ 81%); 363/411 (~ 88%) detected in Hα

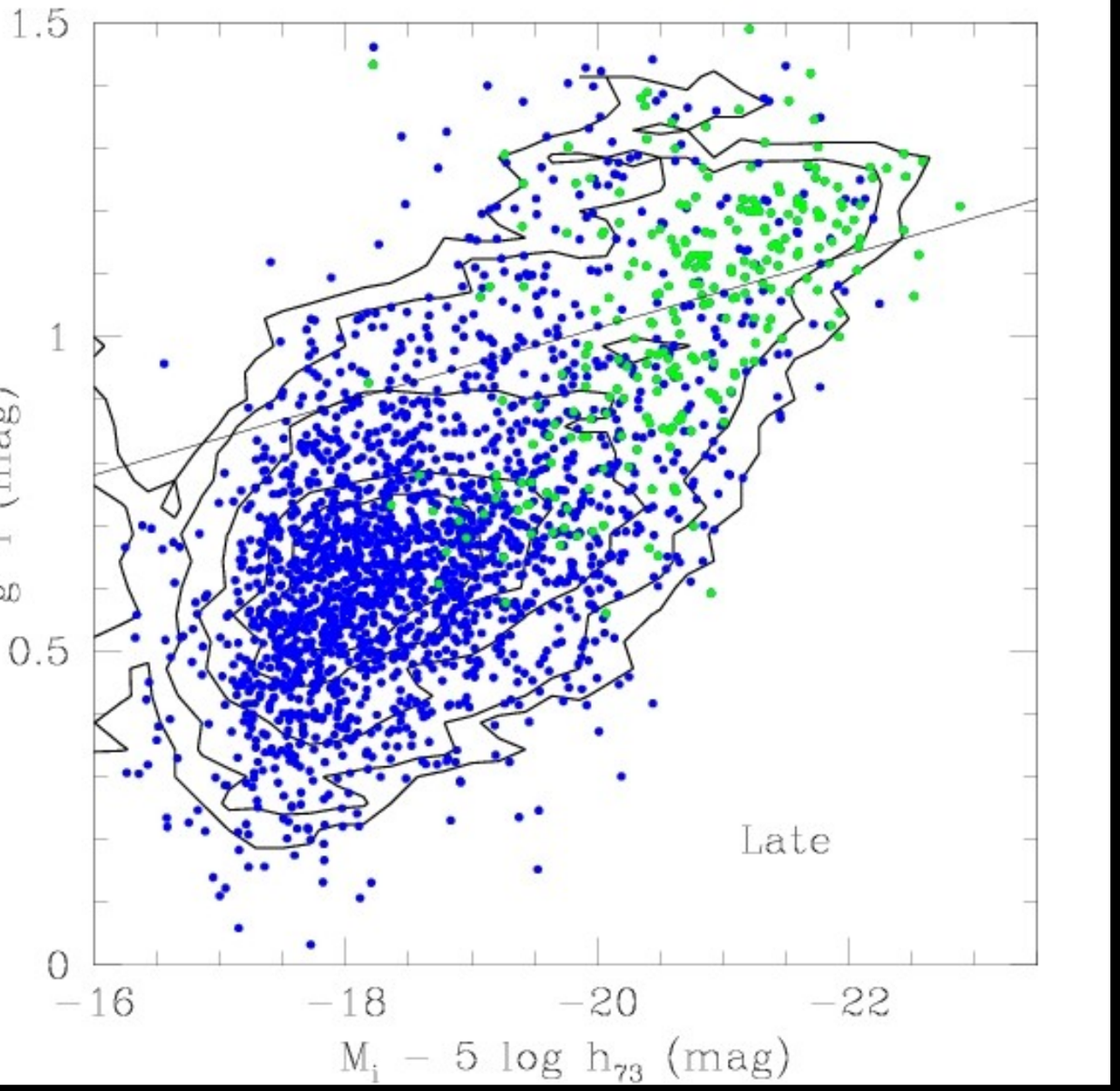


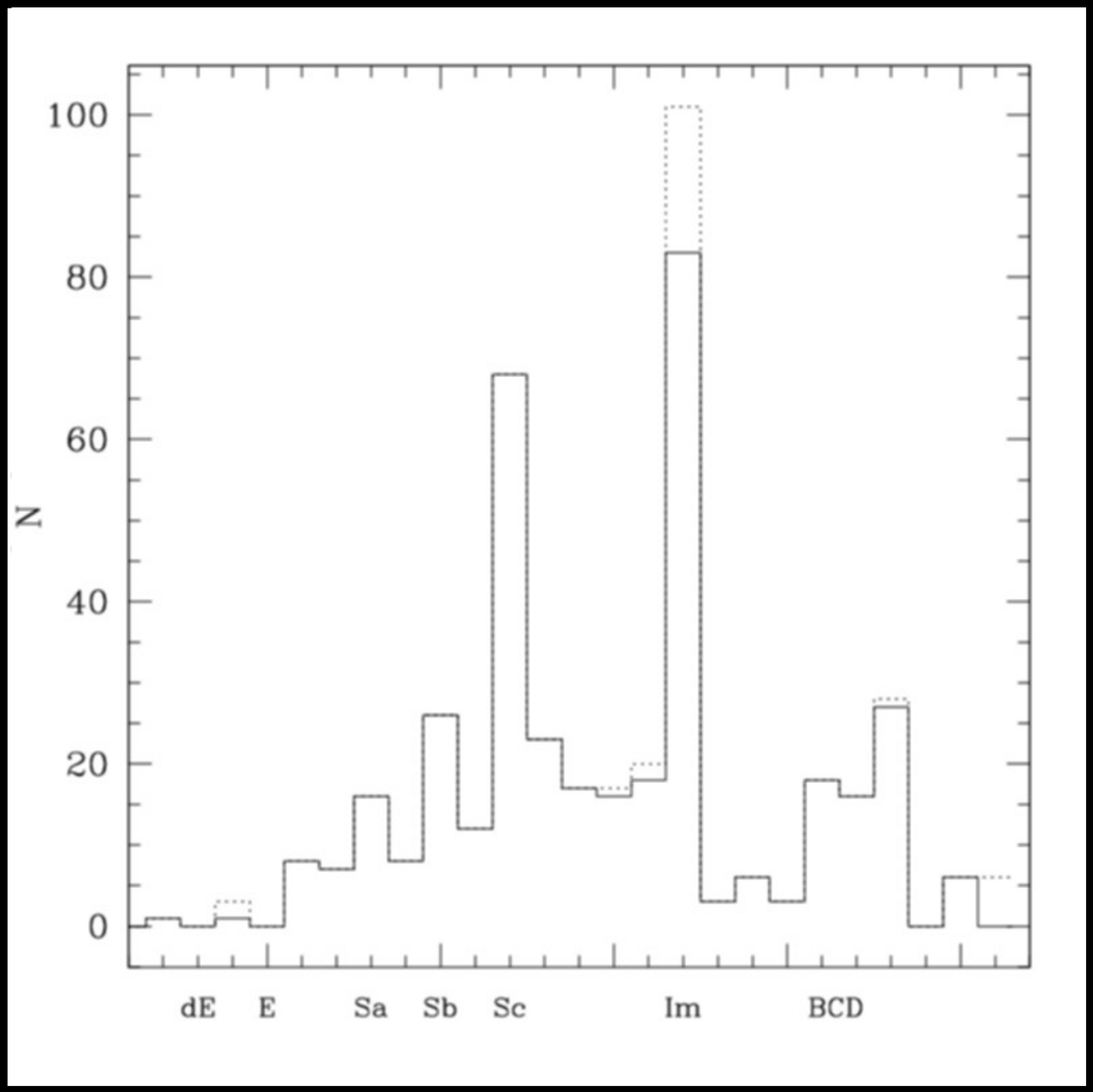
98 not observed targets because:

- 46 *dark galaxies* (Kent et al. 2007)
- 23 SintP < 0.7 mJy km s^{-1}
- 5 near stars ; 3 out velocity range; 21 not yet observed

Selection

optical vs. Radio





dominated by late-type:

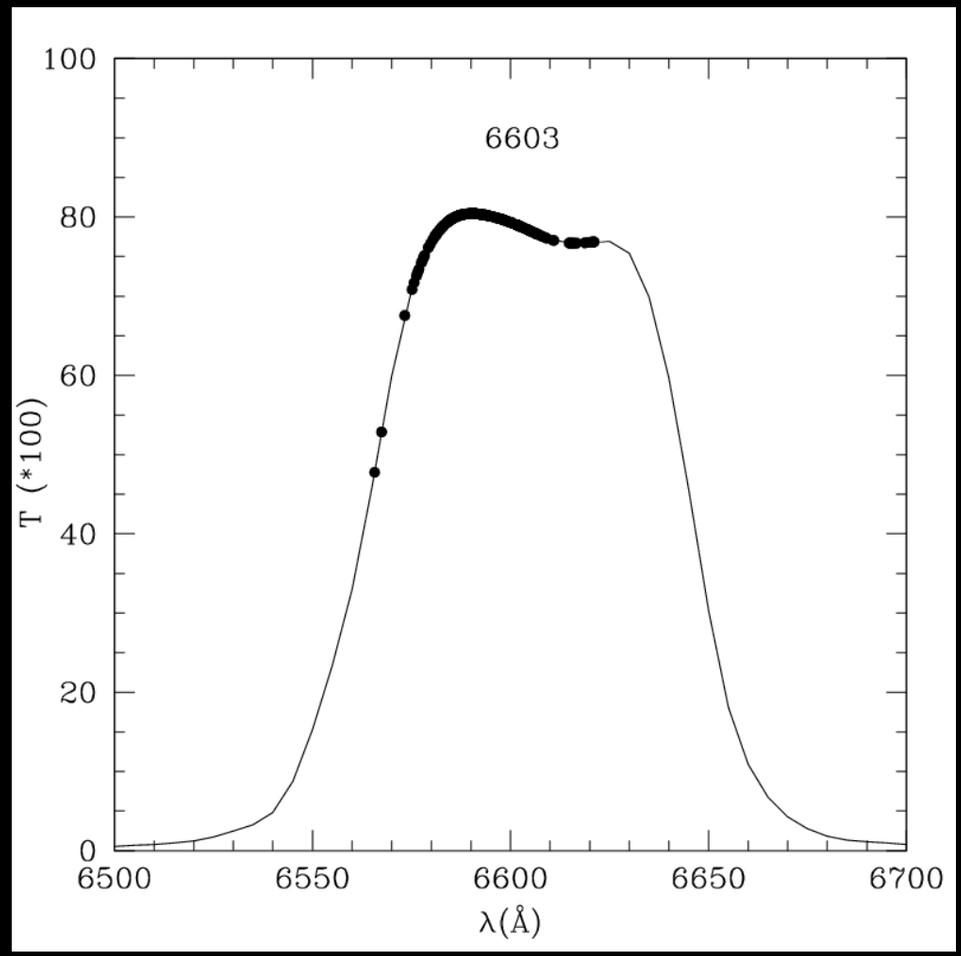
E-S0: 30/509, ~ 6%

Sa-Sm: 190/509, ~ 37%

Irr-BCD: 289/509, ~ 57%

Hα³ Observations

- San Pedro Martir (Mx) telescope (2006 - 2009)
- narrow-band Imaging.



