

# Quest for truly isolated galaxies

Noah Brosch  
Tel Aviv University



EL INGENIOSO  
HIDALGO DON QUI-  
XOTE DE LA MANCHA

*Compuesto por Miguel de Cervantes  
Saavedra.*

DIRIGIDO AL DUQUE DE BEJAR,  
Marques de Gibraleon, Conde de Barcelona, y Banar-  
res, Vizconde de la Puebla de Alcozer, Señor de  
las villas de Capilla, Curiel, y  
Burgillos.

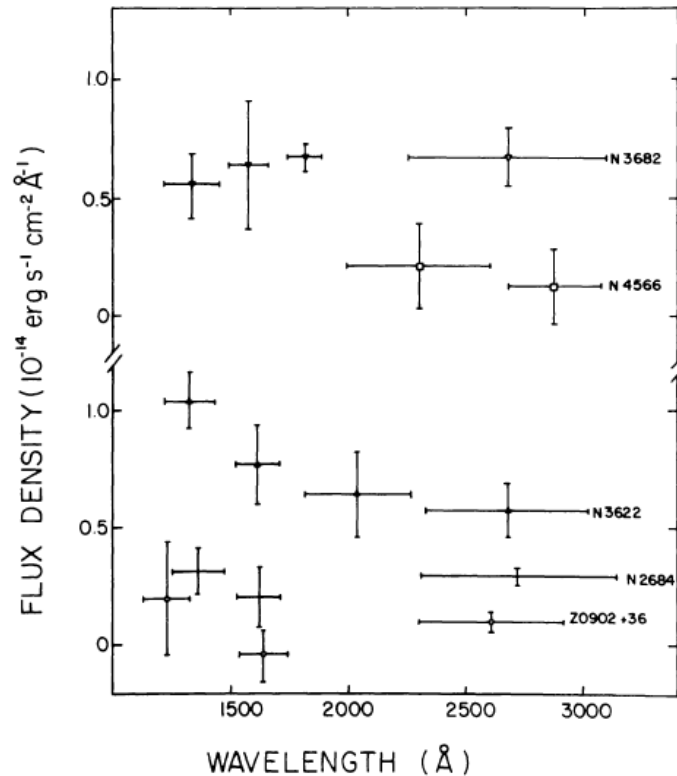


Ano,

1605.

Con priuilegio de Castilla, Aragon, y Portugal.  
EN MADRID, Por Iuan de la Cuesta.  
Vendese en casa de Francisco de Robles, librero del Rey nro señor.

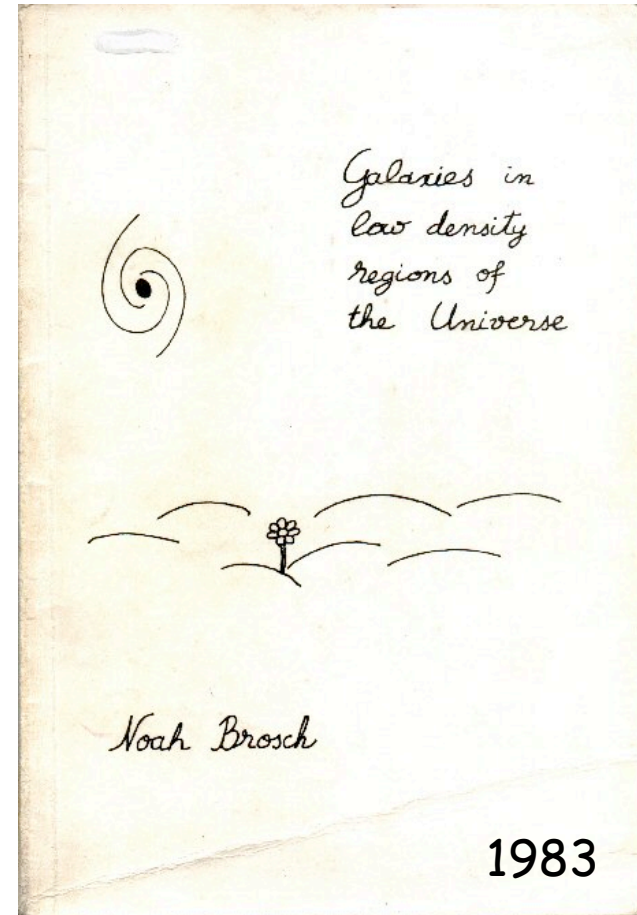
# Isolated galaxies I



Studied for Leiden U. PhD thesis:

- Multiaperture photometry (UBV)
- NIR m-ap photometry (JKL, N=6)
- 5GHz WSRT
- UV spectra of nuclei (IUE)

**Conclusion: "nuclear" SF burst**



Huchra & Thuan (1977) N=12 sample

- No companion  $m < 15.7$  within 45'
- Not in any deV groups
- HI rich (Balkowsky & Chamaraux 1981)





# What is an isolated galaxy?

Idea is to avoid possibility of external interaction.  
Karachentseva criterion  
Relevant parameters: masses, distances, velocities.  
looks for "significant"

optical neighbors

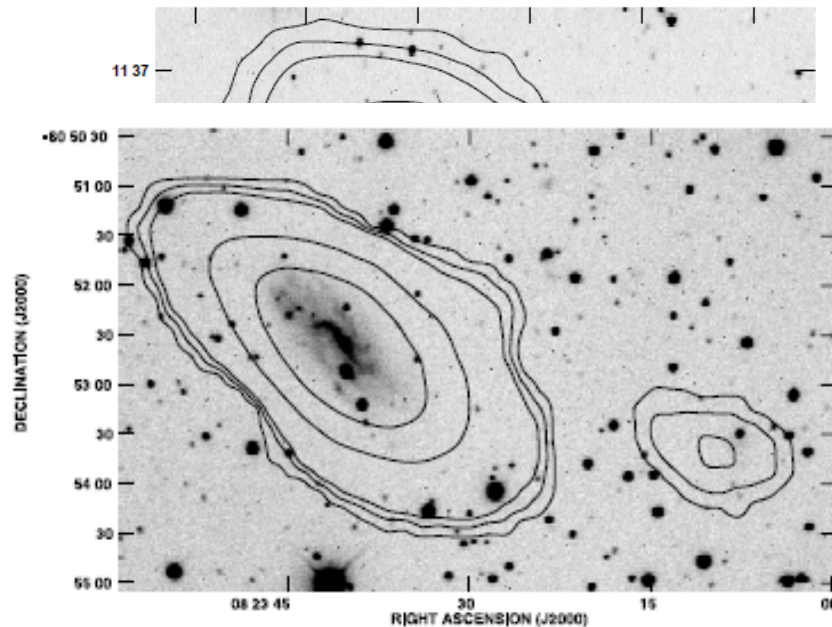
Di Matteo et al. (2008): "...at low redshift, galaxy interactions and mergers trigger only moderate SF enhancements. Strong starbursts where SF rate is increased by 5x+ are rare and found only in ~15% of major galaxy interactions and mergers. Merger-driven starbursts are short-lived, with a typical duration of activity of a few 100 Myr".

However, what if one wants "really isolated" objects?

Pisano et al. (2002, "AN HI/OPTICAL ATLAS OF ISOLATED GALAXIES"):

- Objects from "Nearby Galaxies Catalog"
- Average density of  $M(B) < -16$  galaxies less than  $0.1/\text{Mpc}^3$
- Quiescent (no S or SB)
- $|b| > 10^\circ$
- $N=41$  observed with ATCA &/or VLA

**NB: quest for truly isolated galaxies**



UGC 260:

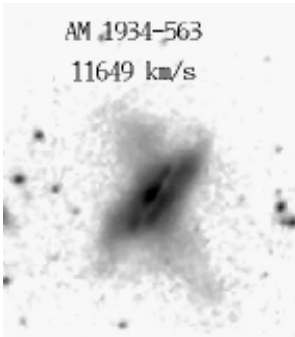
Warp, gas-rich companion  
is this galaxy "isolated"?

