“Galaxy Groups in the Local Volume: an HI Perspective”

Bärbel Koribalski
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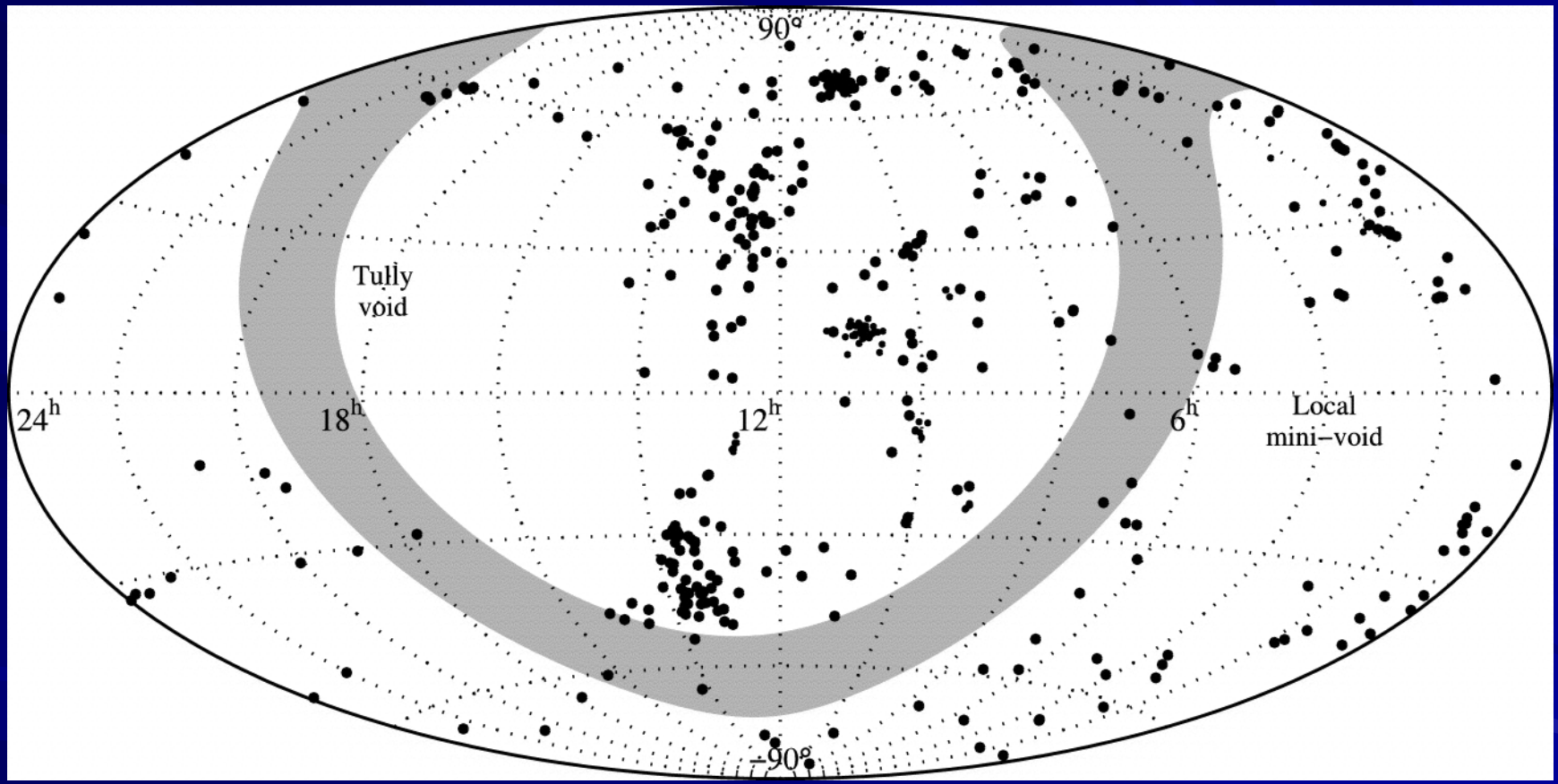
Overview

- Galaxies in the Local Volume (< 10 Mpc)
- Galaxy groups in the LV, e.g.
  - M81 group
  - Sculptor group
  - CenA / M83 group
- **LVHIS** = The `**L**ocal **V**olume **HI** **S**urvey'
- The M83 group – an HI perspective
- M83 – a very hungry galaxy

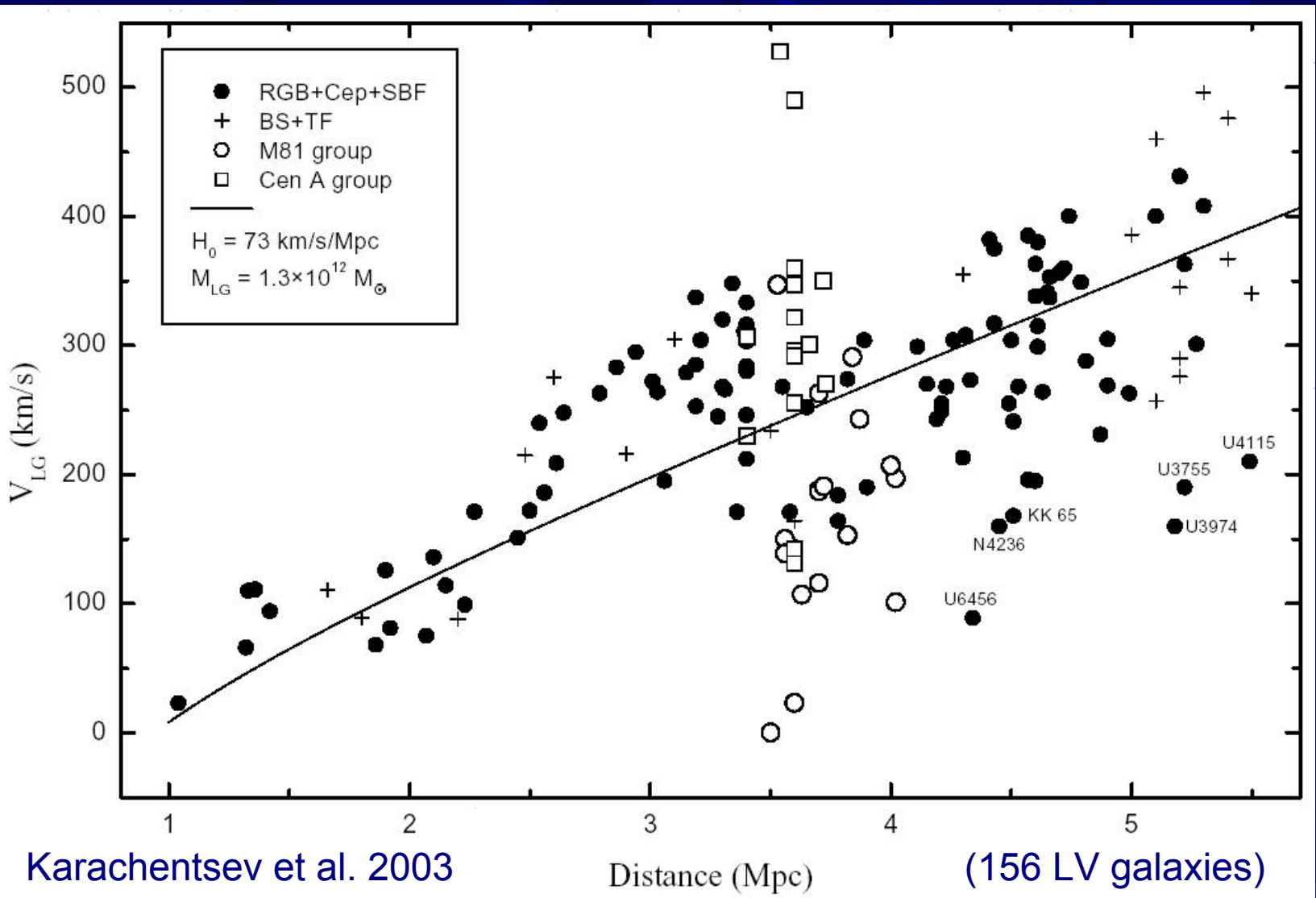
Galaxies in the Local Volume



from Karachentsev et al. 2004 (based on 450 LV galaxies with D < 10 Mpc)

“The Local Volume (LV)”

- the `Local Volume’ = the sphere of radius ~10 Mpc centered on the Local Group
- includes at least 500 known galaxies
- accurate distances are essential to define and study a complete LV galaxy sample
- about 85% of the LV population are dwarf galaxies which contribute ~4% to the local optical luminosity density and roughly 10-15% to the local HI mass density
- in ~60% of the LV galaxies HI has been detected



Karachentsev et al. 2003

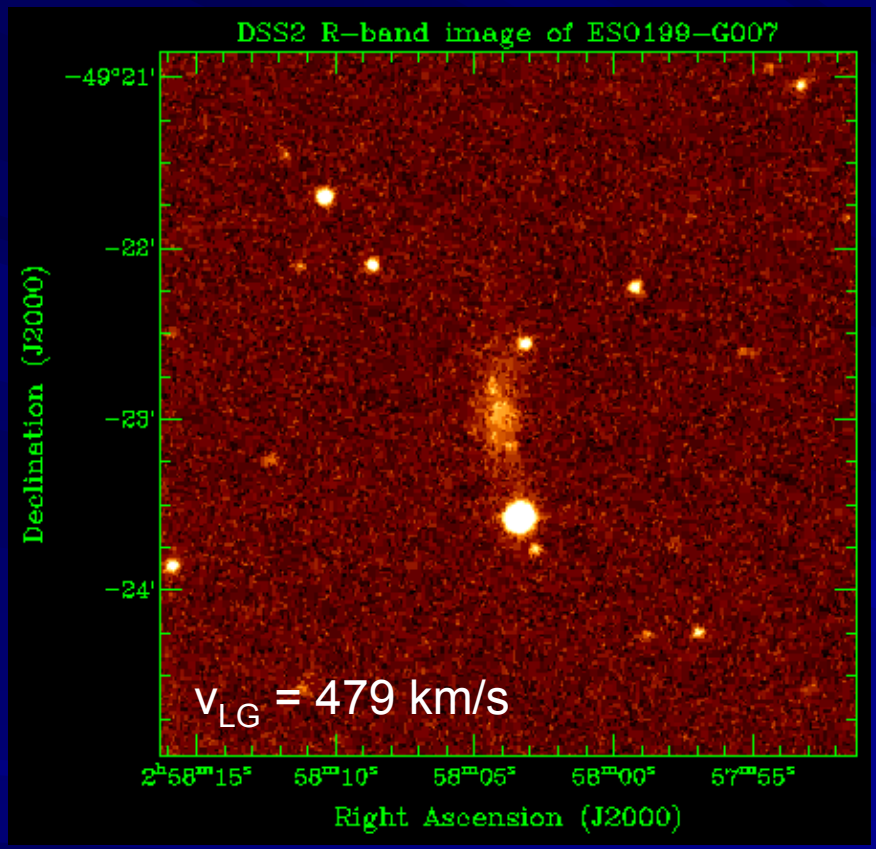
(156 LV galaxies)