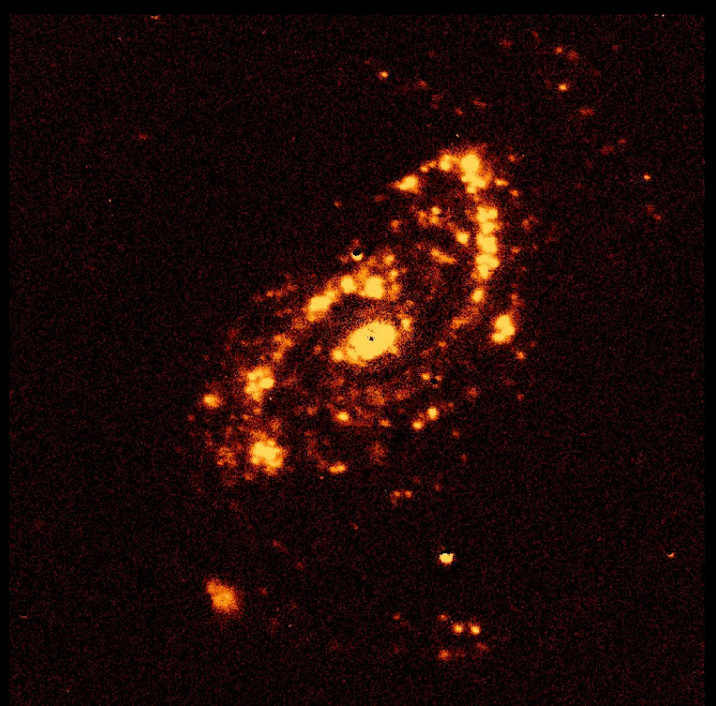
stellar continuum (OFF):

r (Gunn), Δλ ~ 1000 Å

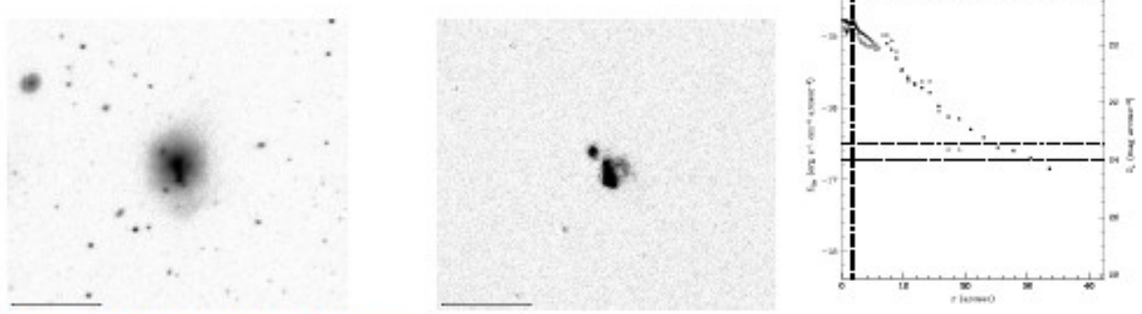
Hα (ON):