ESO 124-15(+B):

Vfaint gas-rich optical companion  
is this galaxy "isolated"?



Optically isolated  $\neq$  really isolated



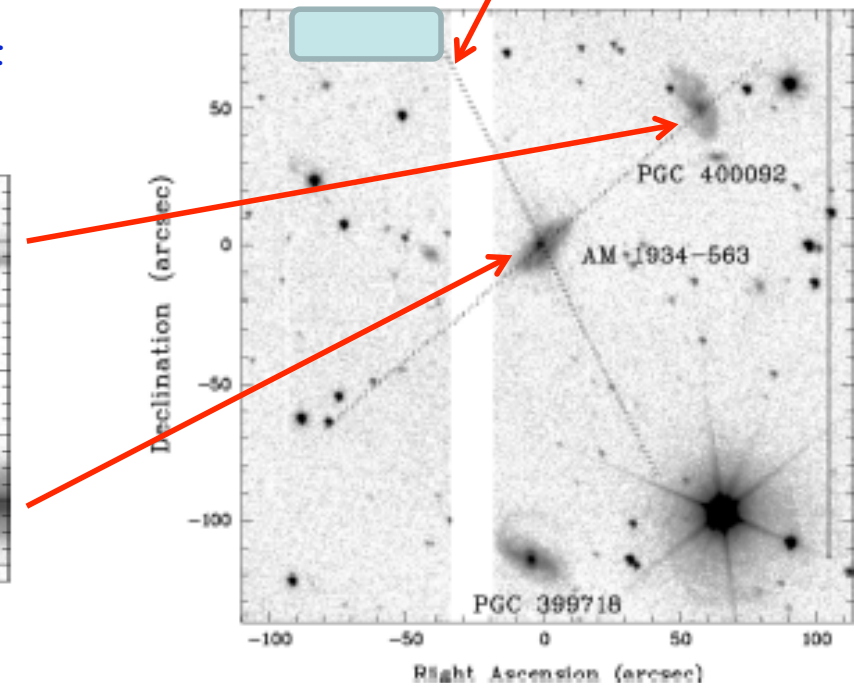
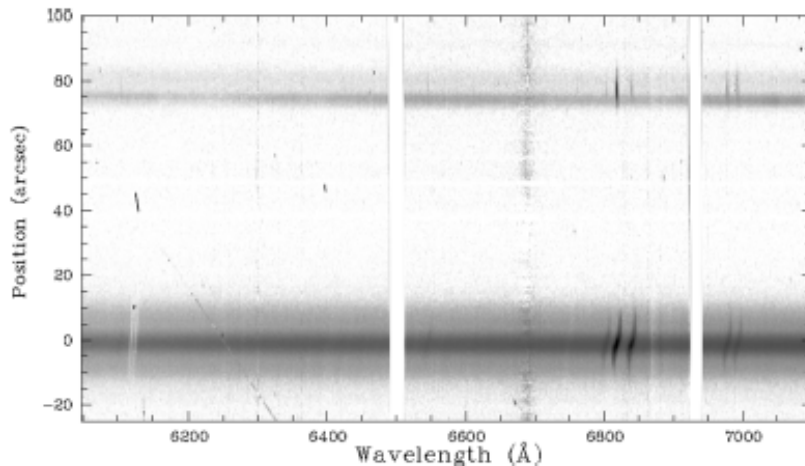
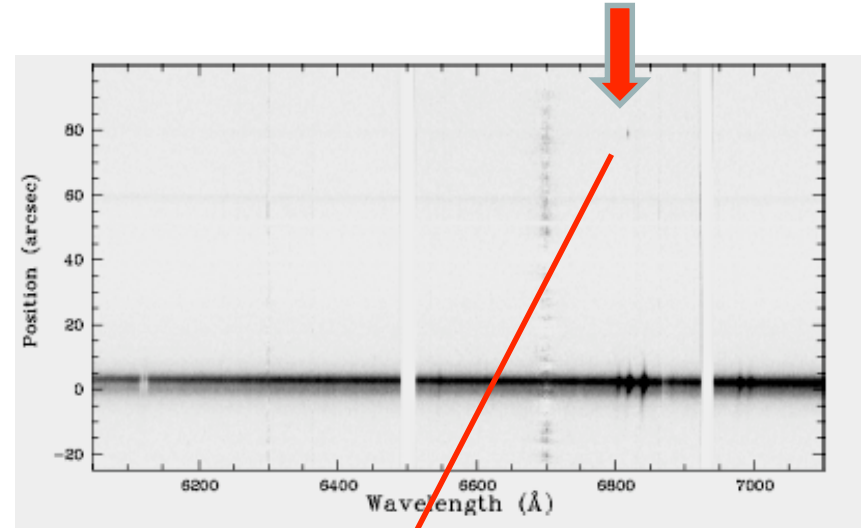
# Isolated galaxies II

AM1934-563 (PRG; not isolated)  
[Brosch, Kniazev & SALT team 2008]

Kinematic study w. RSS@SALT

Serendipitous detection of H $\alpha$  "knot"  
@78"  $\approx$  63 kpc (projected)  
EW(H $\alpha$ )=120 Å;  $\Delta v = -18 \pm 4$  km/sec

Is  $d > 63$  kpc "isolated", or "chip off polar ring"?



# Isolated galaxies III

Sample of  $M > -18$  galaxies with no catalogued galaxies within 2 Mpc

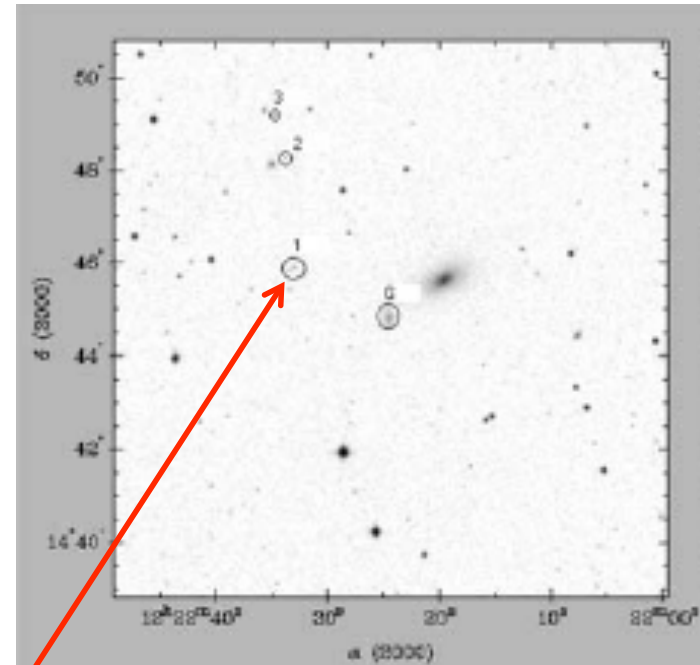
Imaged at rest-frame H $\alpha$  ( $50\text{\AA} \approx \pm 1000$  km/s)  
[Brosch et al., 2006]