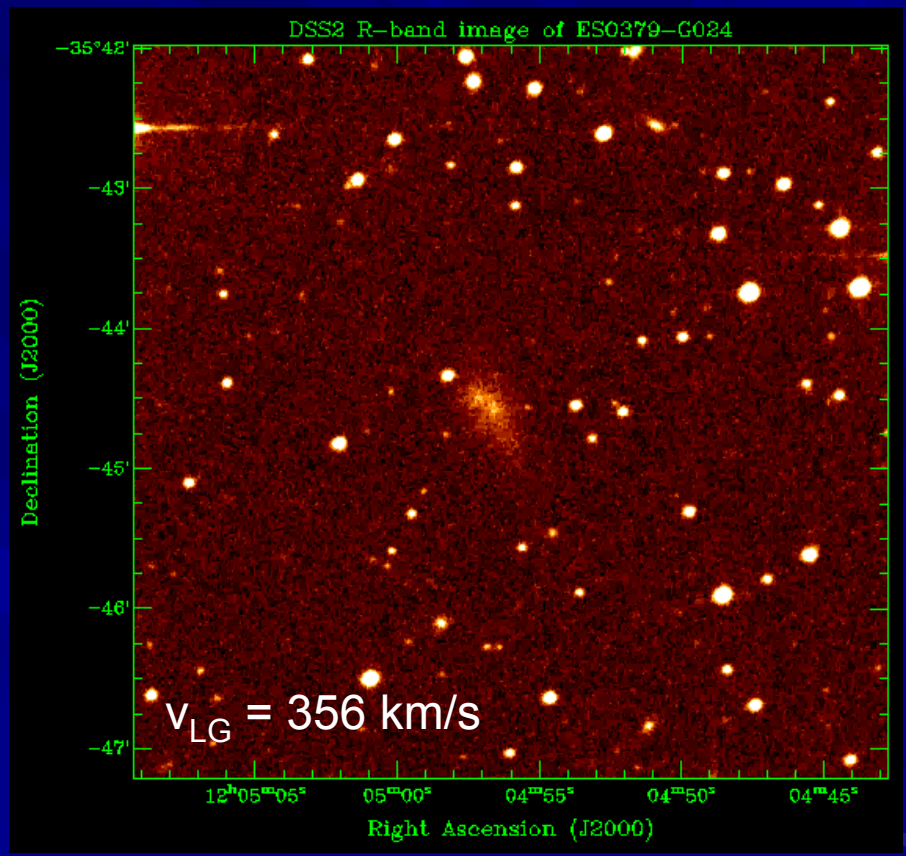
Fig. 4. Radial velocity – distance relation for 156 Local Volume galaxies. The galaxies with accurate distance estimates ("Cep", "RGB", "SBF", and "mem") are shown as filled circles, and galaxies with less reliable distance estimates ("BS" and "TF") are indicated as crosses. The members of M 81 and Cen A groups with distances in the range of 3.4–4.0 Mpc are shown by open circles and open squares, respectively. The regression line corresponds to the Hubble relation with $H_0 = 73$ km s^{-1} Mpc^{-1}, curved at small distances assuming a decelerating gravitational action of the Local Group with a total mass of 1.3×10^{12} $M_\odot$.

How do we find more LV galaxies ?

- HI surveys, e.g.
  - HIPASS (= HI Parkes All-Sky Survey) covered the sky to $\delta < +22^{o}$ with an HI mass limit of $M_{HI} = 10^{6} \times D^{2}$ Msun
- high-resolution HI imaging with interferometers such as the VLA & ATCA
- optical redshift surveys
- essential: accurate distances to define and study complete galaxy sample

New Local Volume galaxies





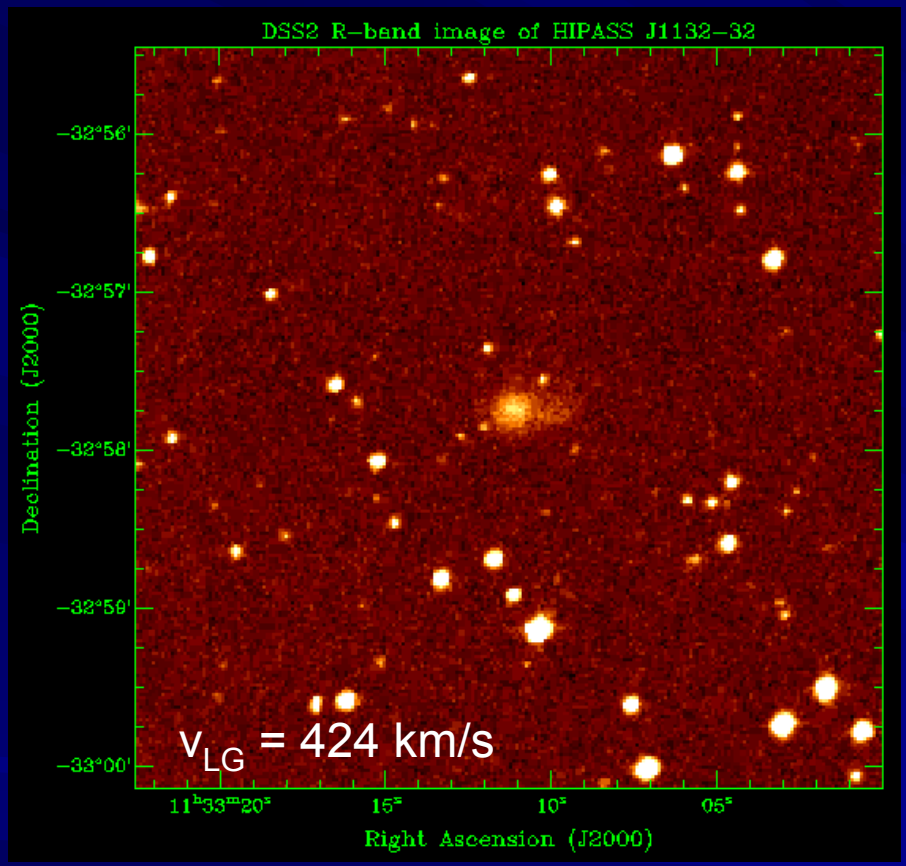
ESO199-G007 (HIPASS J0258-49)

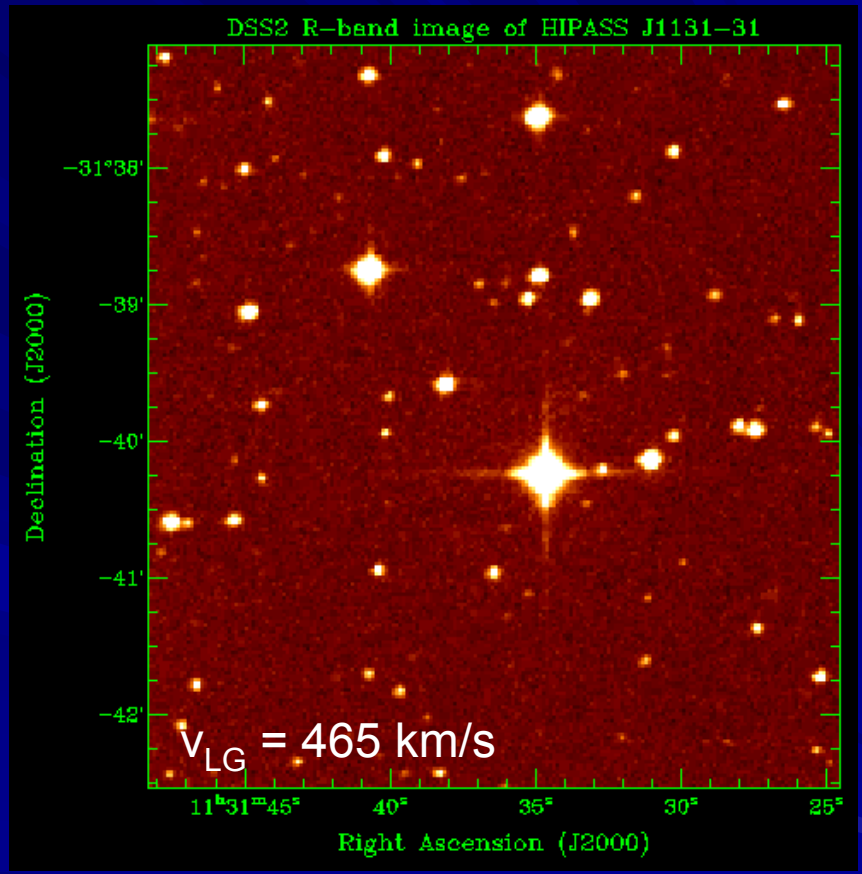
D_{Ho} = 6.4 Mpc, M_{HI} = 2.0 x 10^7 Msun

ESO379-G024 (HIPASS J1204-35)

D_{Ho} = 4.7 Mpc, M_{HI} = 1.8 x 10^7 Msun

New Local Volume galaxies





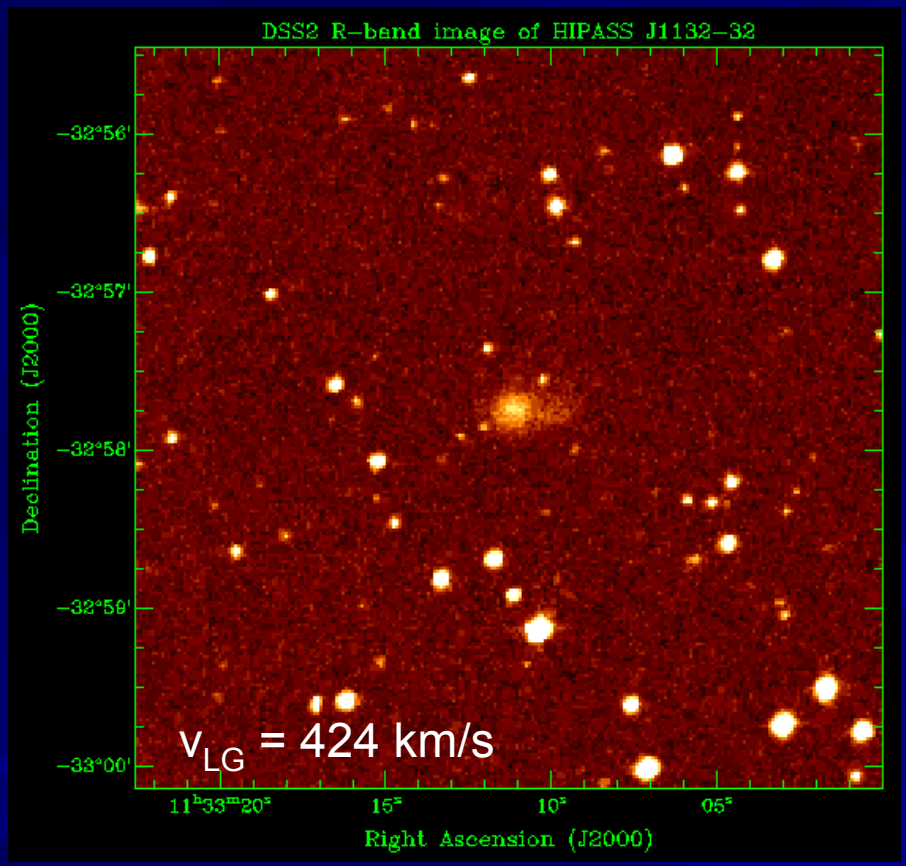
HIPASS J1132-32 (HICAT)