λ_c = 6603 Å, Δλ ~ 80 Å

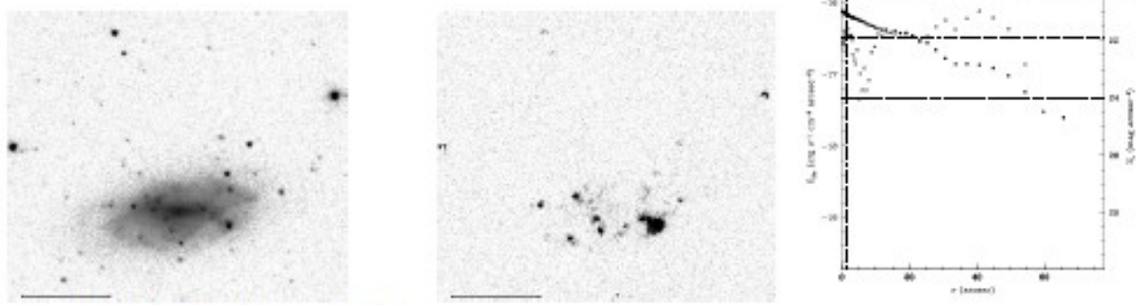
NET = ON - OFF



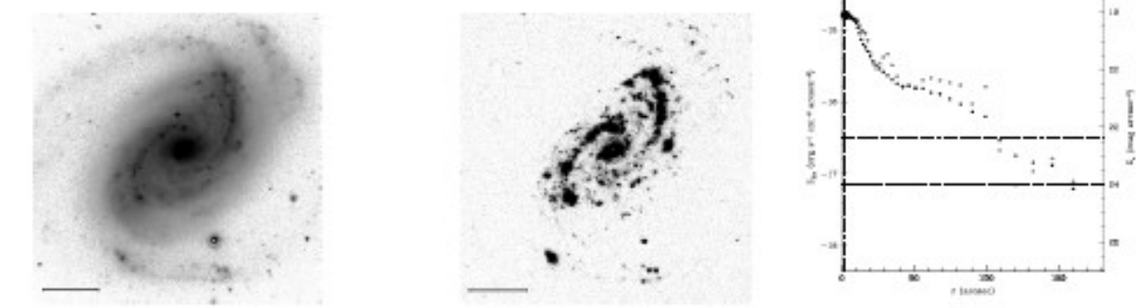
RA: 131652.1 DEC: 123254



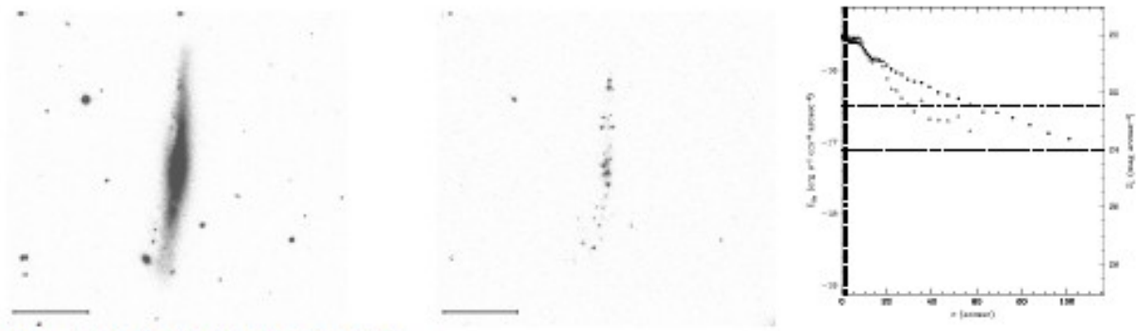
RA: 132038.1 DEC: 094714



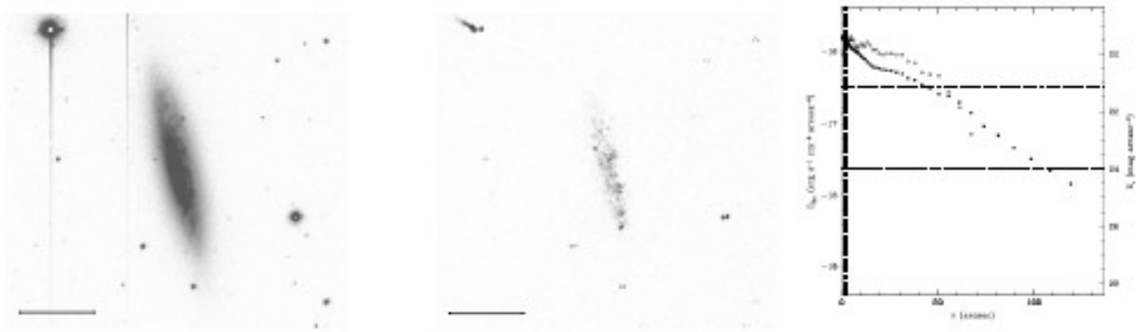
RA: 133732.1 DEC: 085306



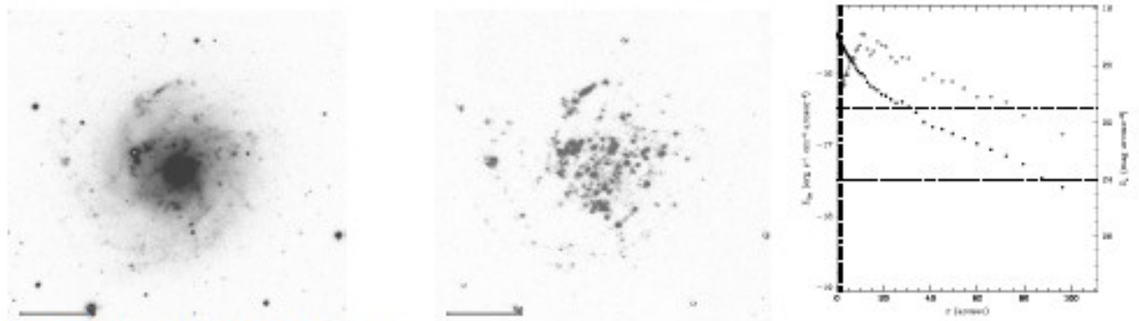
RA: 135411.2 DEC: 051336



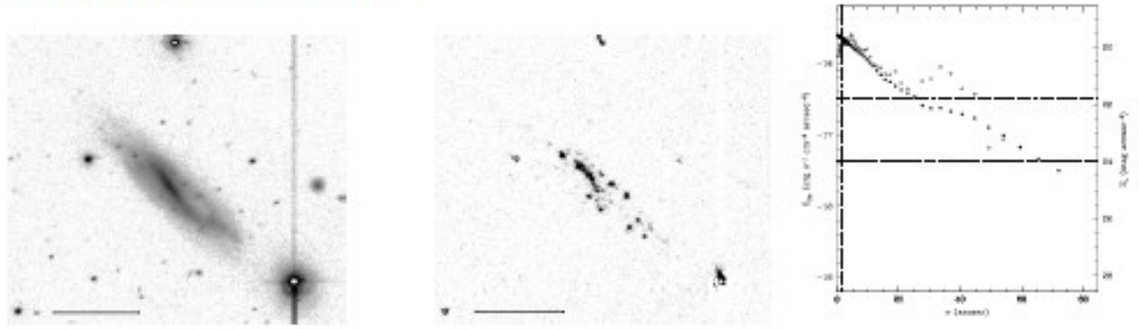
RA: 135458.4 DEC: 052000



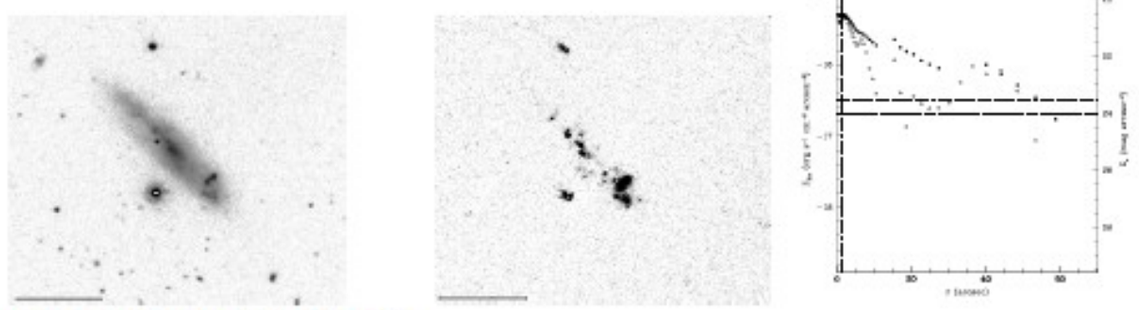
RA: 143324.3 DEC: 042700



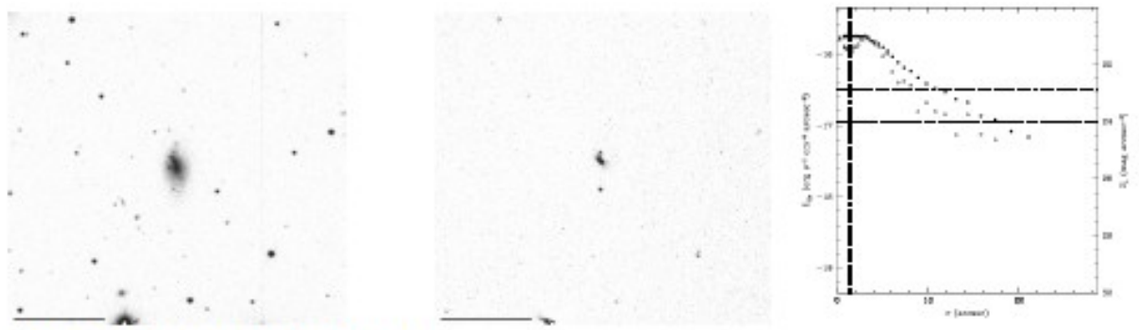
RA: 143533.2 DEC: 125427



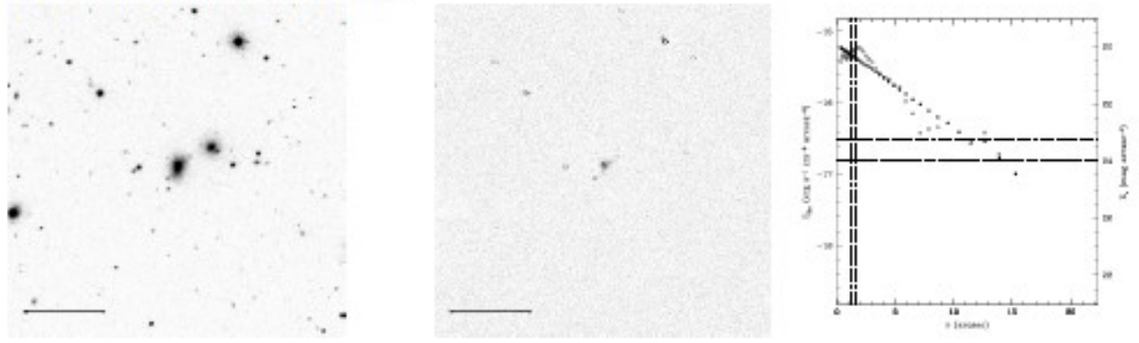
RA: 143539.9 DEC: 131012



RA: 143912.4 DEC: 090805



RA: 144119.2 DEC: 074735

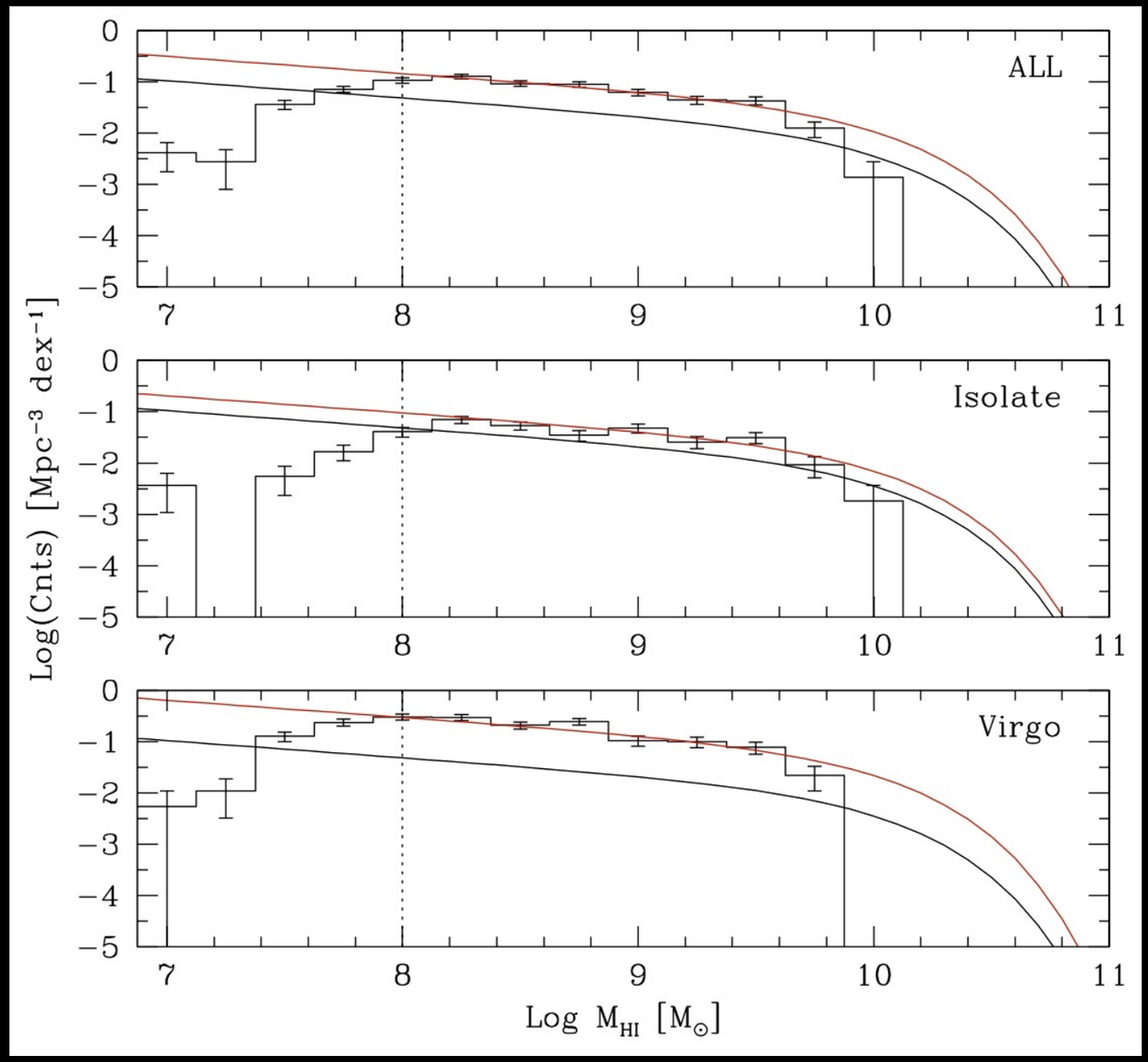


Hα³ : radio completeness

- overdensity All: 2.99
- overdensity isolated: 1.95
- overdensity Virgo: 6.01

Completeness:

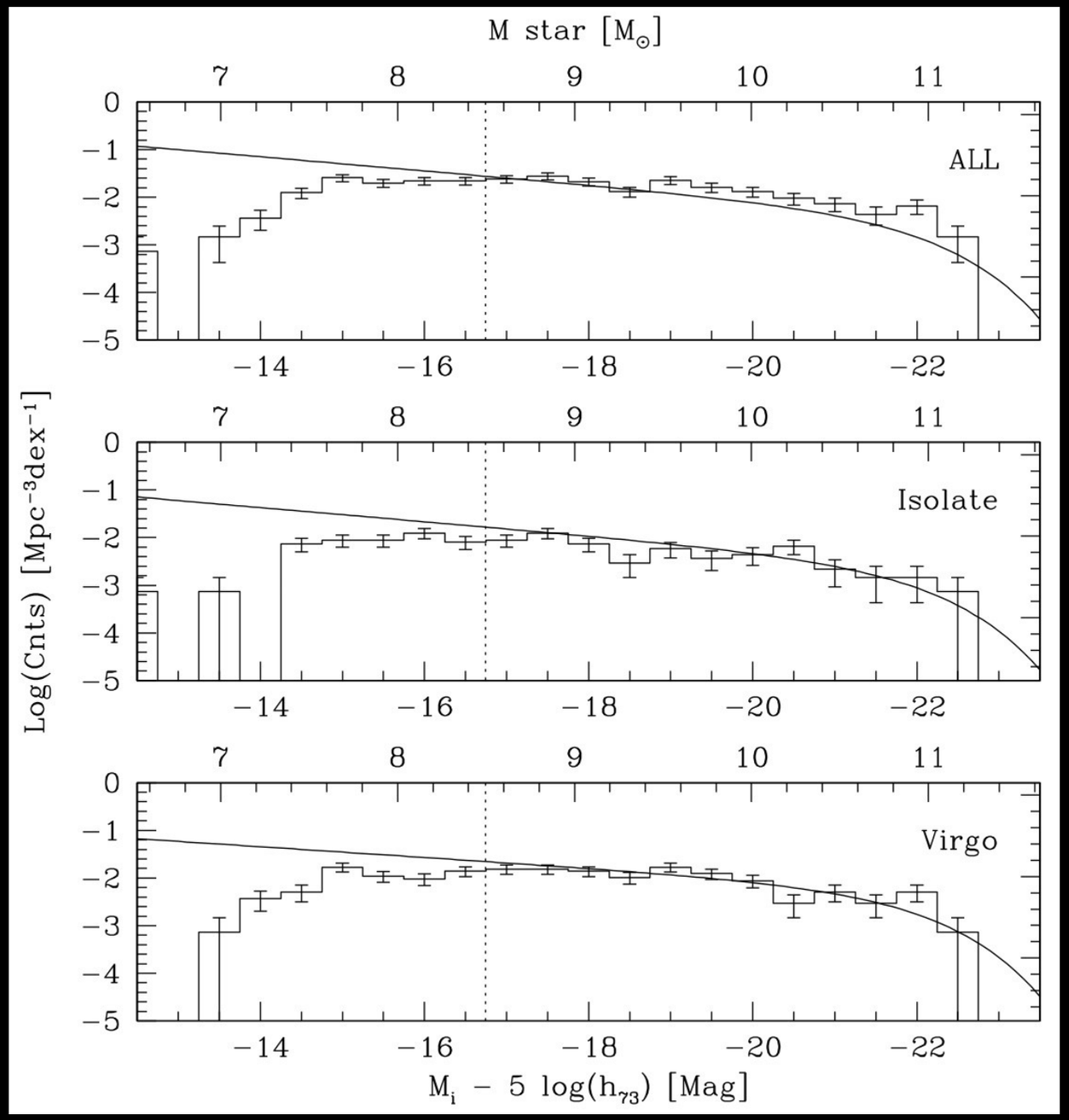
$$\log\left(\frac{M_{HI}}{M_{\odot}}\right) = 8.0$$



Hα³: optical completeness

Completeness:

$$Log\left(\frac{M_*}{M_\odot}\right) = 8.5$$

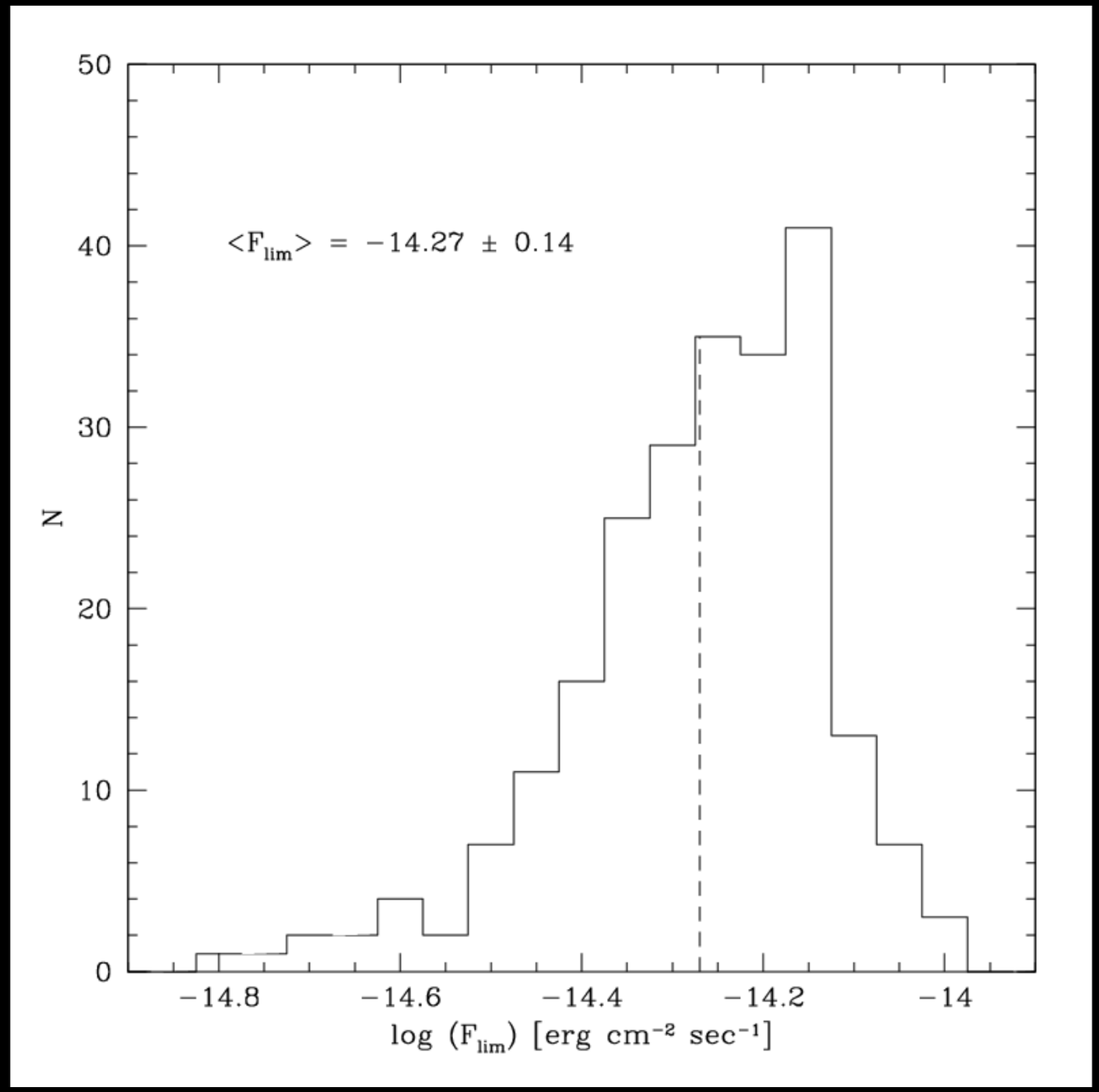


Hα³: Sensitivity

<log F_{lim}> = -14.27 ± 0.14 erg cm^{-2} s^{-1}(1σ)

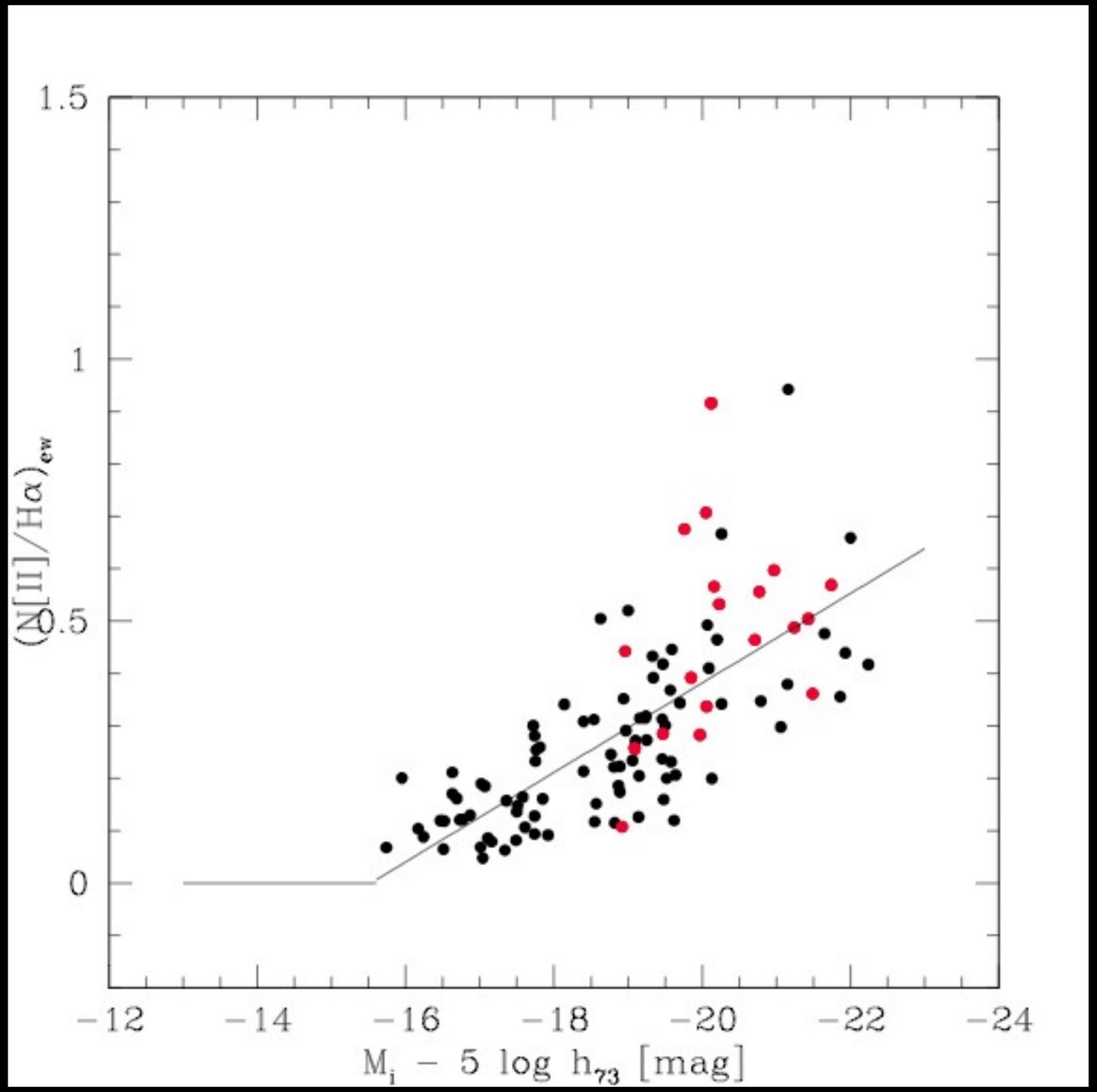
<SFR_{lim}> = 1.3x10^{-3} M_o yr^{-1}

at Virgo



Corrections to Hα flux : deblending from [NII]