Found 20 possible companions

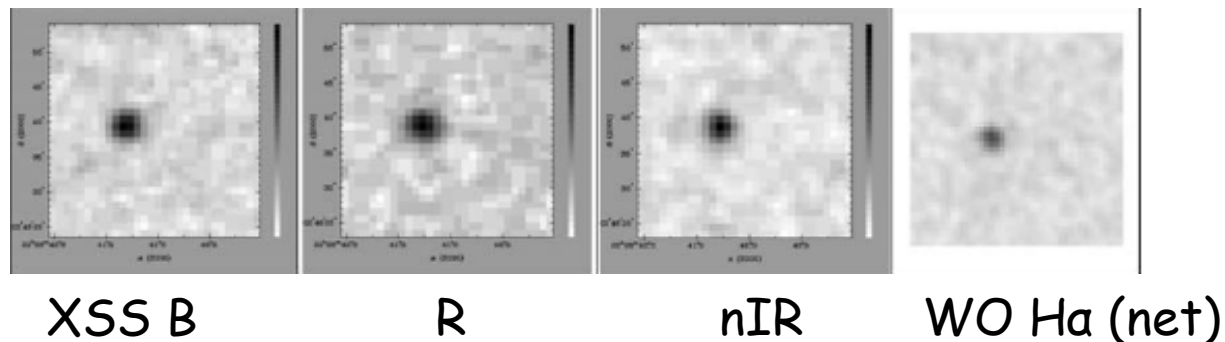
Similar to:

"Ha Dots : The Nature of Isolated  
Extragalactic Emission Line Sources"

Jessica Kellar, 2008 honors thesis  
Wesleyan college (Salzer)



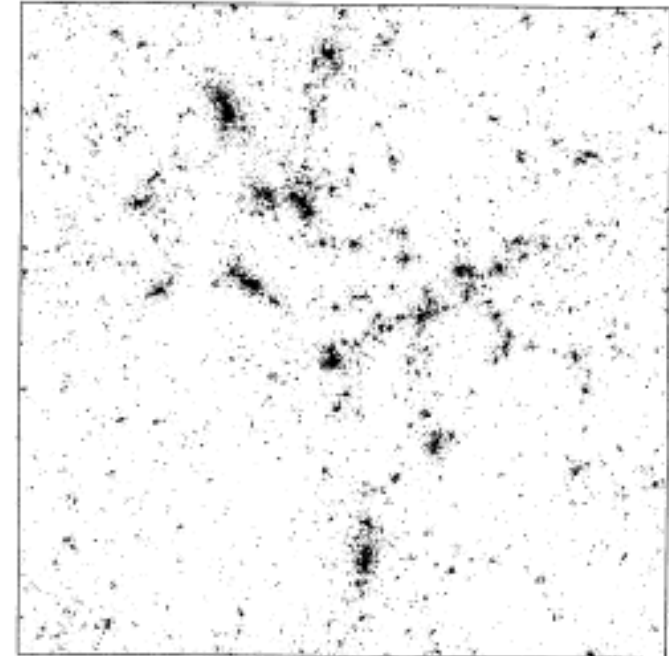
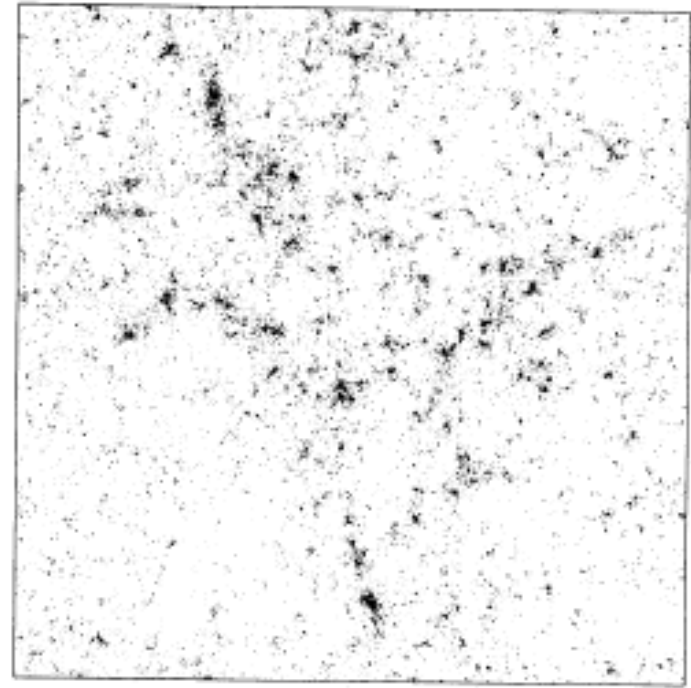
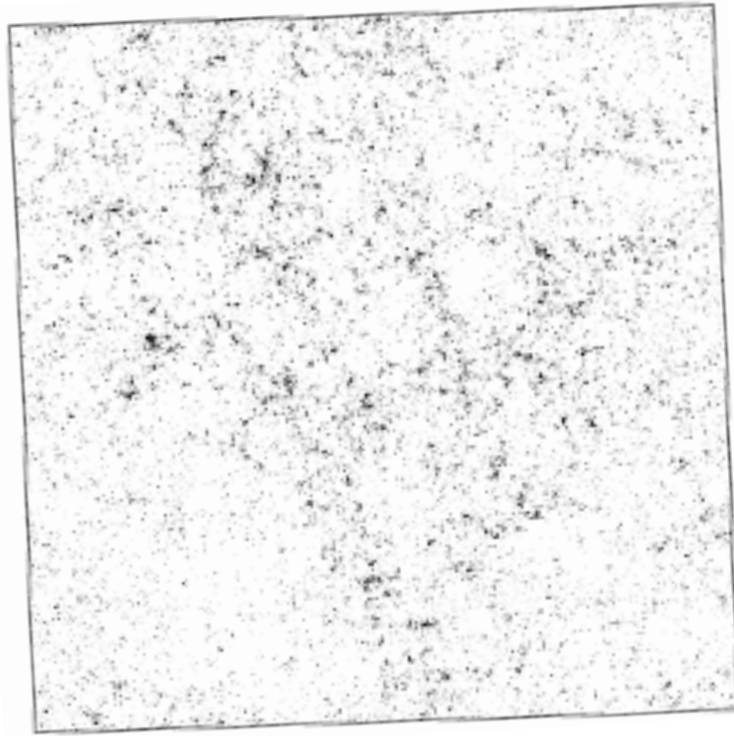
PC2225+0216





# Preliminary conclusions

1. Star formation is ubiquitous, except in the very centers of clusters
2. Even seemingly isolated dwarf galaxies have small, faint, star-forming companions
3. There may be an additional factor triggering star formation
4. Large DM concentrations "waiting to be seeded" by HI?
5. Where is the DM?



Structure formation by gravitational clustering  
(Efsthathiou et al. 1988 MNRAS 235, 715)