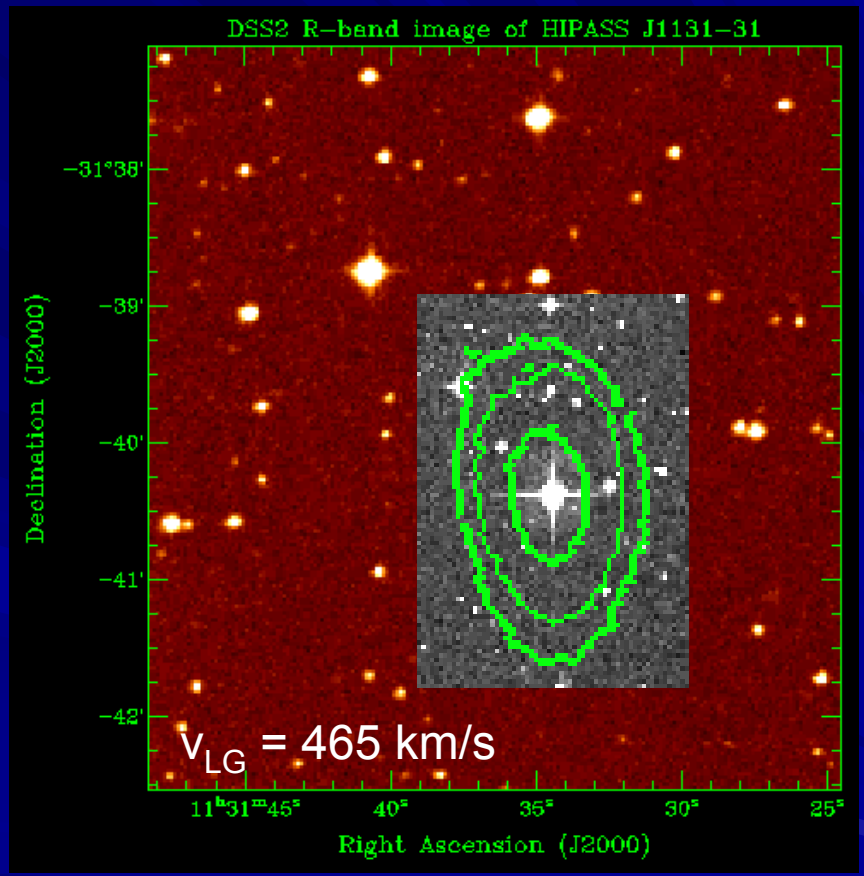
D_{Ho} = 5.7 Mpc, M_{HI} = 2.1 x 10^7 Msun

HIPASS J1131-31, but where ??

D_{Ho} = 6.2 Mpc, M_{HI} = 2.3 x 10^7 Msun

New Local Volume galaxies





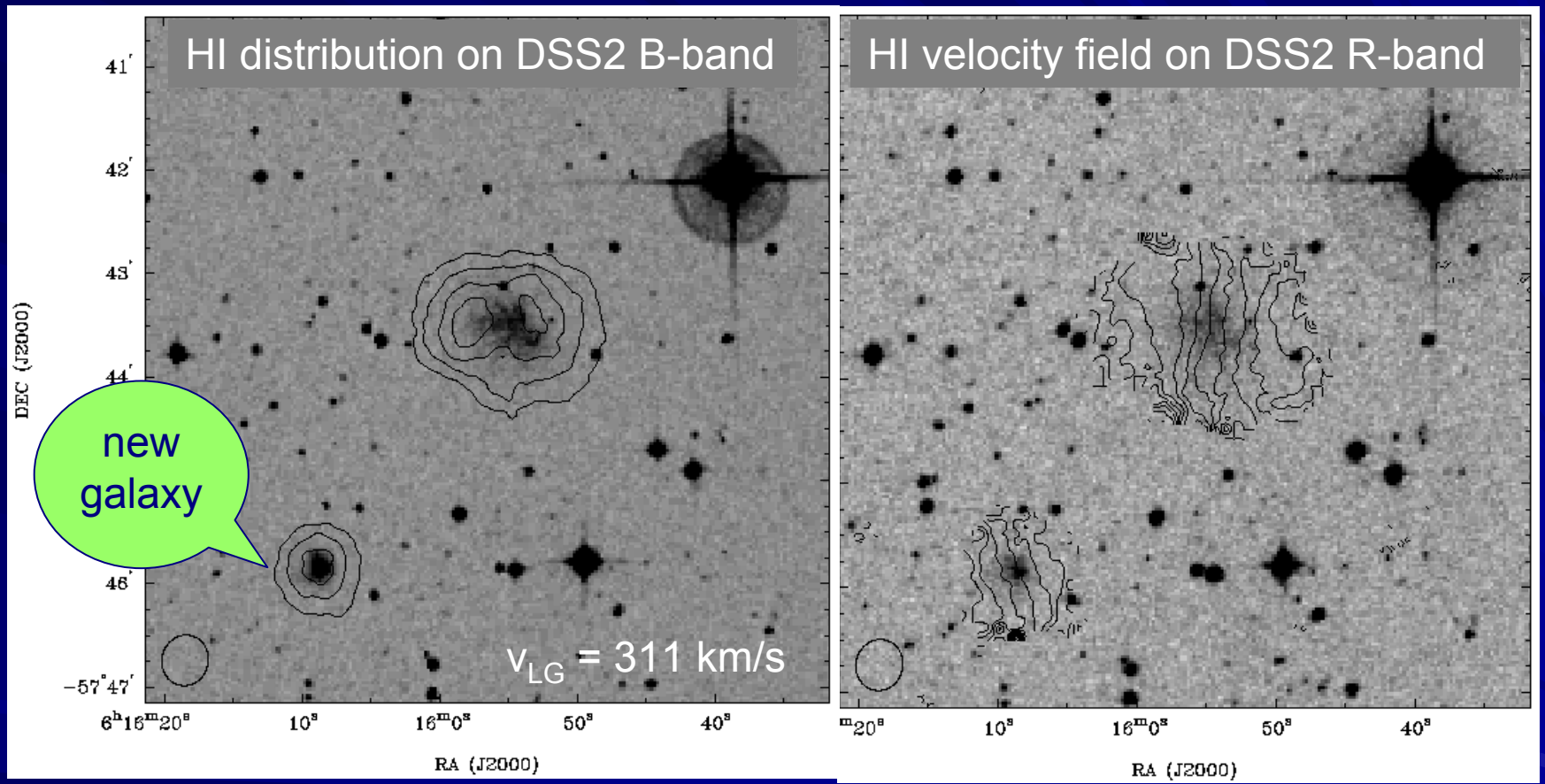
HIPASS J1132-32 (HICAT)

D_{Ho} = 5.7 Mpc, M_{HI} = 2.1 x 10^7 Msun

HIPASS J1131-31, behind the star !

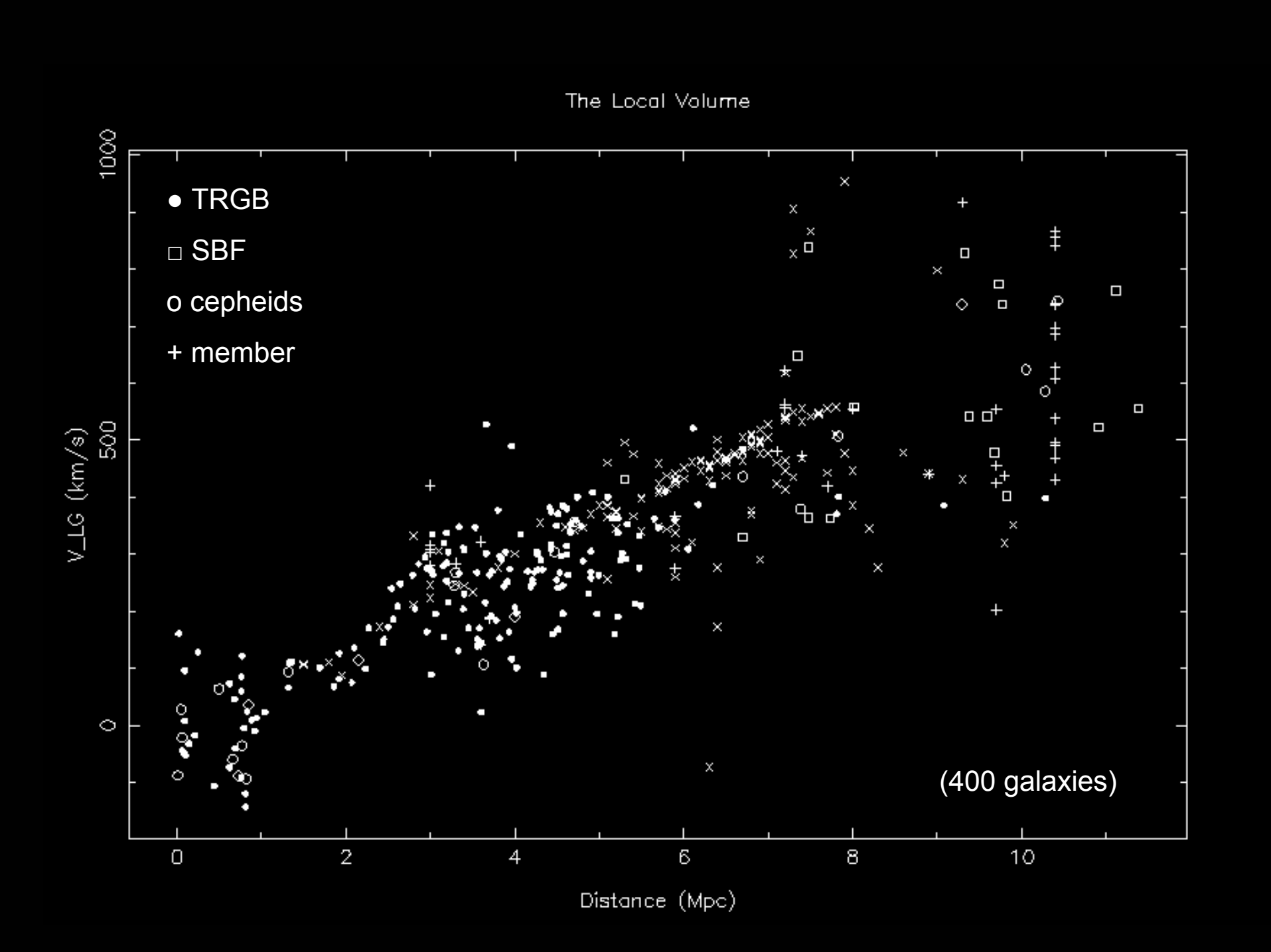
D_{Ho} = 6.2 Mpc, M_{HI} = 2.3 x 10^7 Msun