- For 108/411 objects with d.s.spectra
- Empirical law:
- [NII]/Hα as function of absolute mag

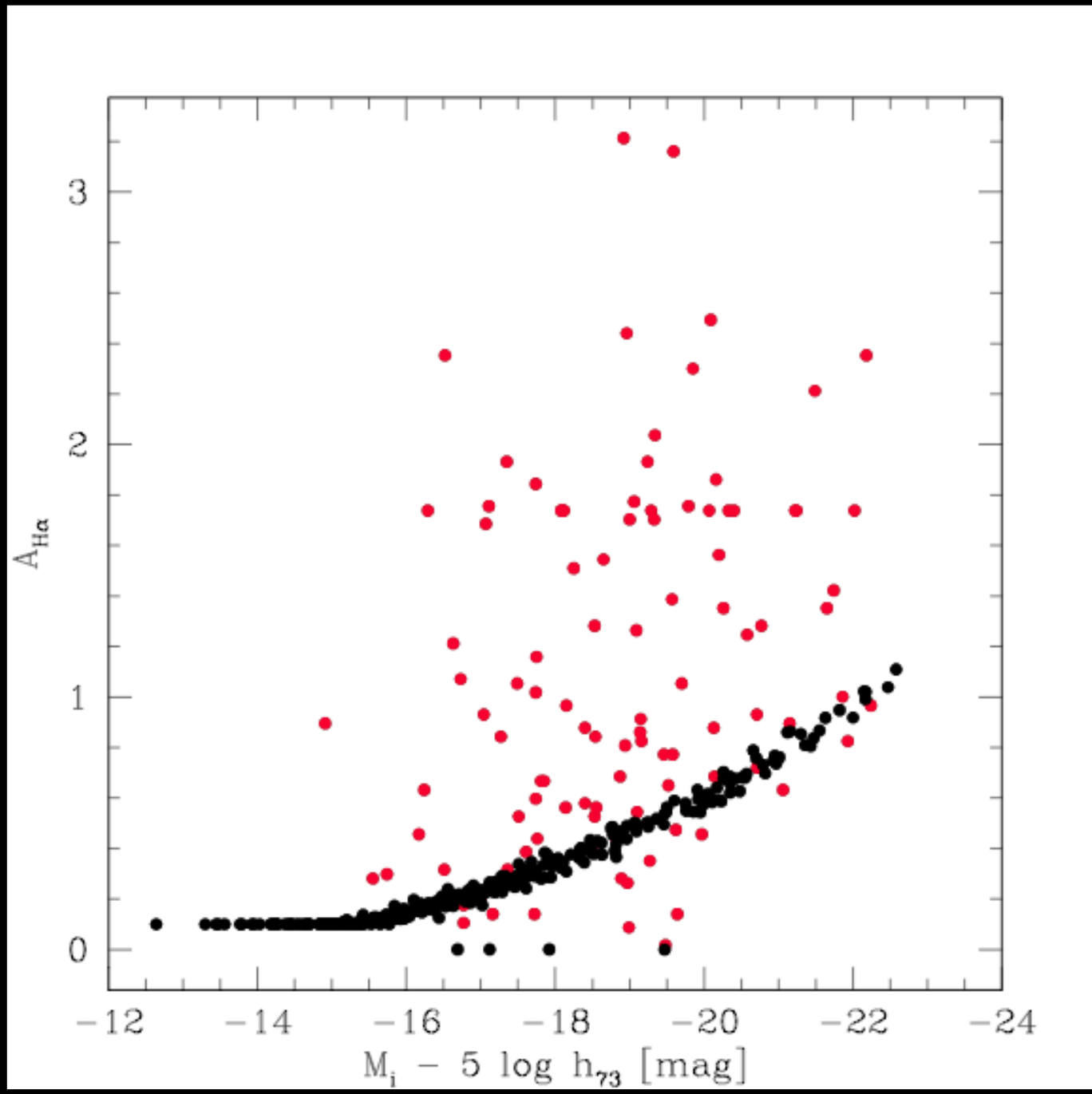


Corrections to Hα flux : internal extinction

For 108/411 objects with d.s.spectra
A(Hα) from Balmer decrement

Otherwise as Lee et al. (2009)

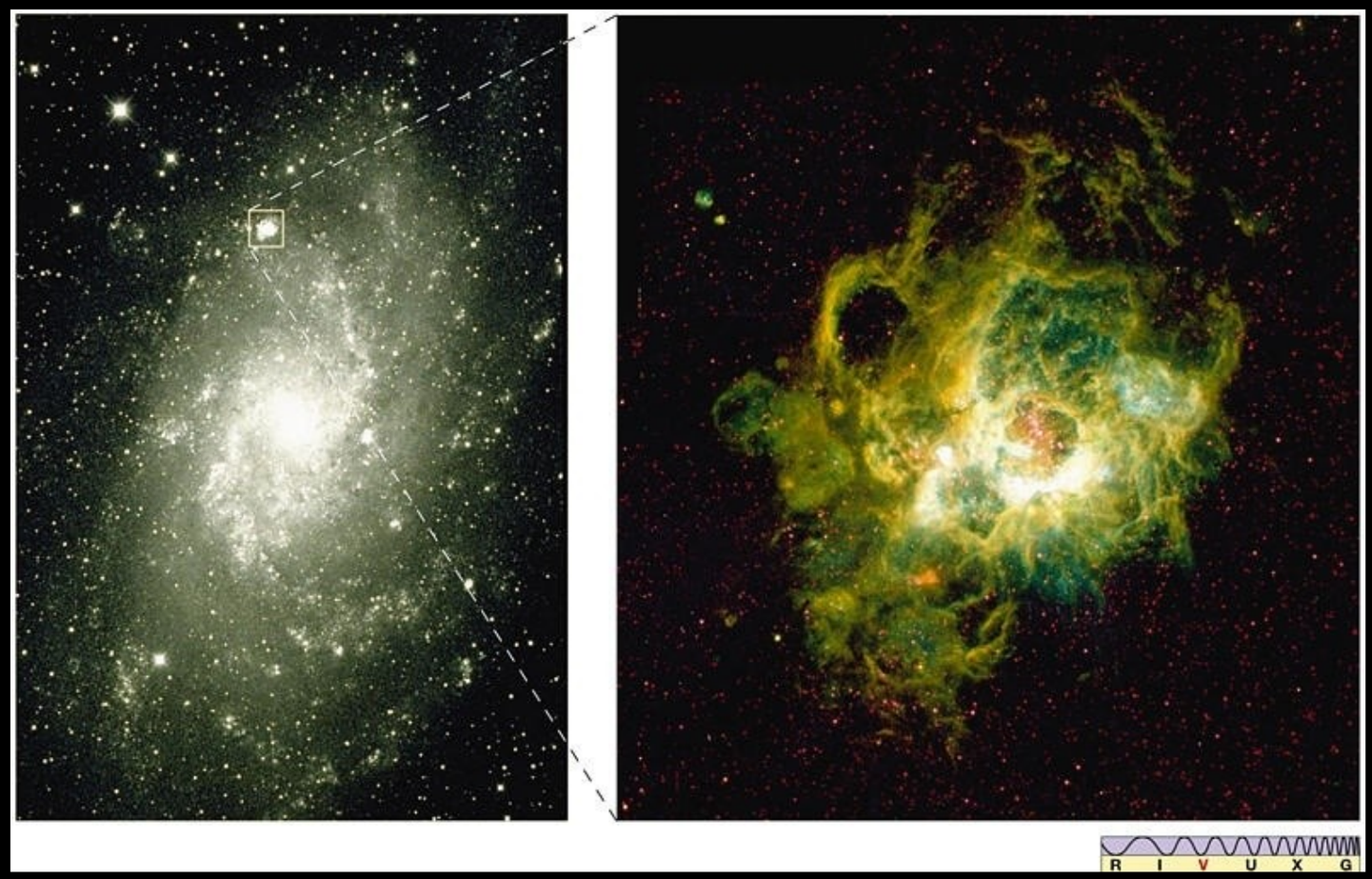
$$A(H\alpha)_{\rm Lee} = \begin{cases} 1.971 + 0.323 M_B + 0.0134 M_B^2 & \text{se } M_B \leq -14.5 \\ 0.10 & \text{se } M_B \geq -14.5. \end{cases}$$



Star formation rate

Once Hα is corrected for:
- contamination from [NII]
- internal extinction
- MW extinction