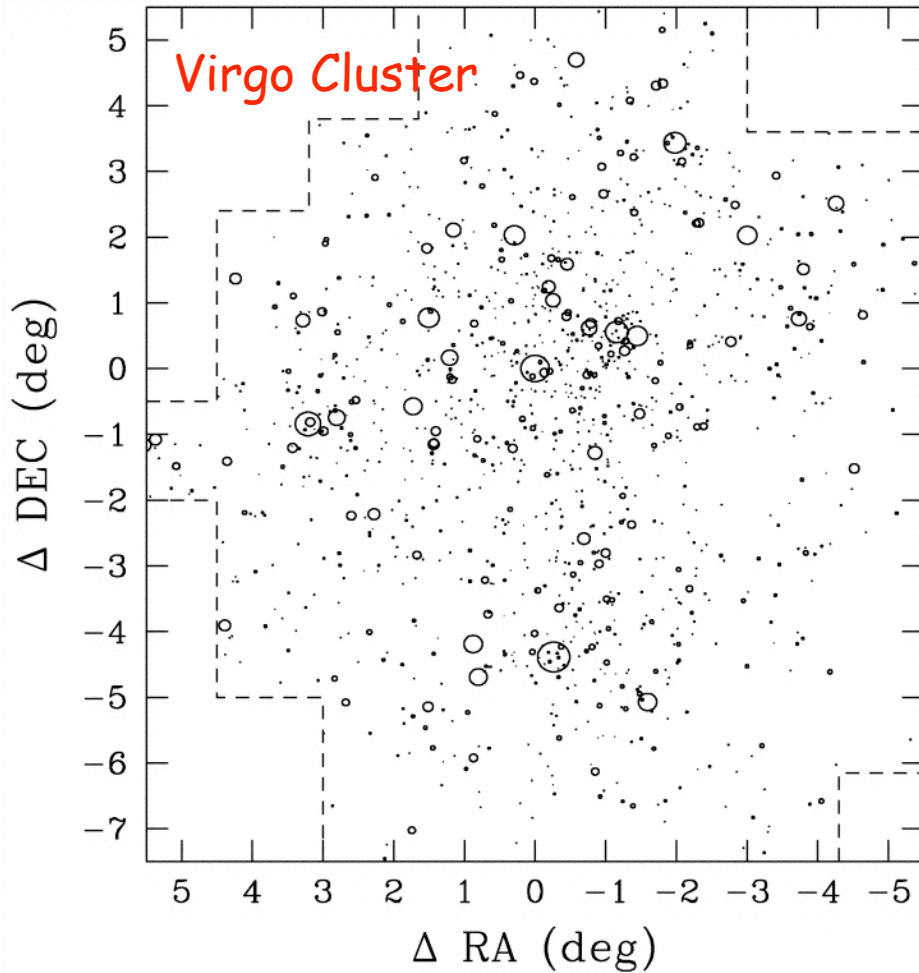
DM "digging trenches" in space

Galaxies (may) form in trenches

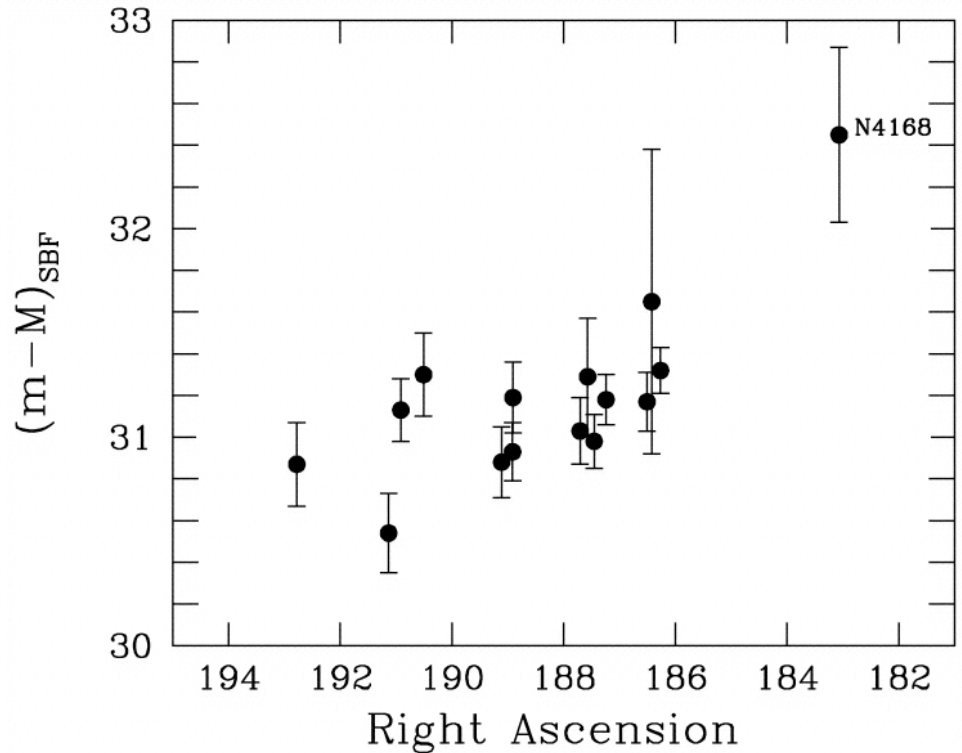
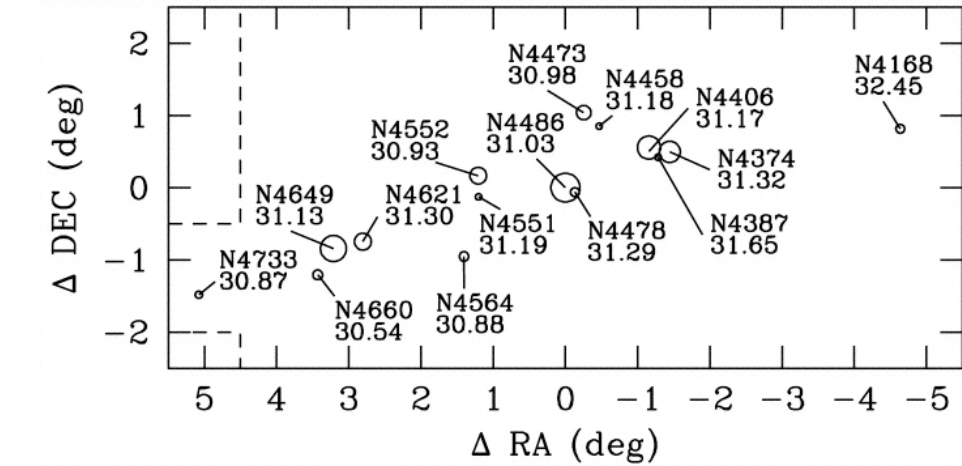


Galaxy Chains  
Pvt. Ltd.