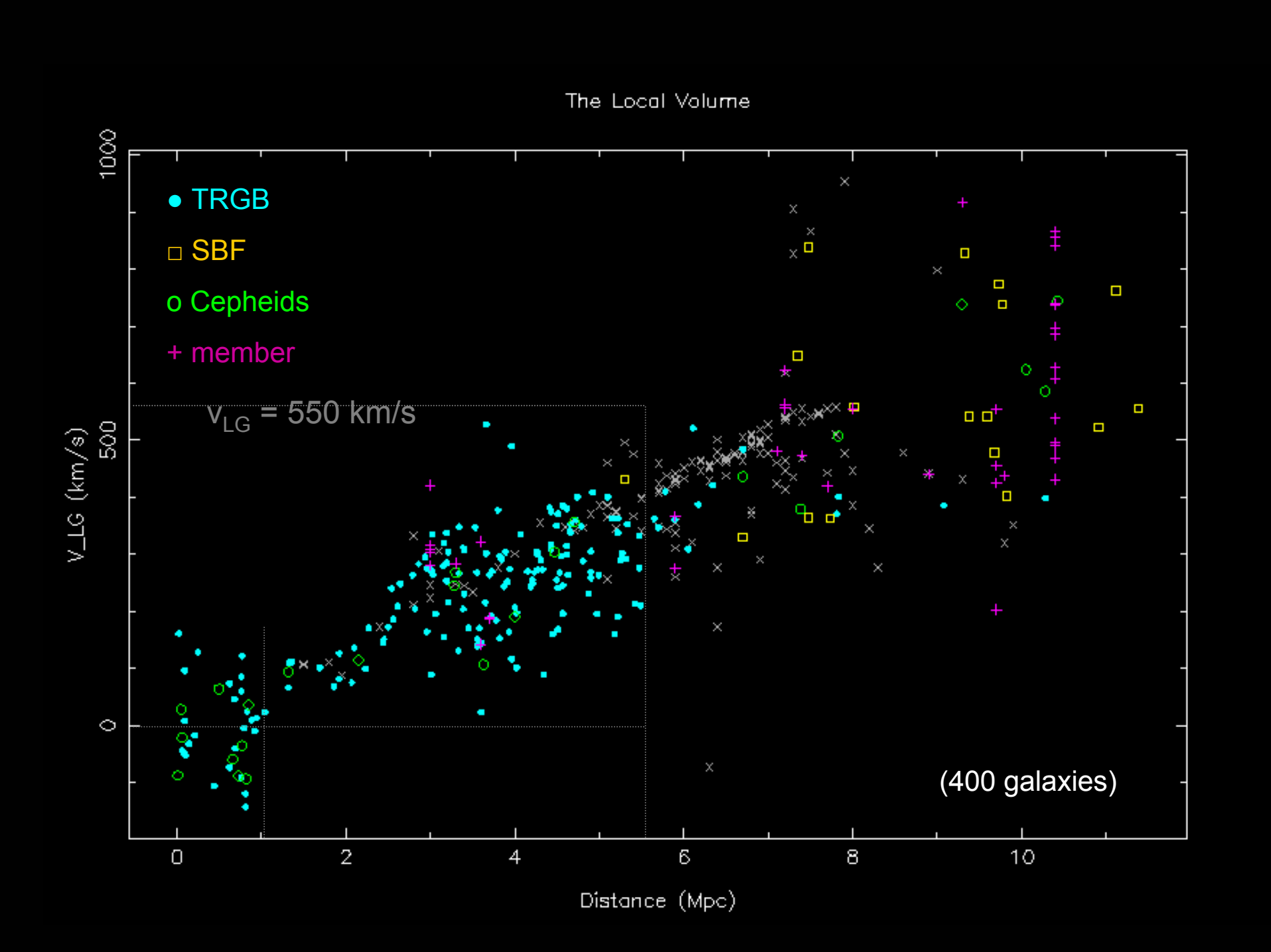
ESO121-G020 + companion !!



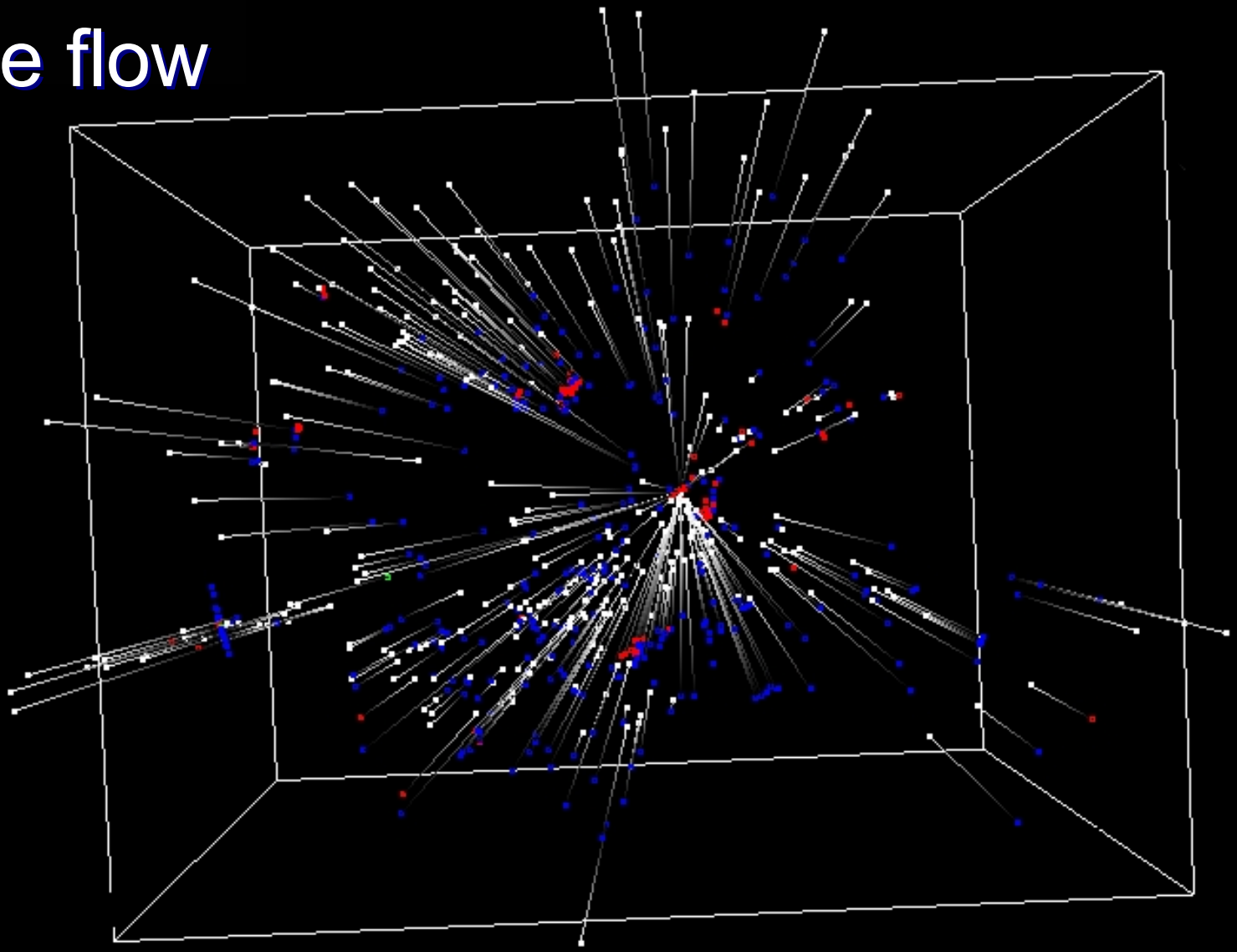
(HIPASS J0615-57) D_{Ho} = 4.1 Mpc and M_{HI} = 5.7 x 10^7 $M_\odot$ (Parkes)

M_{HI} = 2.6 x 10^7 $M_\odot$ (ESO121-G020) ; M_{HI} = 6.1 x 10^6 $M_\odot$ (companion)


The Local Volume
• TRGB
□ SBF
o cepheids
+ member
(400 galaxies)
V_LG (km/s)
Distance (Mpc)
0
500
1000
0
2
4
6
8
10

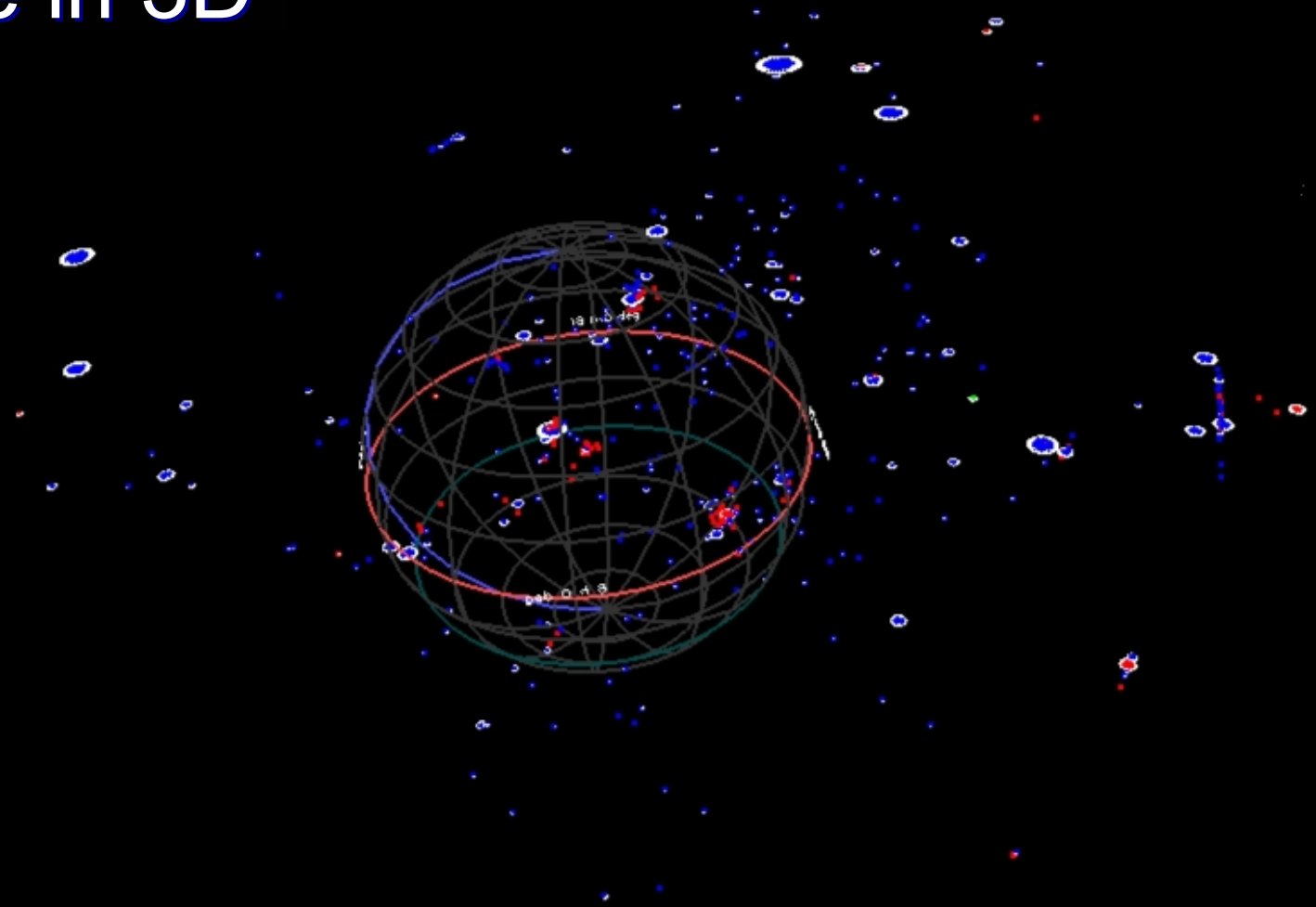

The Local Volume
• TRGB
□ SBF
o Cepheids
+ member
v_{LG} = 550 km/s
(400 galaxies)
V_LG (km/s)
Distance (Mpc)
0
500
1000
0
2
4
6
8
10