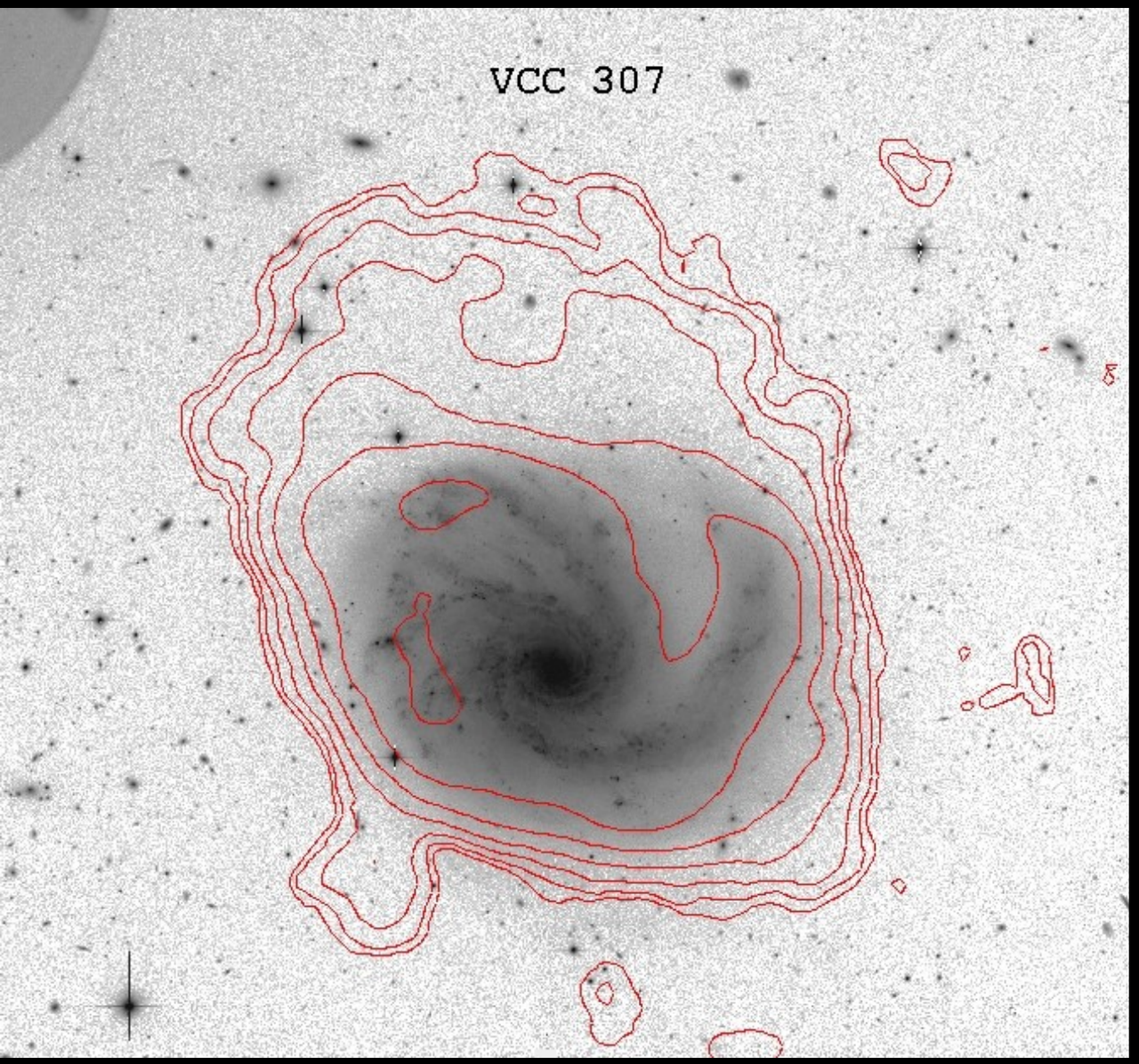
LHα can be converted into SFR of OB stars ($M > 8M_\odot$, $t < 4\times10^6$ yrs)

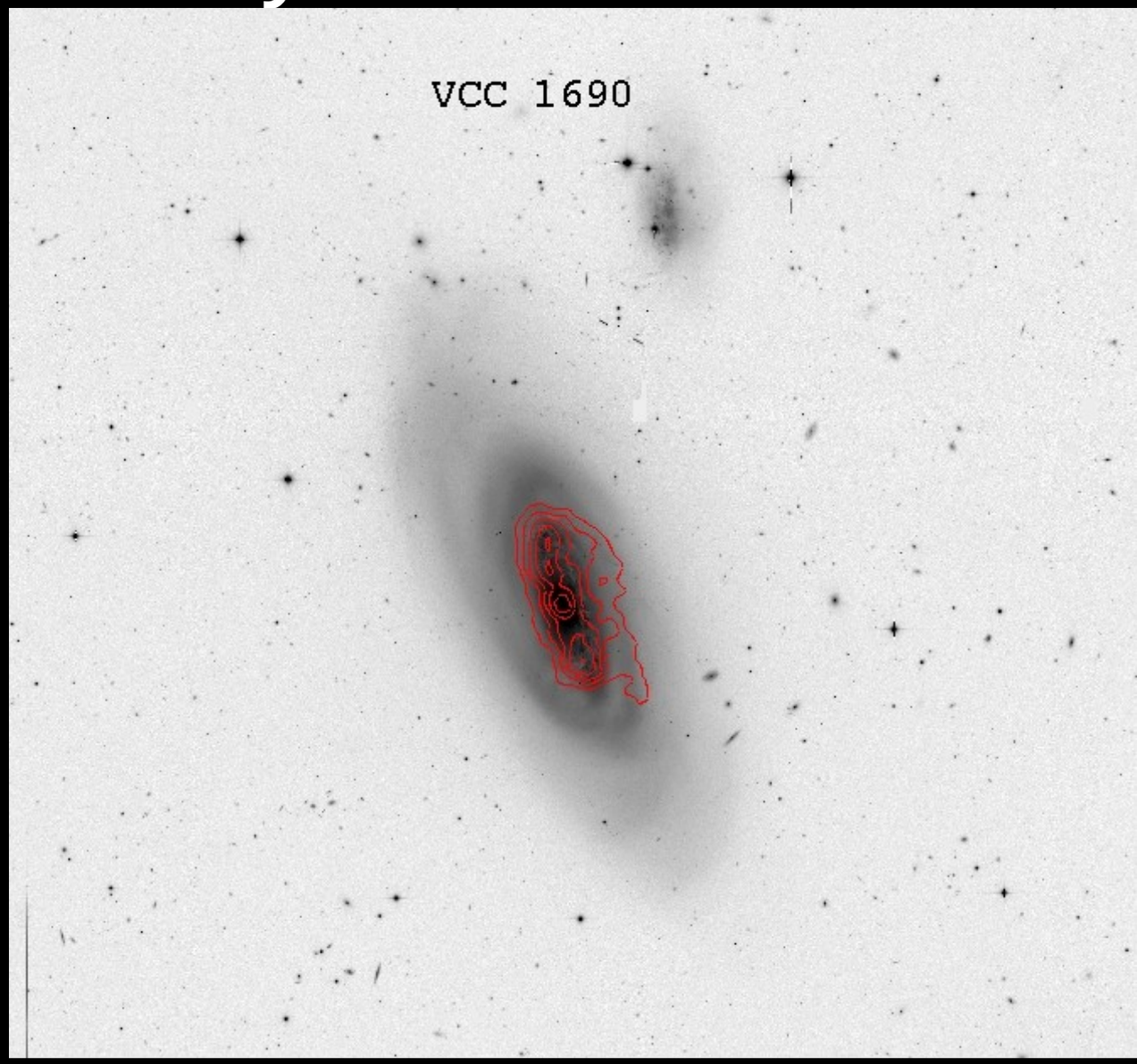


Kennicut (1998):

$$SFR\ [M_\odot\ yr^-1] = 7.93 \times 10^{-42}\ \left(\frac{L_{H\alpha}}{erg\ s^{-1}}\right).$$

HI deficiency





Def_{HI} = 0.09

Def_{HI} = 0.97

$$Def_{HI} = \langle \log M_{HI}(T^{obs}, D^{obs}_{opt}) \rangle - \log M^{obs}_{HI}$$