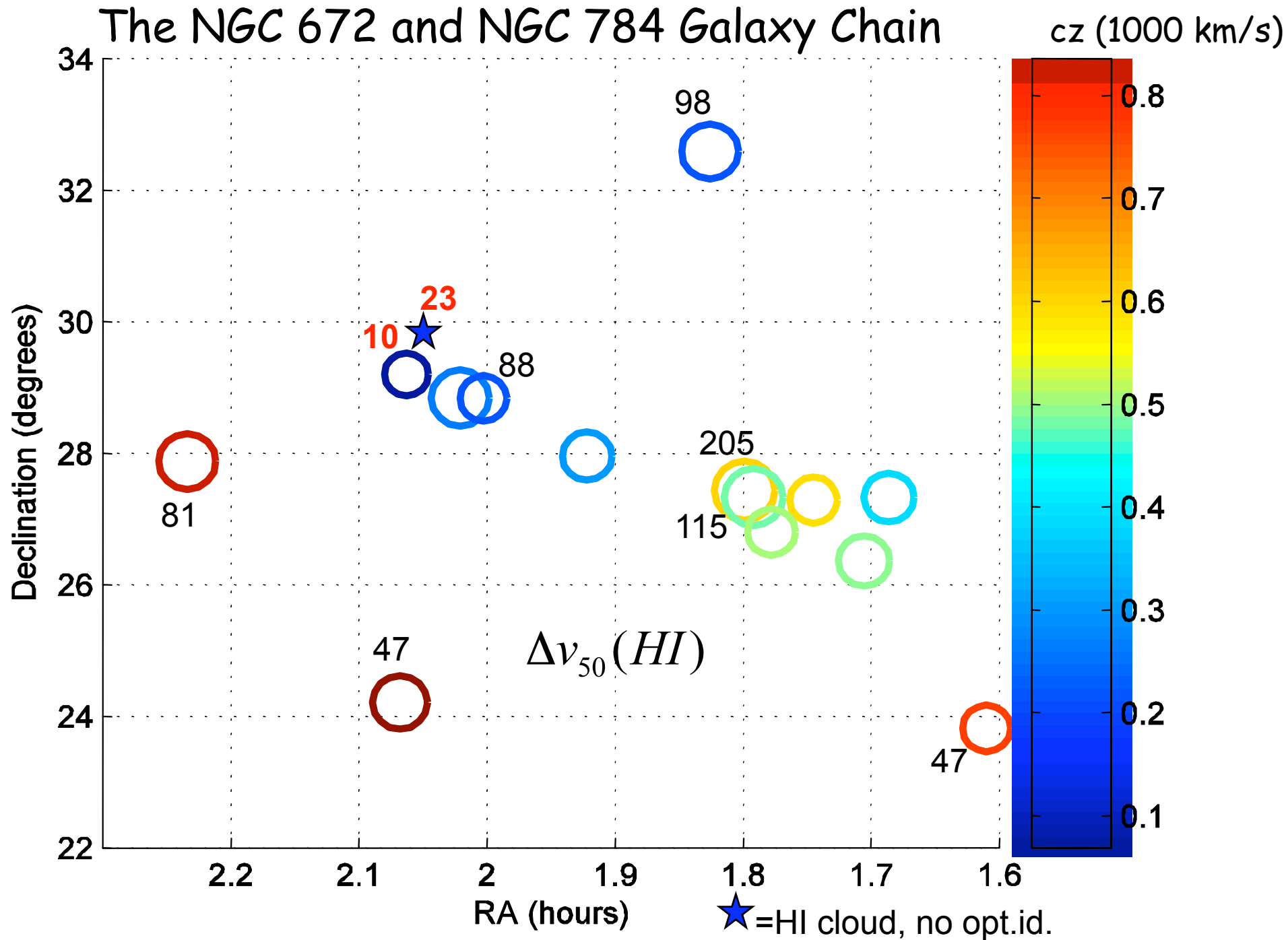
# Galaxy Chain in the Virgo Cluster



West & Blakeslee (2000 ApJ 543, L27)