The local Hubble flow



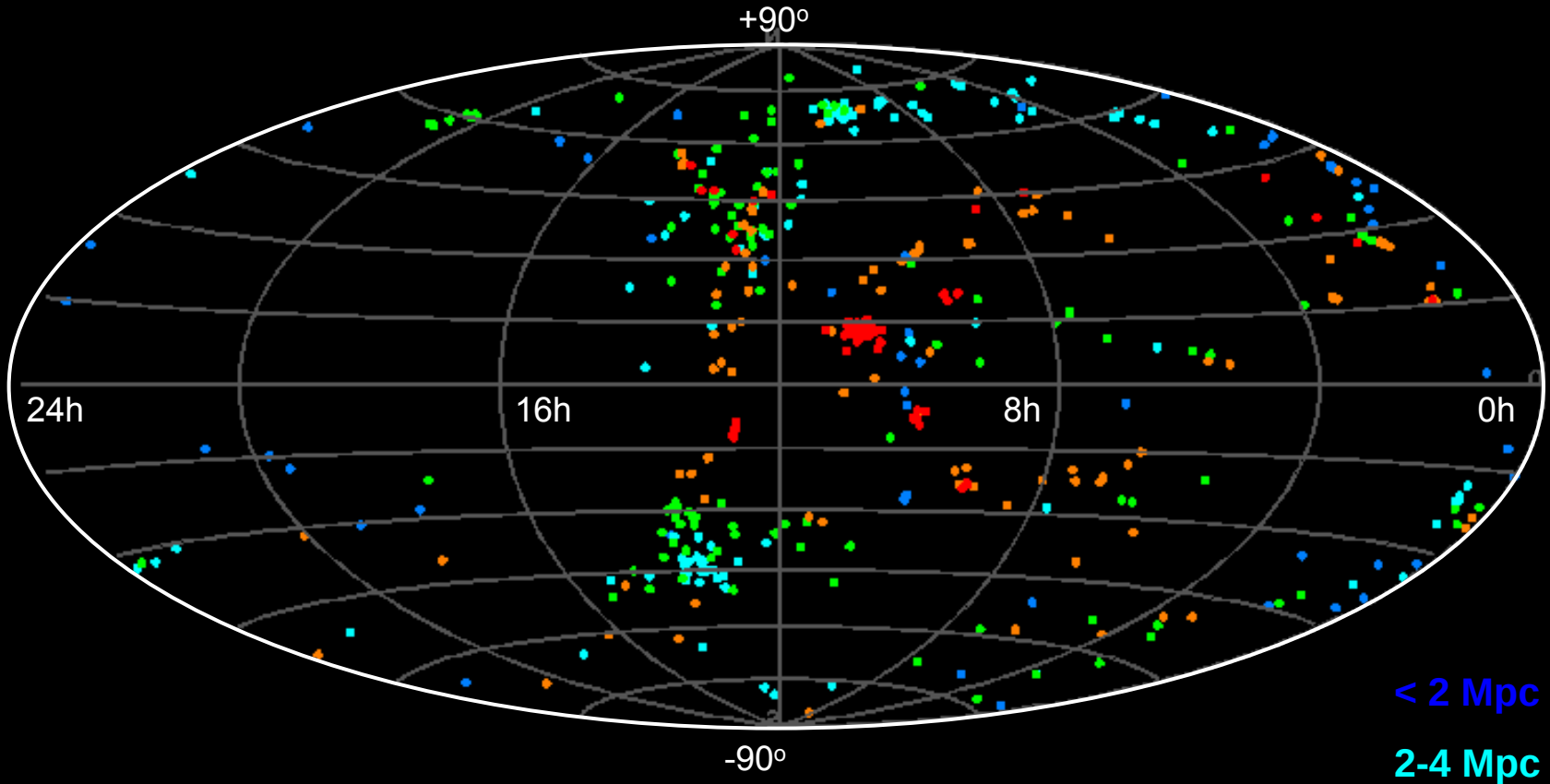
3D animation by Chris Fluke (Swinburne University)

The Local Volume in 3D

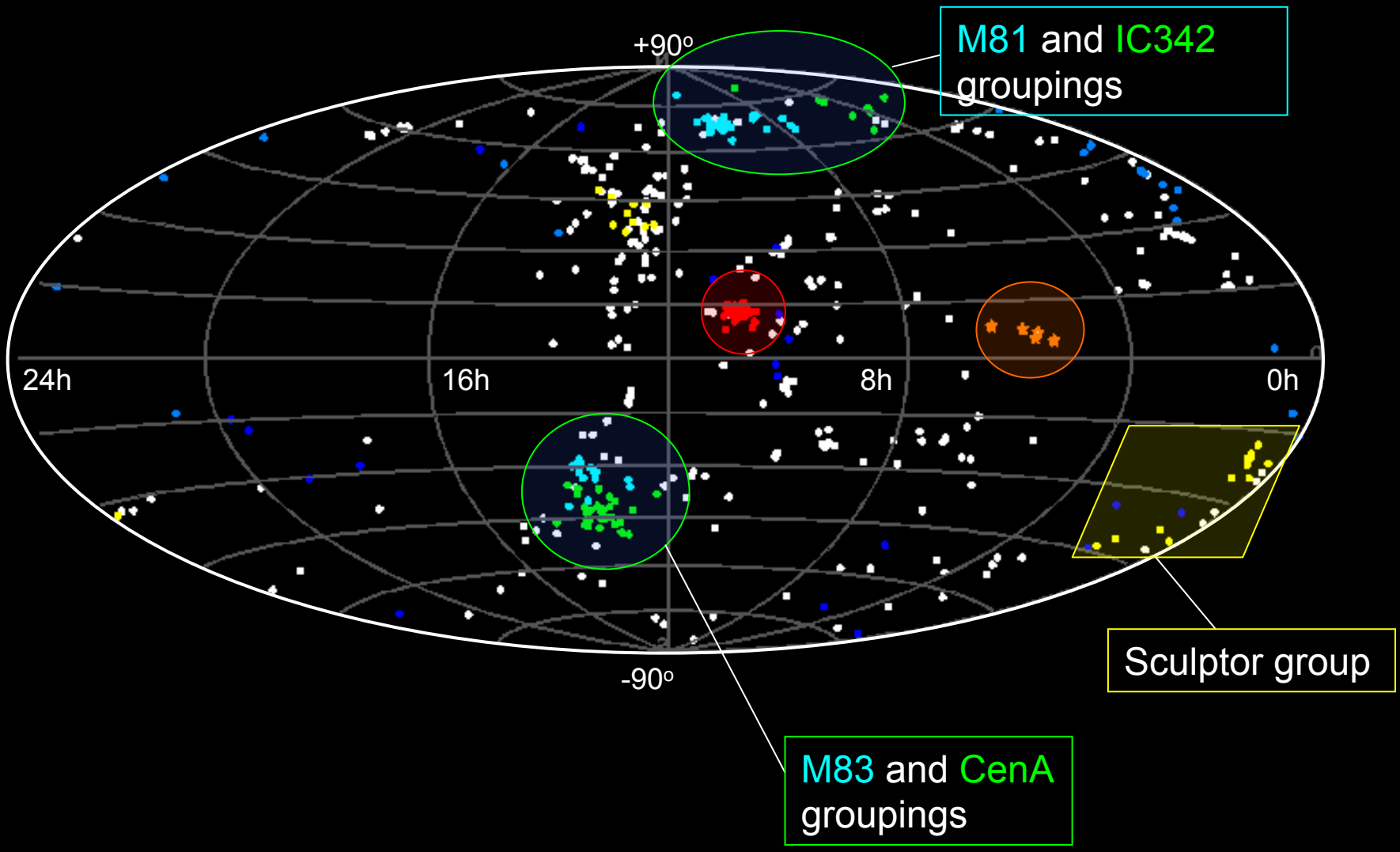


3D animation by Chris Fluke (Swinburne University)