Haynes & Giovanelli 1984

umperturbed & deficient galaxies

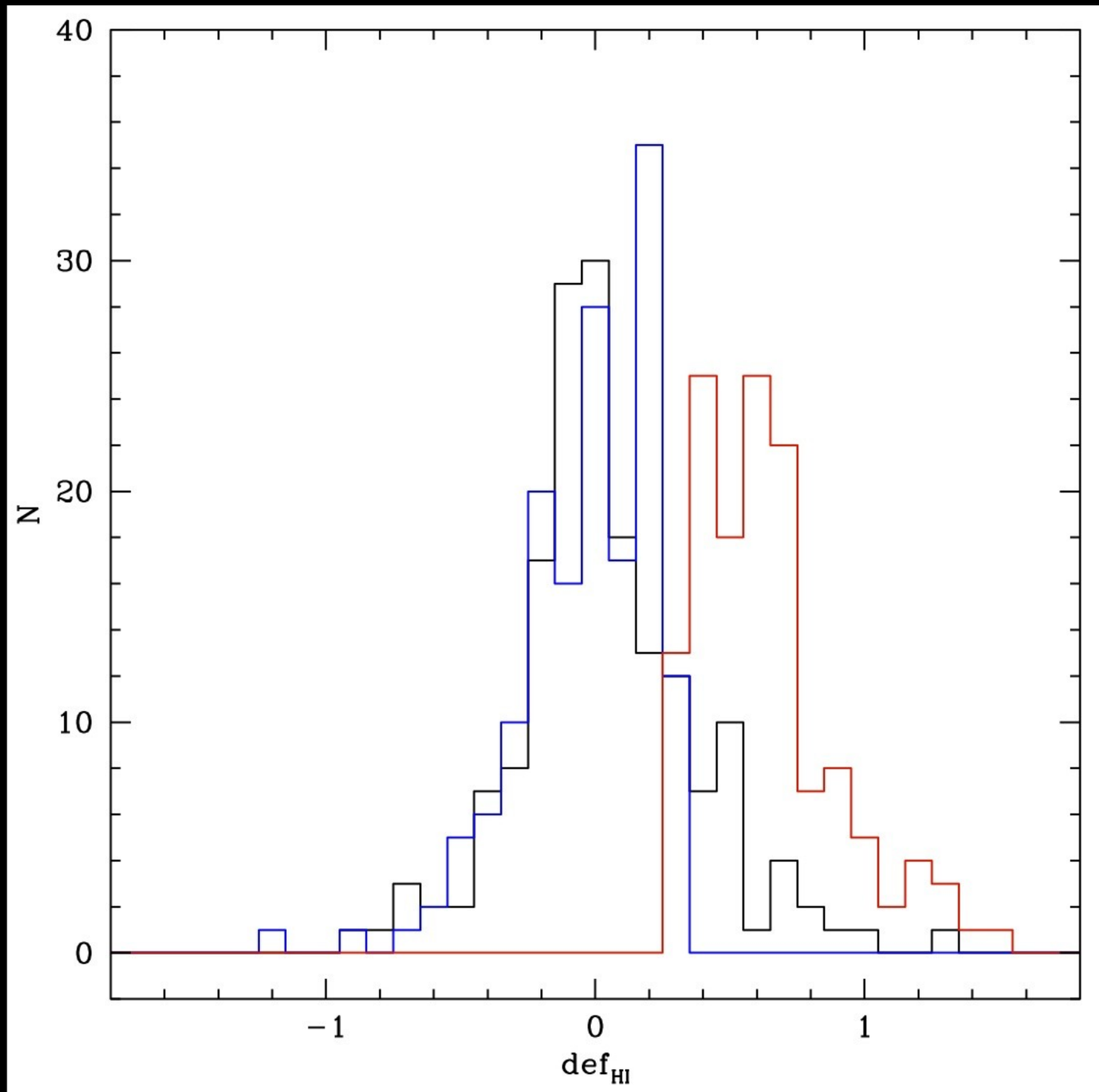
Isolated galaxies have null deficiency

$$\langle Def_{HI} \rangle^{iso} = 0.03 \pm 0.34$$

$$\langle Def_{HI} \rangle^{vir} = 0.28 \pm 0.42$$

Not all galaxies in Virgo are deficient

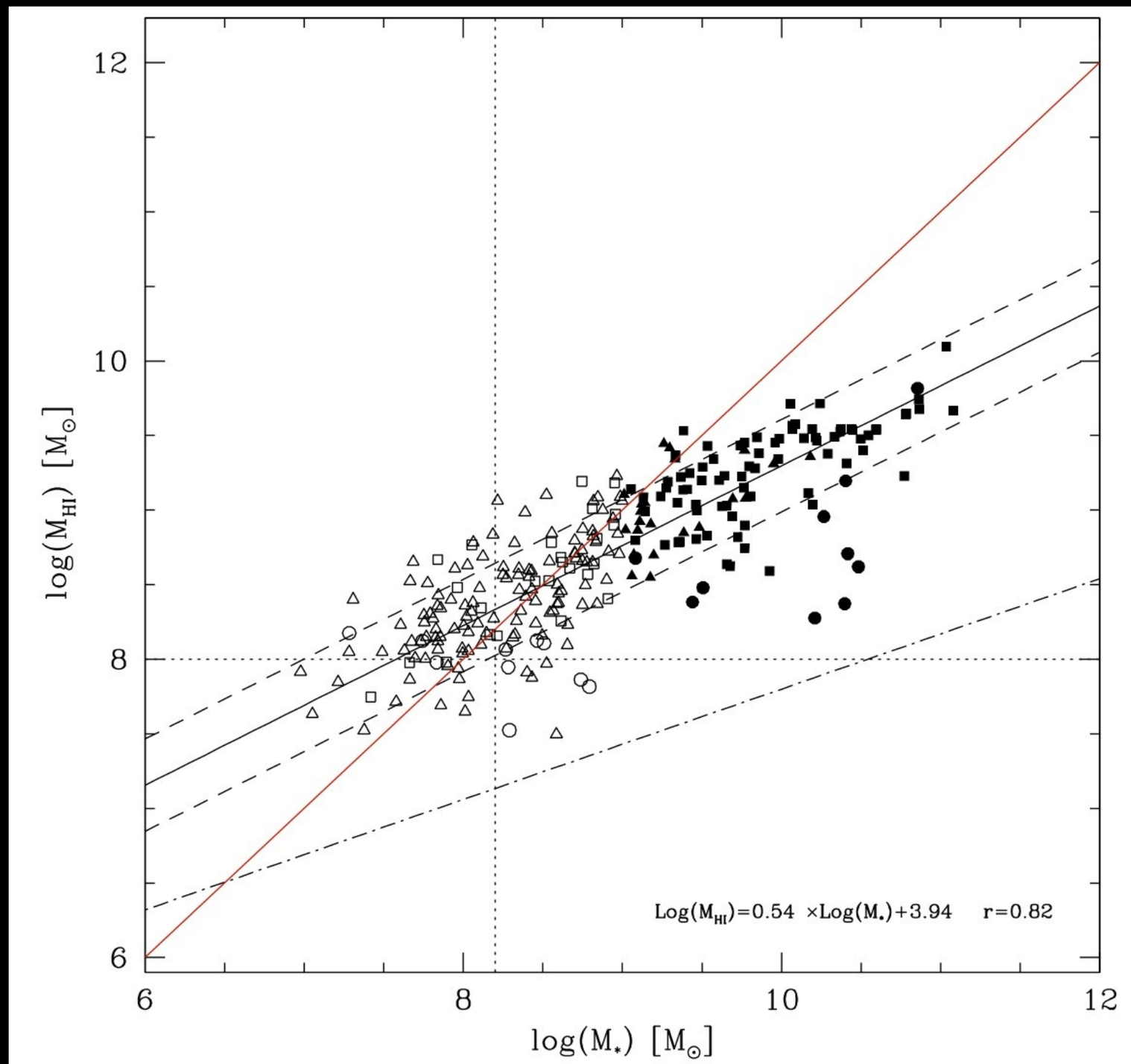
$$\langle Def_{HI} \rangle^{V_{ND}} = 0.03 \pm 0.25$$
$$\langle Def_{HI} \rangle^{V_D} = 0.63 \pm 0.26$$



Scaling Relations : Downsizing

HI mass increases less than Star mass

(umperturbed galaxies)



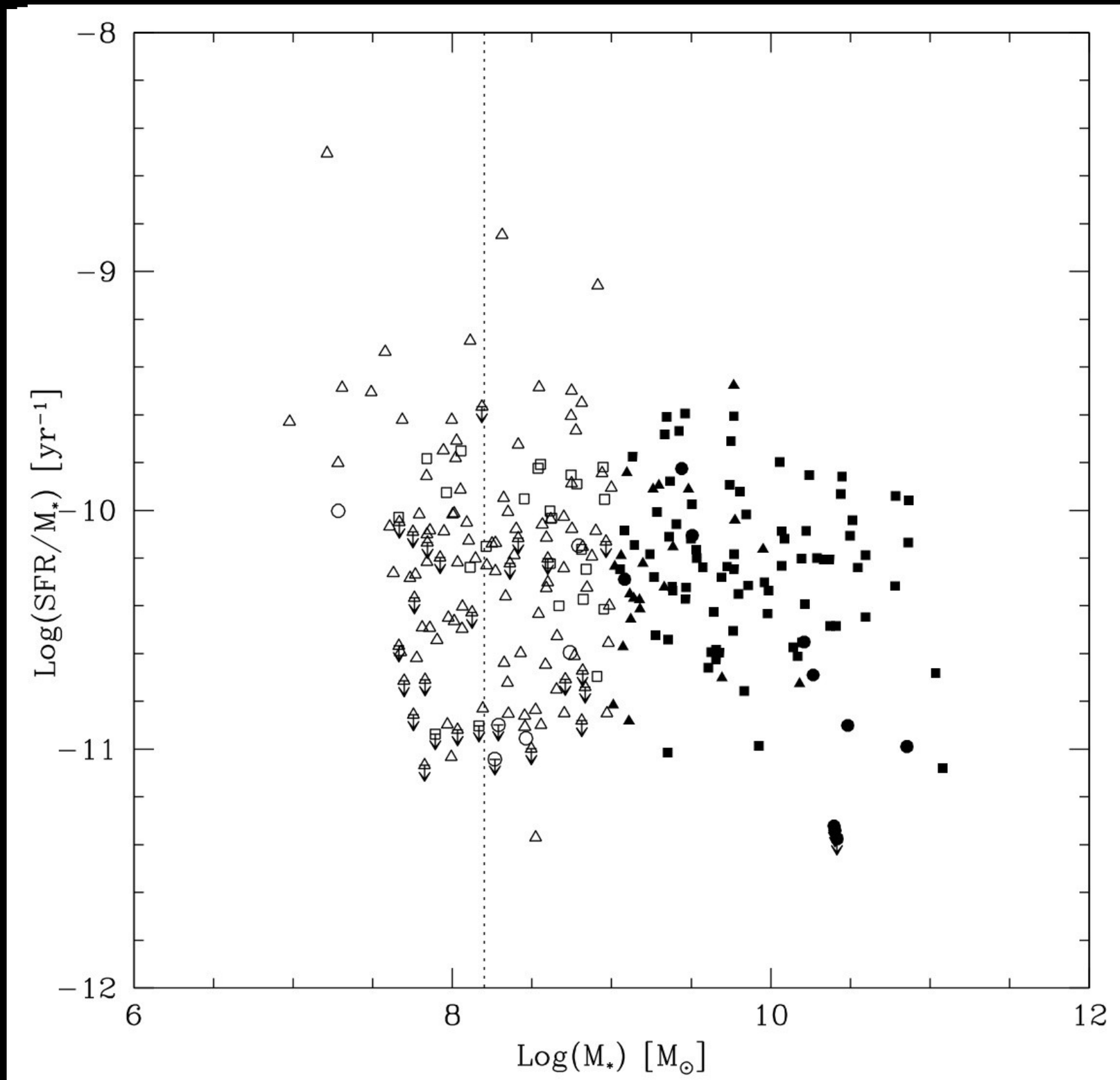
Downsizing

massive galaxies have < HI/stars

have constant SSFR

have residual lifetime less than Dwarf galaxies

(umperturbed galaxies)