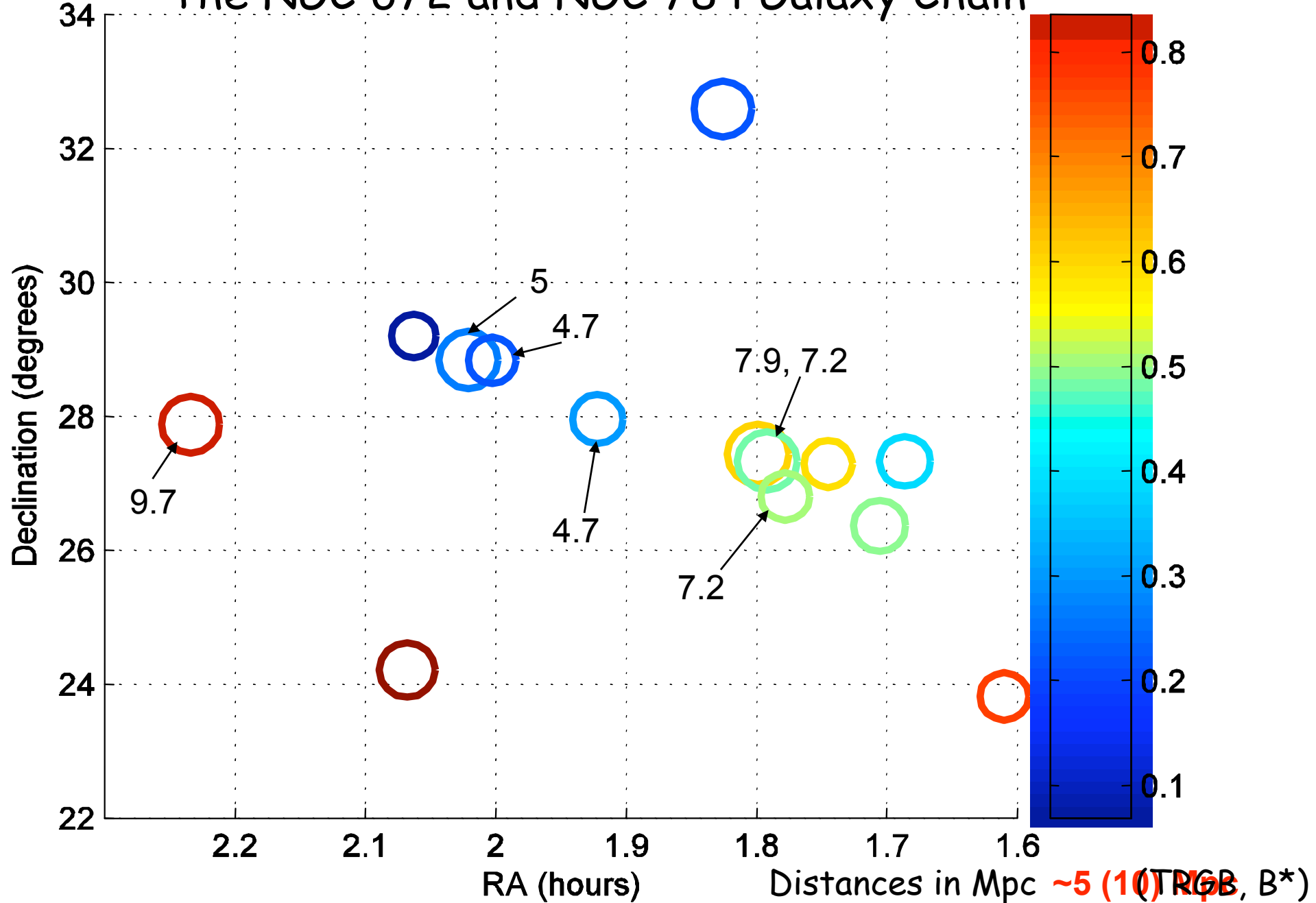


# The NGC 672 and NGC 784 Galaxy Chain

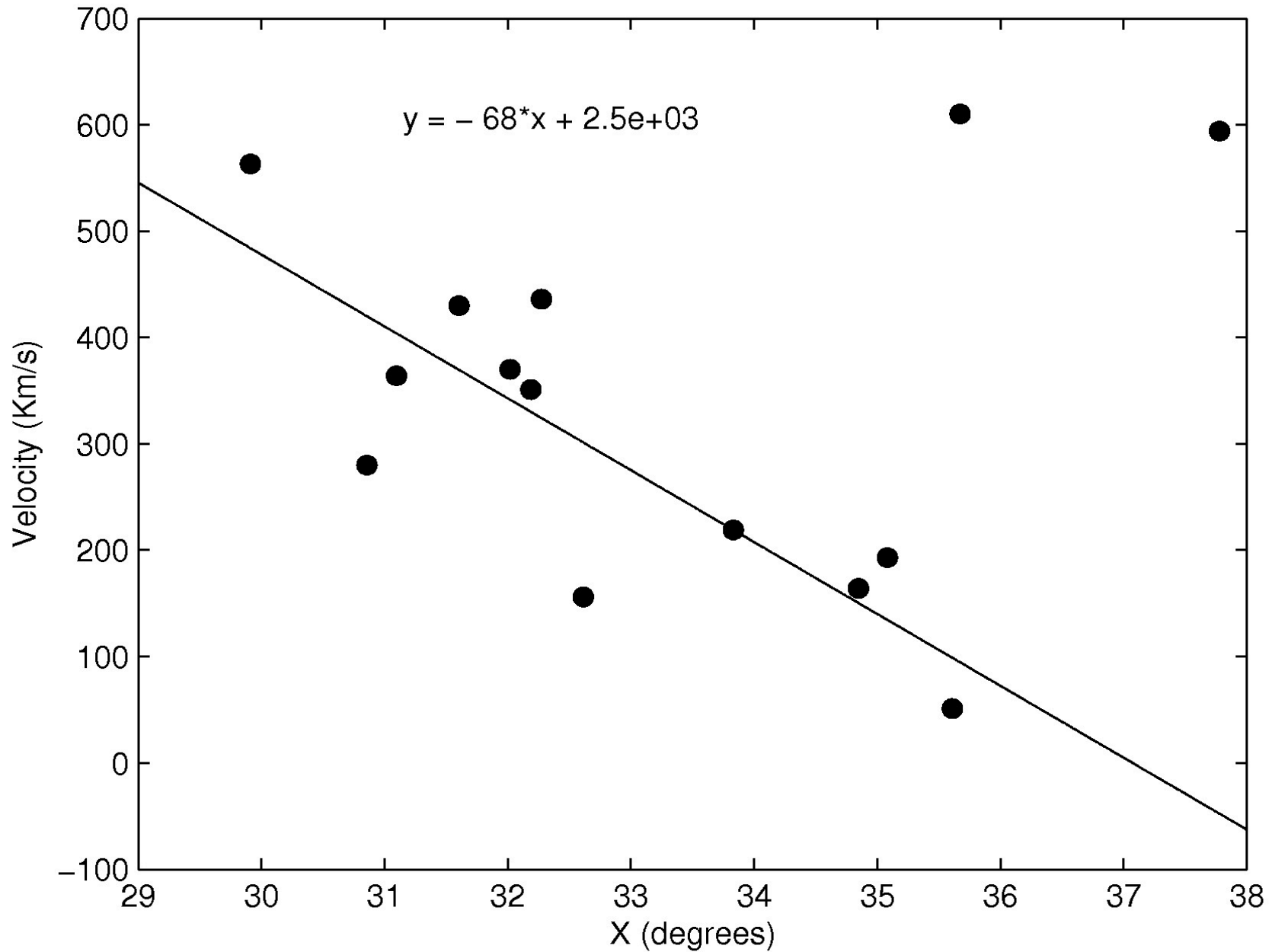




# The NGC 672 and NGC 784 Galaxy Chain



# The NGC 672 and NGC 784 Galaxy Chain



Velocity-distance indicates this is a kinematically-coherent structure  
**Filament?**

# Galaxy chain-summary

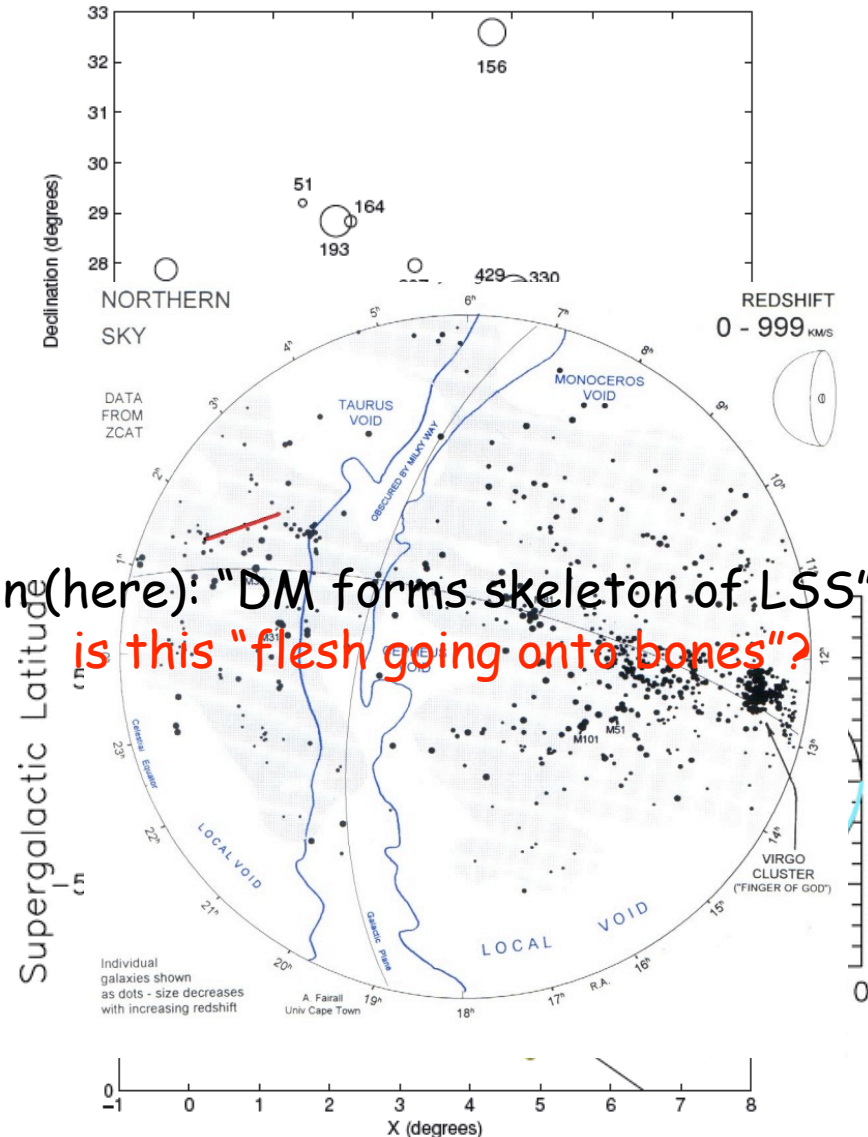


Galaxy alignment  
-kinematic structure

"Anti-Virgo" location  
local void (SGL: 322,-3→329,-7).

All dwarfs, currently show SF

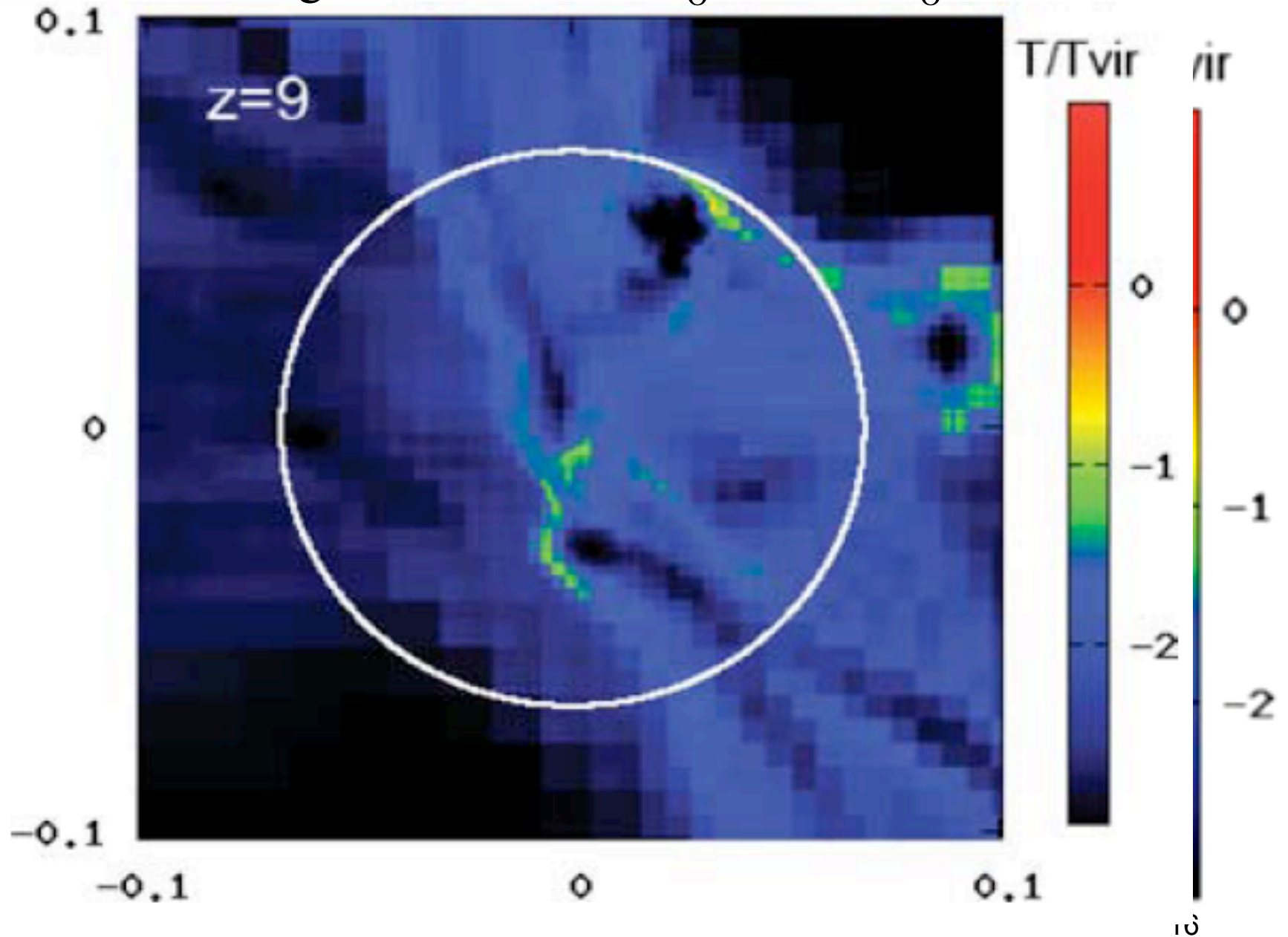
Intergalactic gas accretion  
onto DM filament?