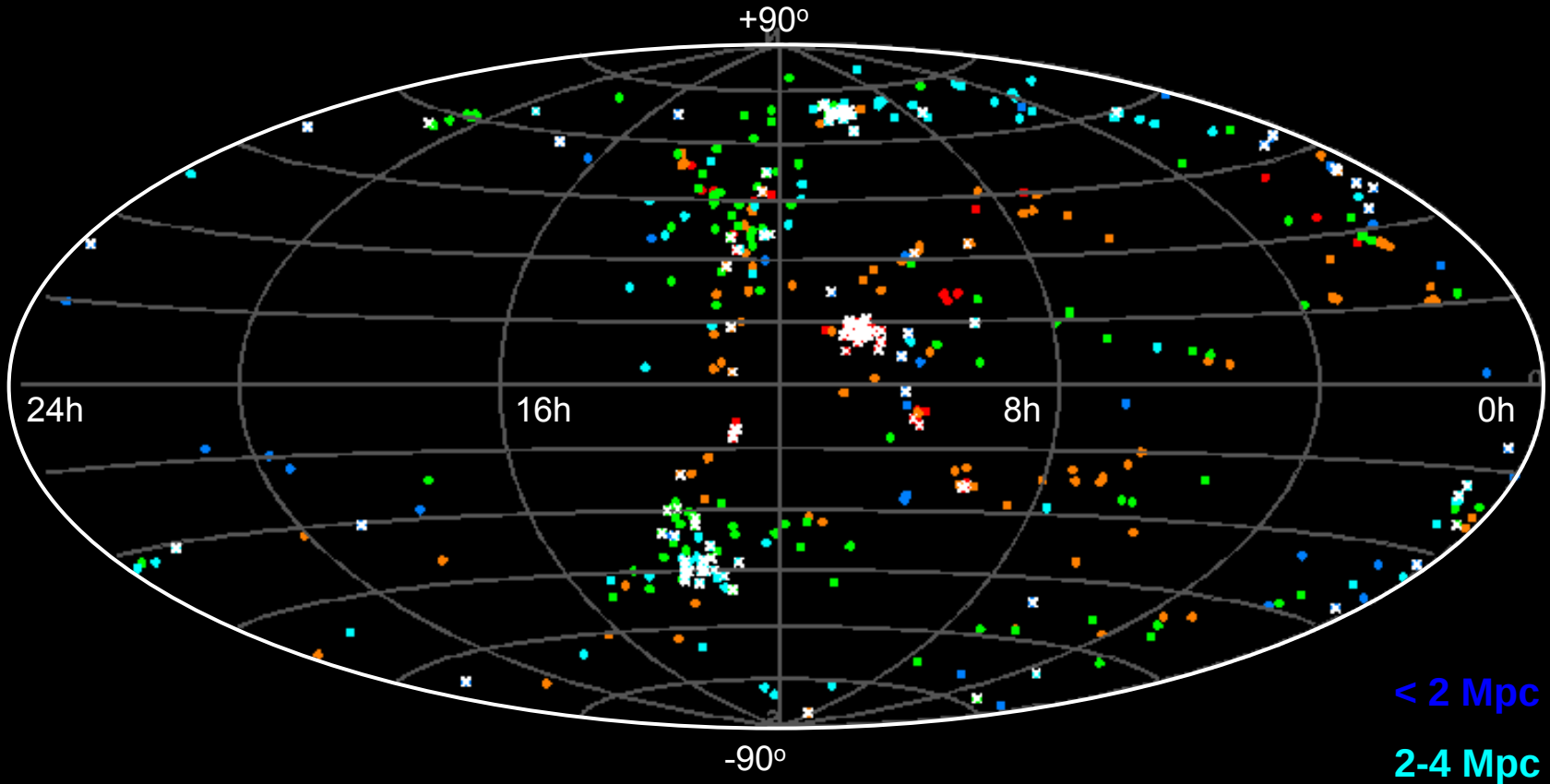
Galaxies in the Local Volume



LV Galaxy Groups



LV Galaxies with HI gas



< 2 Mpc

2-4 Mpc

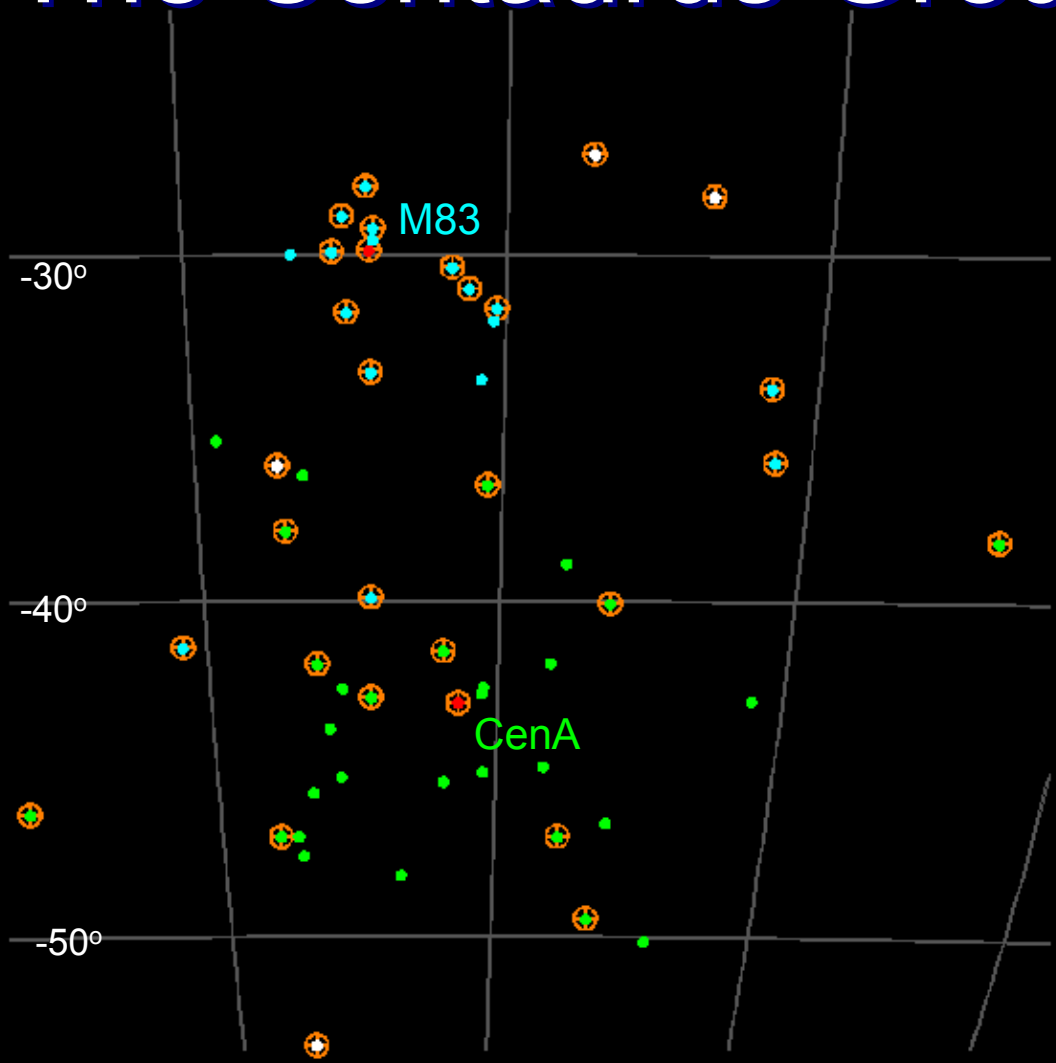
4-6 Mpc

6-8 Mpc

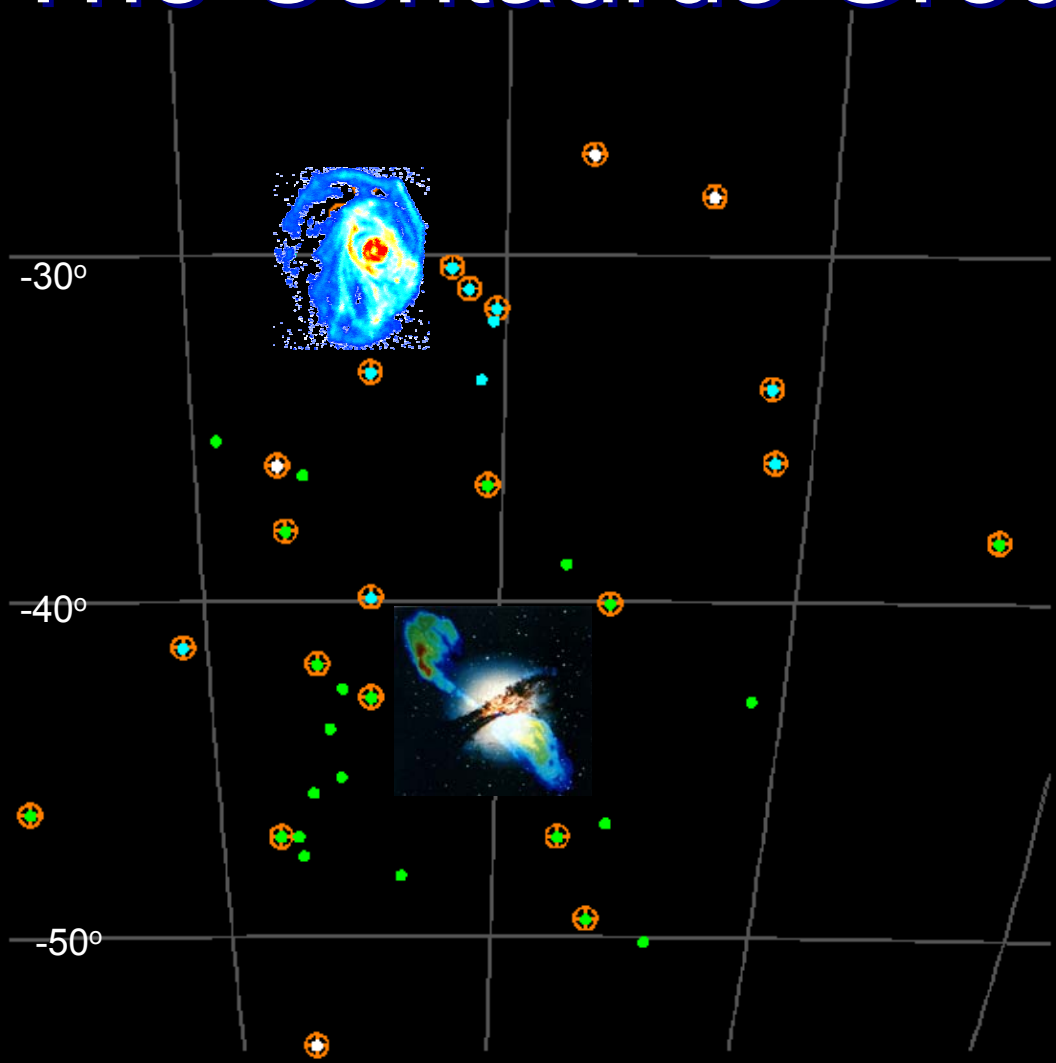
> 8 Mpc

Galaxies marked with x have not been detected in HI.