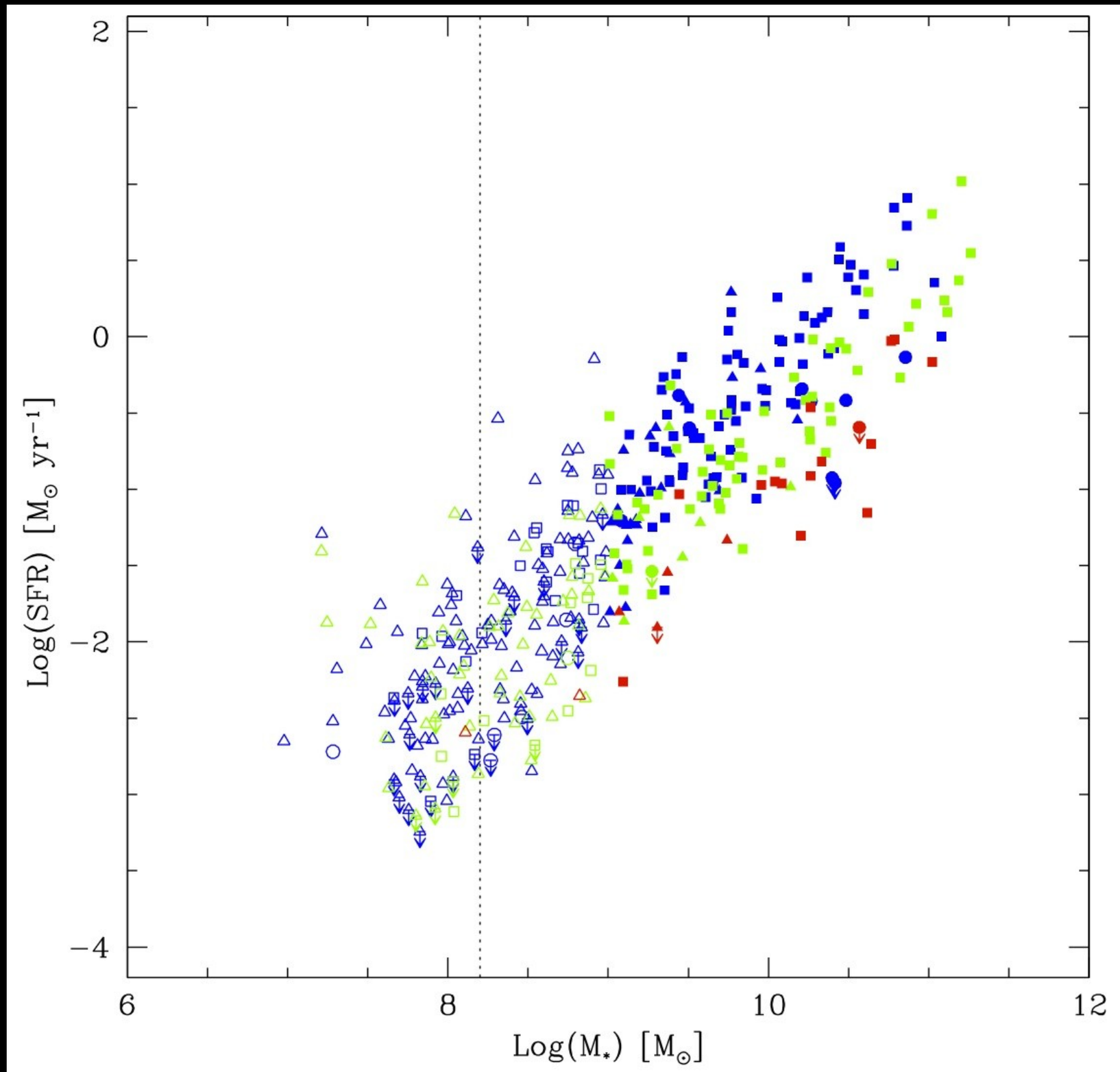


Environmental Effects

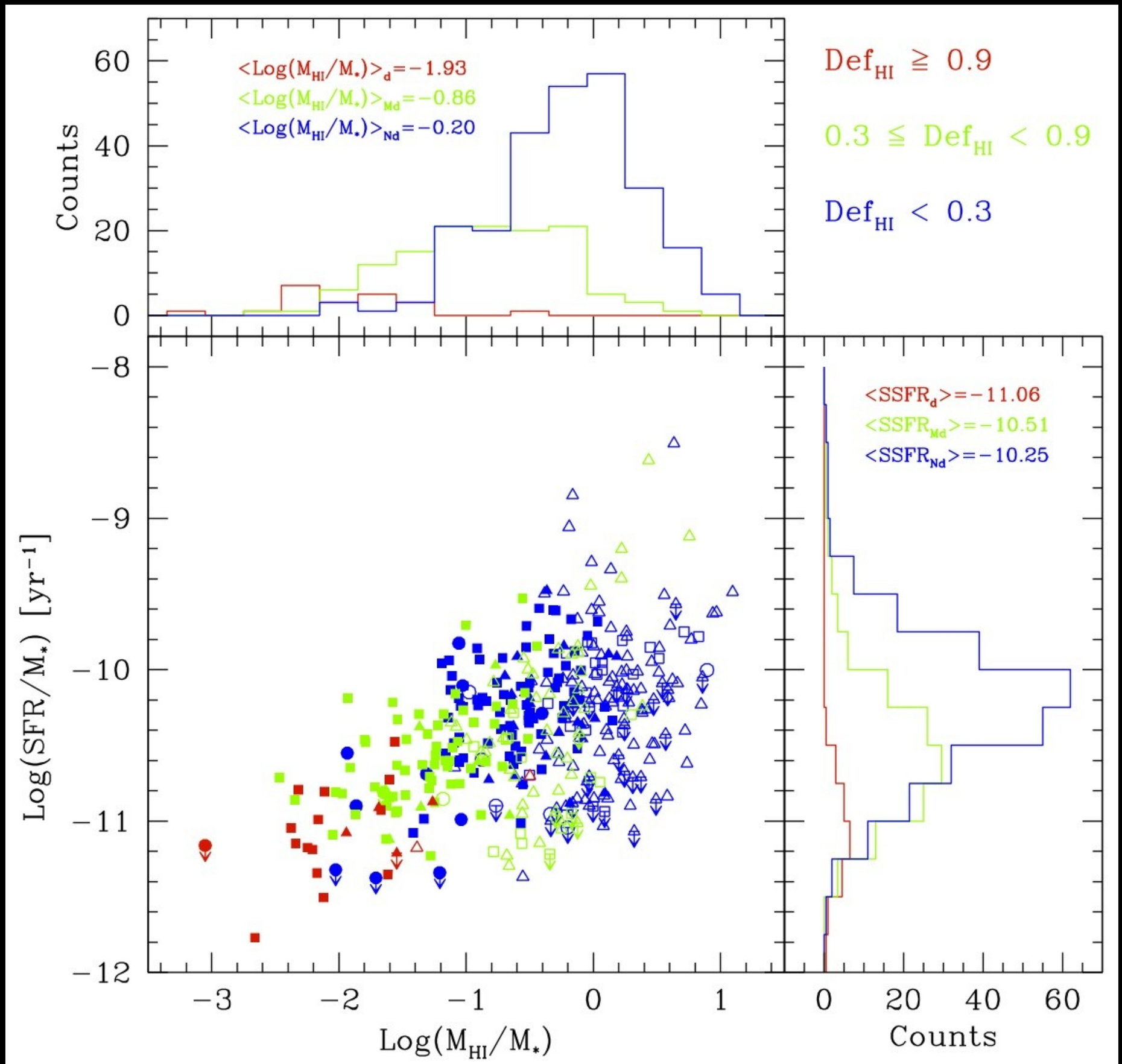
$Def_{HI} < 0.3$

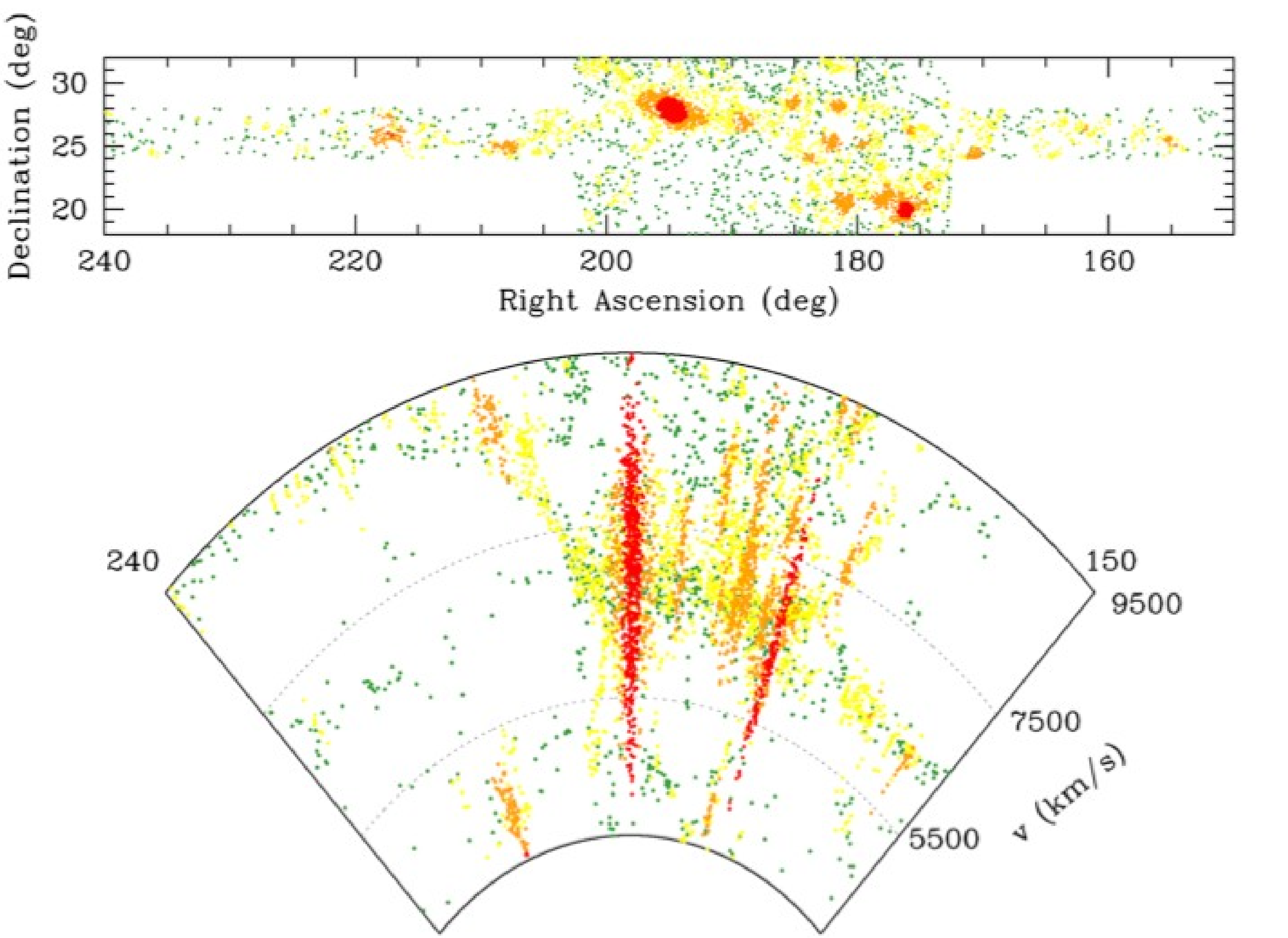
$0.3 \leq Def_{HI} < 0.9$

$Def_{HI} \geq 0.9$



Environmental Effects





Ongoing & Future plans

- Extend Hα^3 to the Coma supercluster

•(team expands to mex. collaborators L.Gutierrez & H. Hernandez)

Thank you