Croton (here): "DM forms skeleton of LSS"  
is this "flesh going onto bones"?

From Tully et al. 2008, ApJ 676, 184

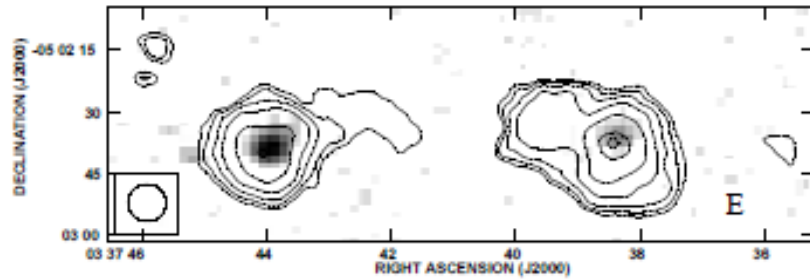
Dekel & Birnboim 2006 high mass =  $3 \times 10^{11} M_{\odot}$   $2 \times 10^{10} M_{\odot}$  = low mass



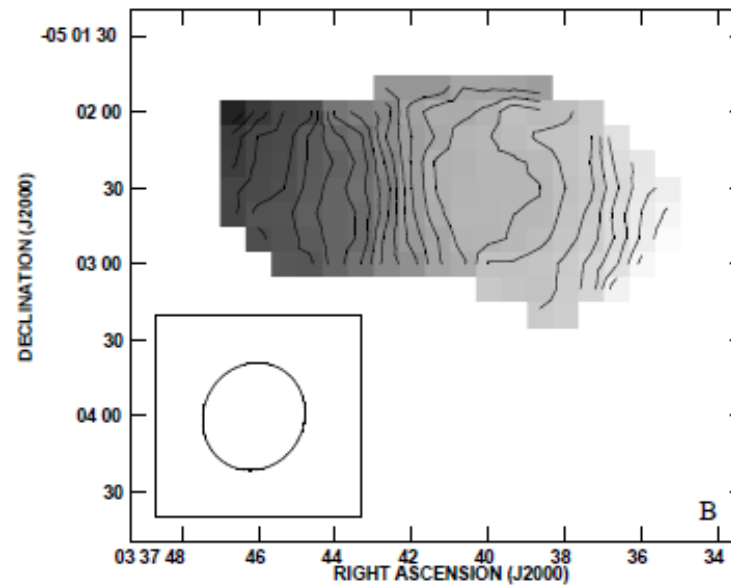
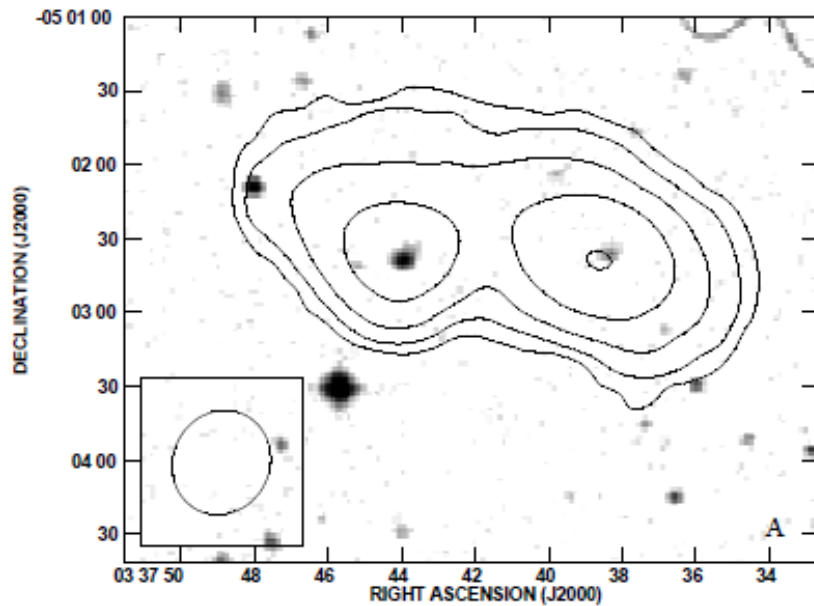
Low-mass haloes accrete cold gas also at low- $z$



# SBS0335-052



Ekta et al. 2009 (arXiv 0904.4797v1)  
Pair of interacting and SF dGs  
Located near edge of large void  
(major merger?)