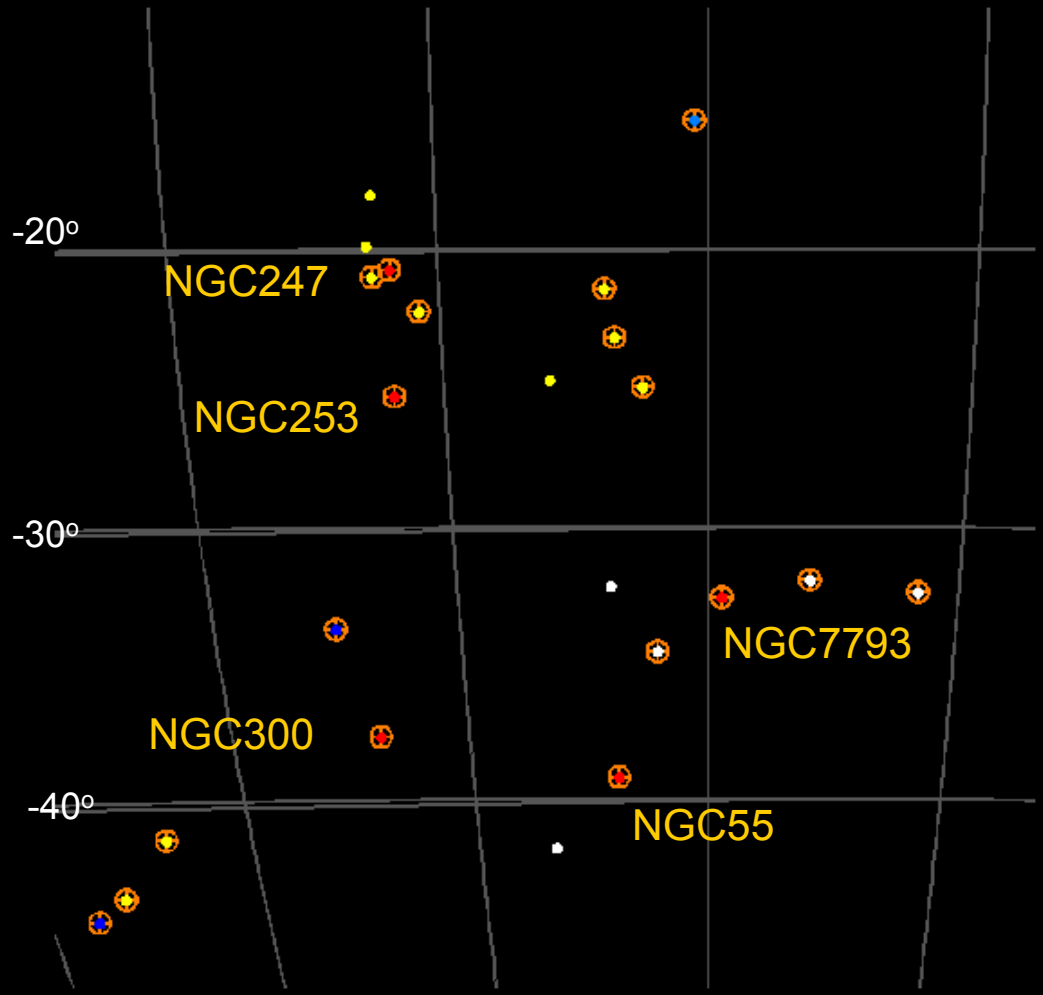
The Centaurus Group



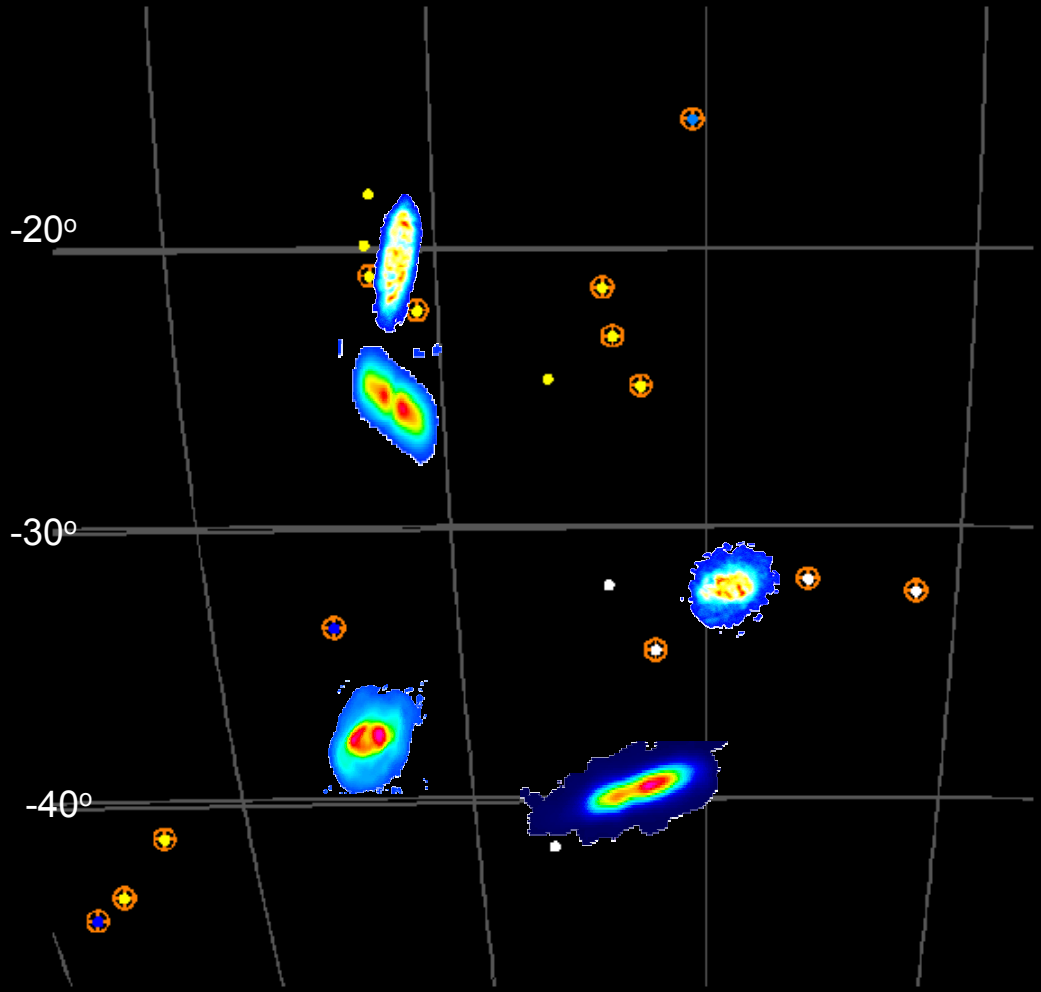
The Centaurus Group



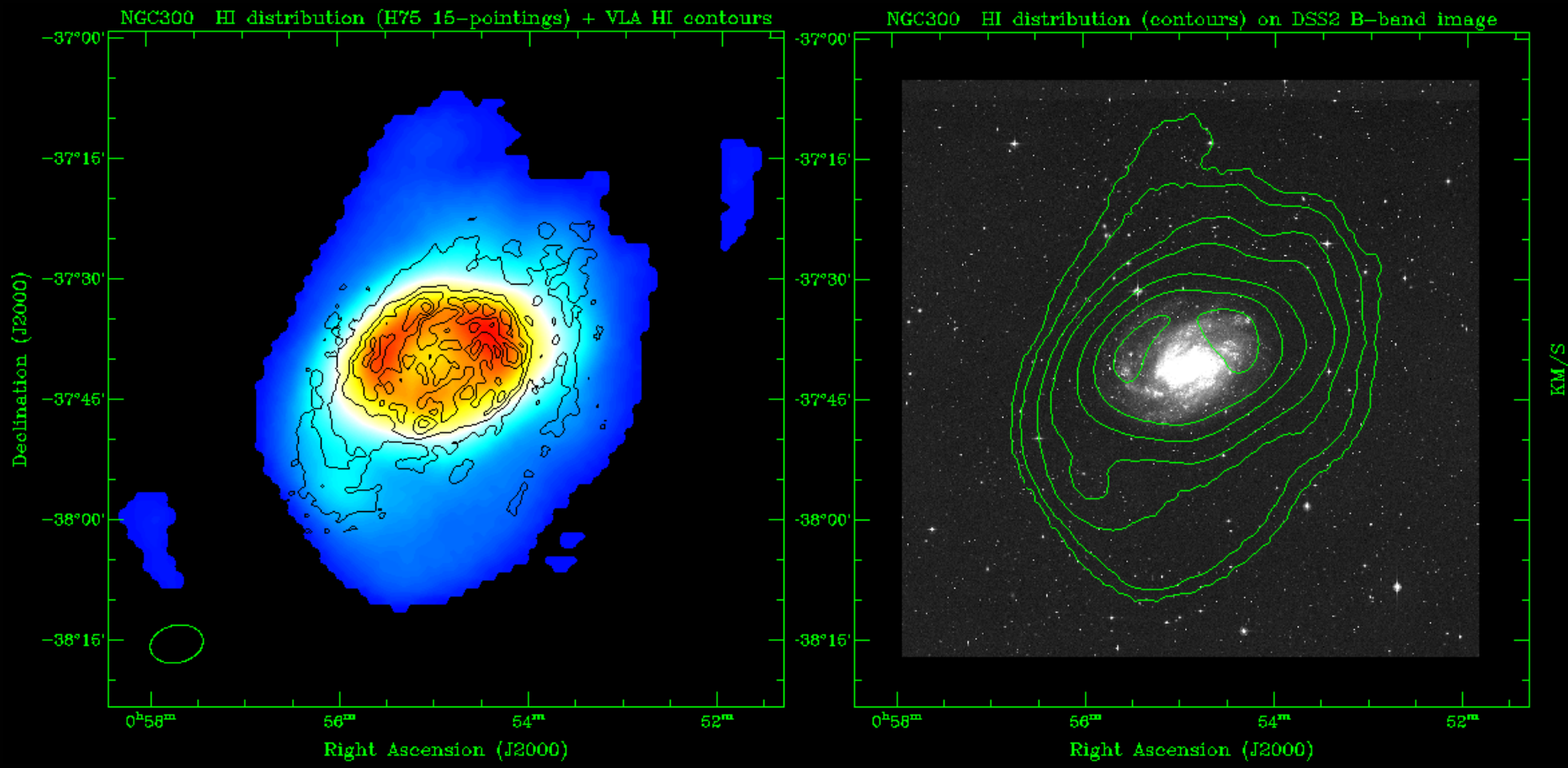
The Sculptor Group



The Sculptor Group

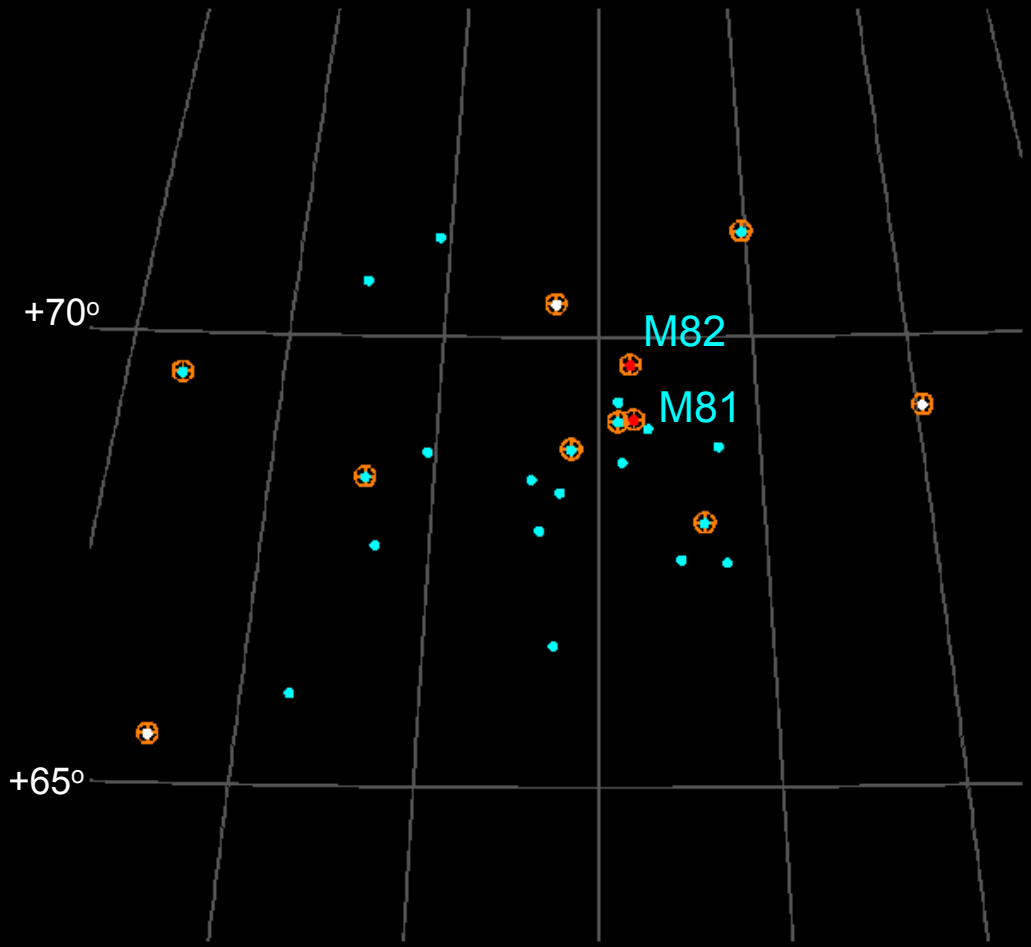


NGC 300 in Sculptor

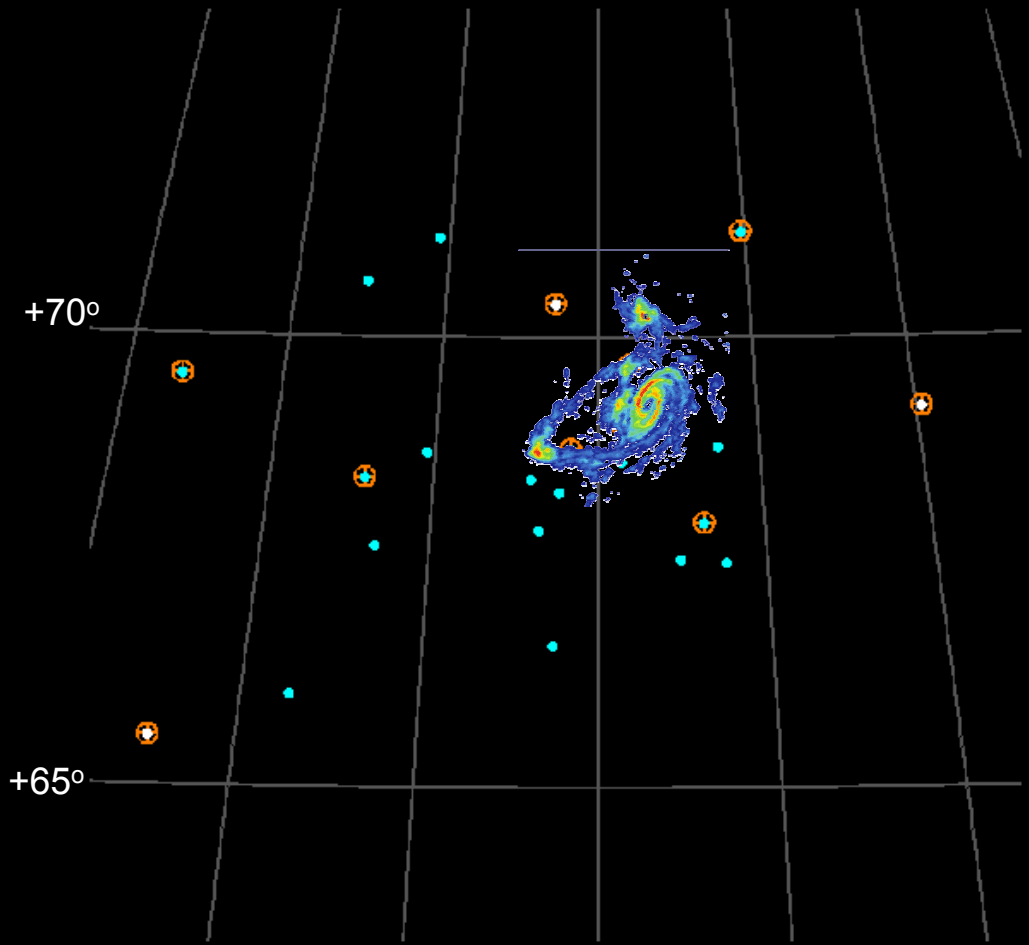


Cepheid distance = 2.15 Mpc

The M81 Group