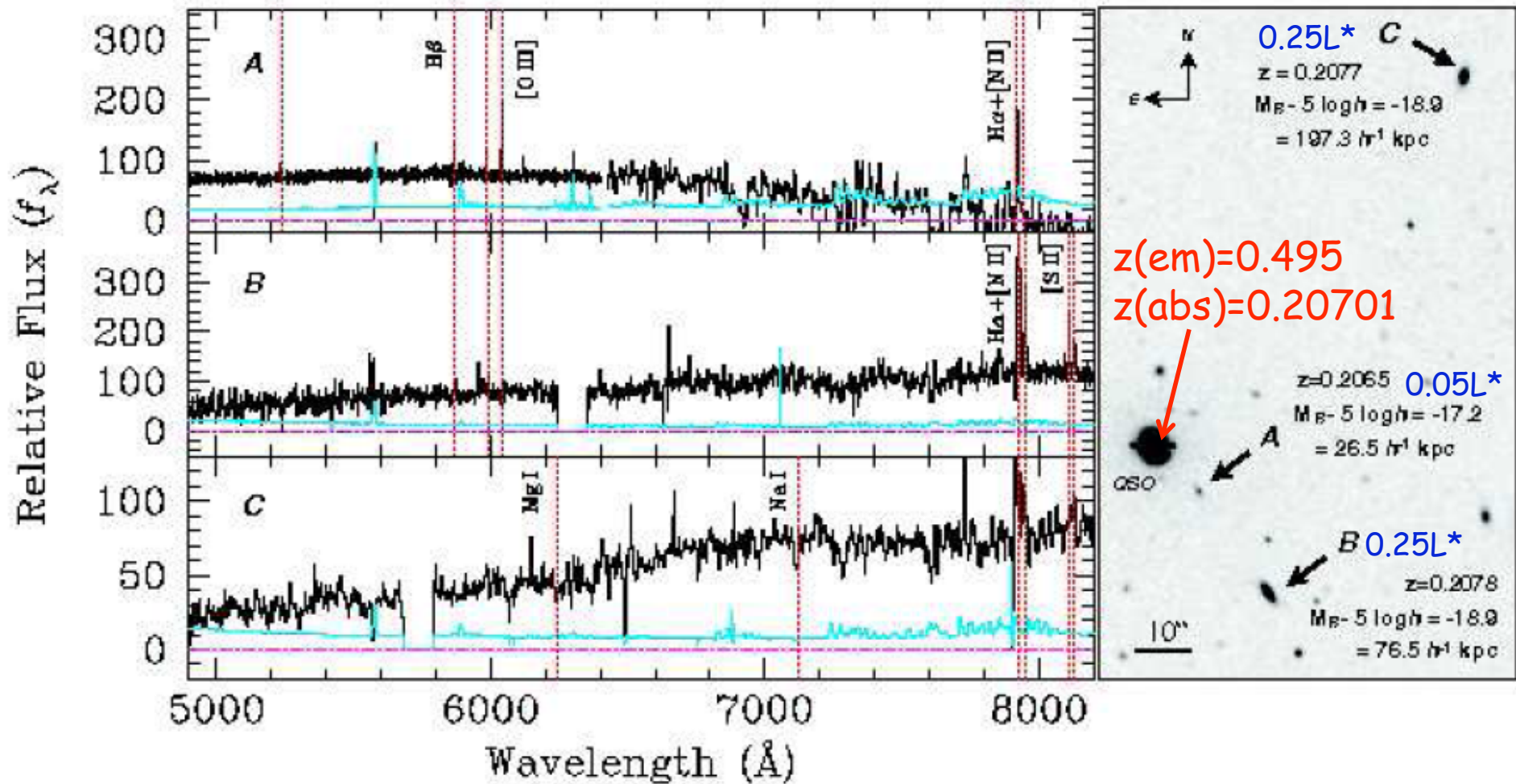
Alternative explanation:

Both galaxies now forming from accreted external gas onto DM

# Group of dGs in large cloud

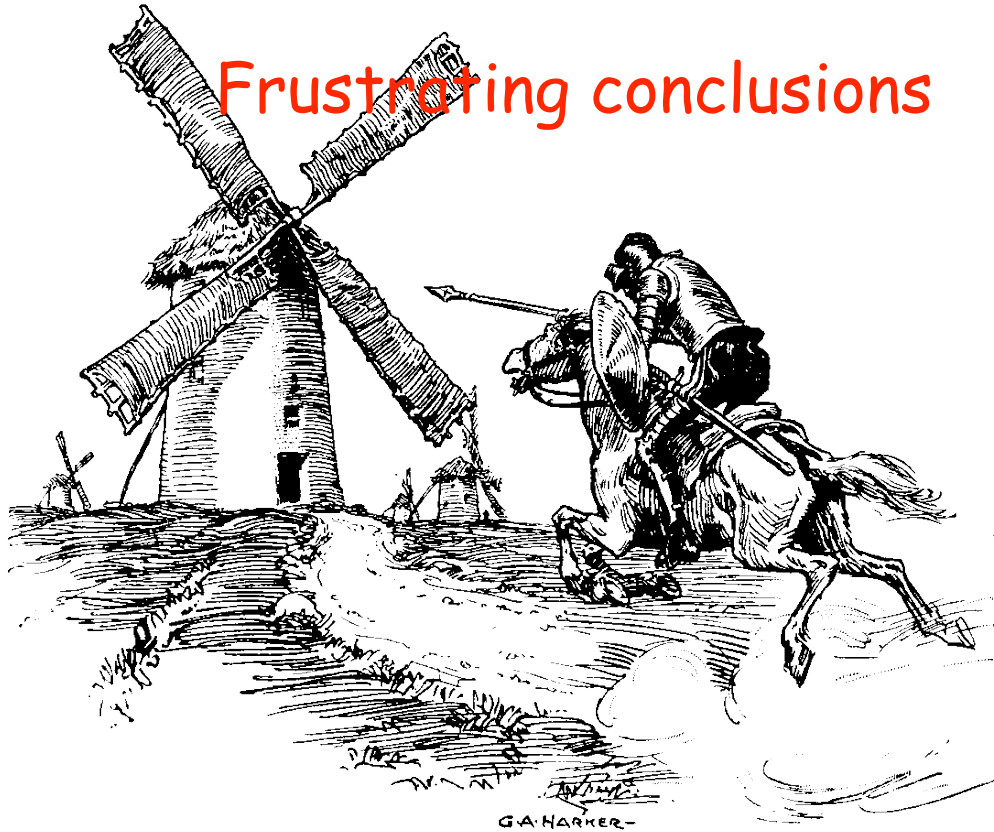
Mulchaey & Chen arXiv:0905.1327 (Tuesday)

Hot gas (Ne VIII) at least 76.5 kpc/h from  $0.25 L^*$  galaxy. All galaxies w. low SF



Large DM halo with some galaxies and cooling gas?

# Frustrating conclusions



Noctem verterunt in diem,  
et rursum **post tenebras spero lucem.**  
(Vulgata; Job 17:12)

לַיְלָה לַיּוֹם יְשִׁימוּ, אֹרֶב קָרוֹב מִפְּנֵי חֶשֶׁךְ

## EL INGENIOSO HIDALGO DON QUI- XOTE DE LA MANCHA

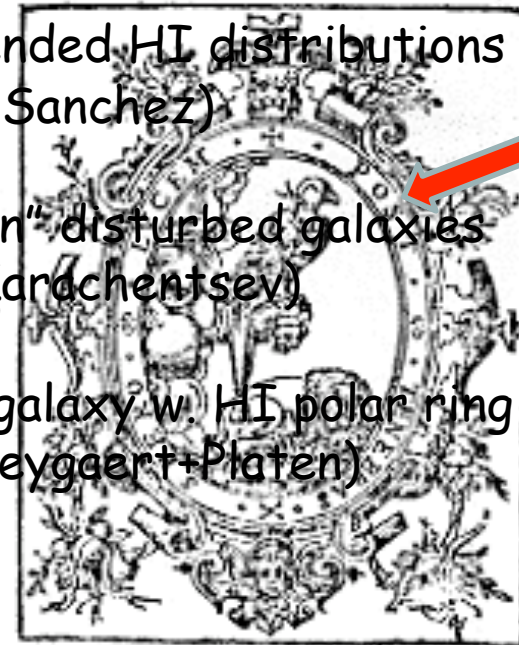
Compuesto por Miguel de Cervantes  
Saavedra.

DIRIGIDO AL DUQUE DE BEJAR,  
Don Juan de Austria, Duque de Alba, y Banar-  
res, Vizconde de la Puebla de Alcozer, Señor de  
(Serra) las villas de Capilla, Curiel, y  
Burgillos.

V. extended HI distributions  
(Lopez Sanchez)

"Orphan" disturbed galaxies  
(Igor Karachentsev)

"Void" galaxy w. HI polar ring  
(v.d. Weygaert+Platen)



1605.

Con privilegio de Castilla, Aragon, y Portugal.  
EN MADRID, Por Juan de la Cuesta.  
Vendese en casa de Francisco de Robles, librero del Rey nro señor.