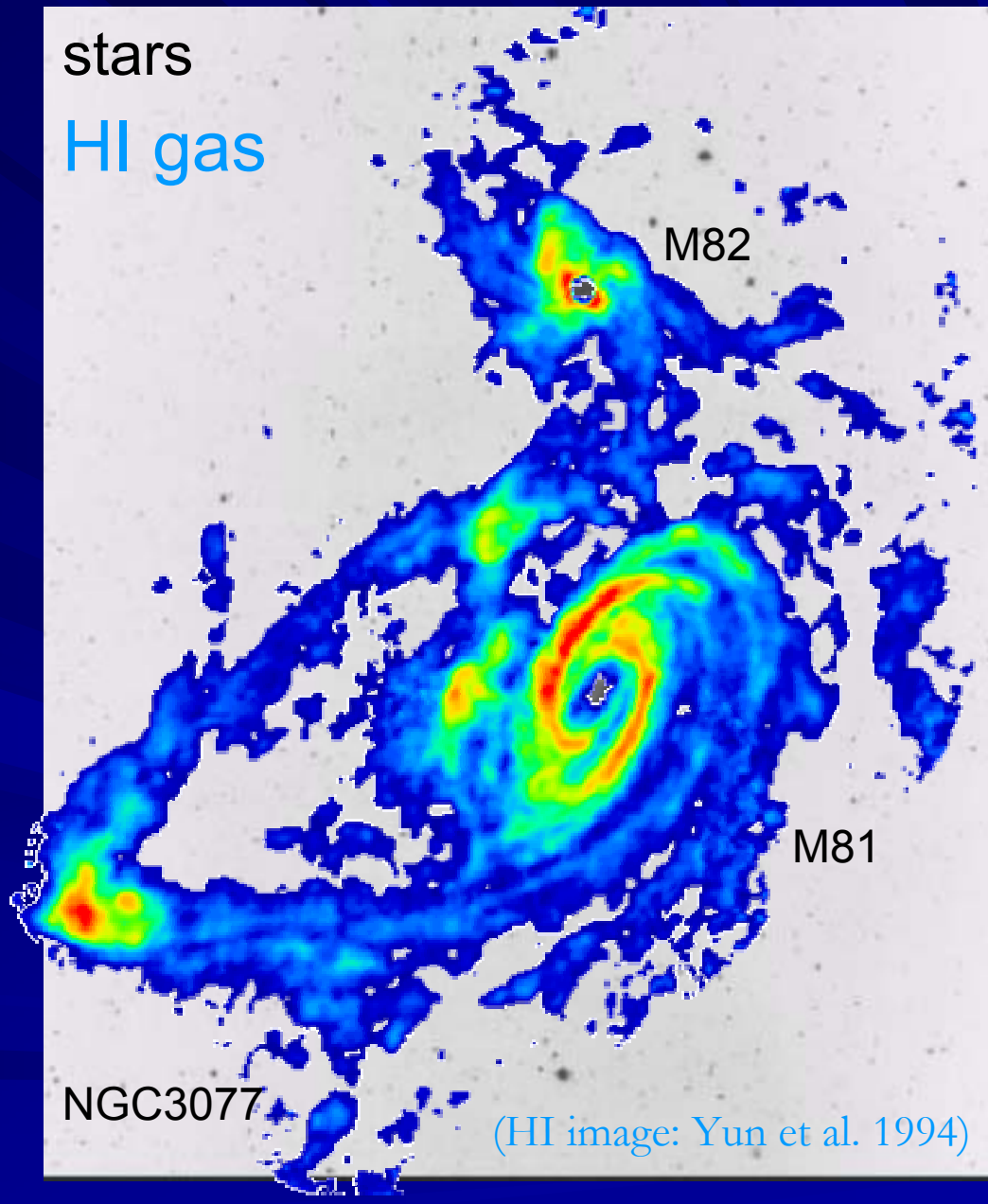


(part of) The M81 Group

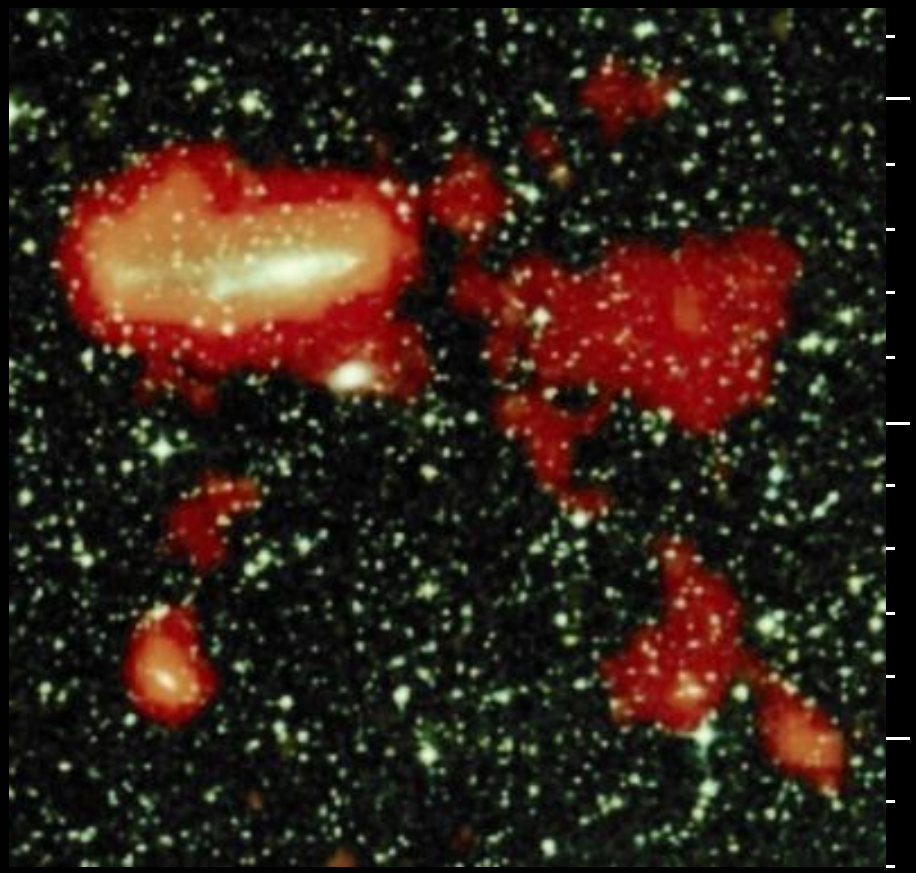


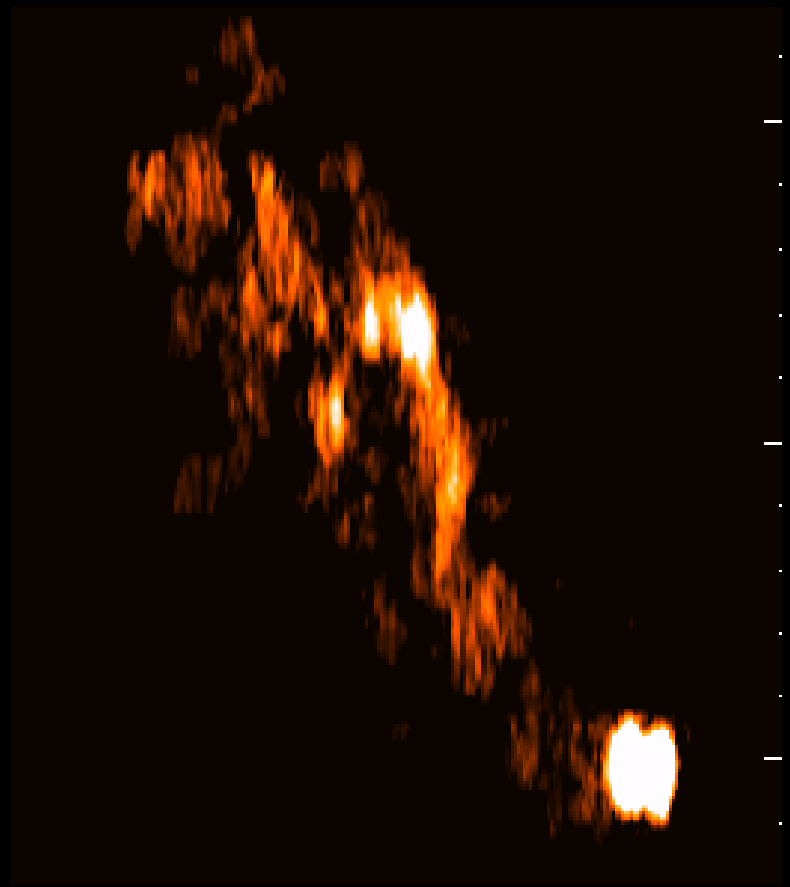
The interacting galaxy group

M81-M82-NGC 3077



Gas between galaxies !





while
most galaxies appear to live in
galaxy groups, and
many are clearly interacting with
their closest neighbours,
some appear to be rather isolated.

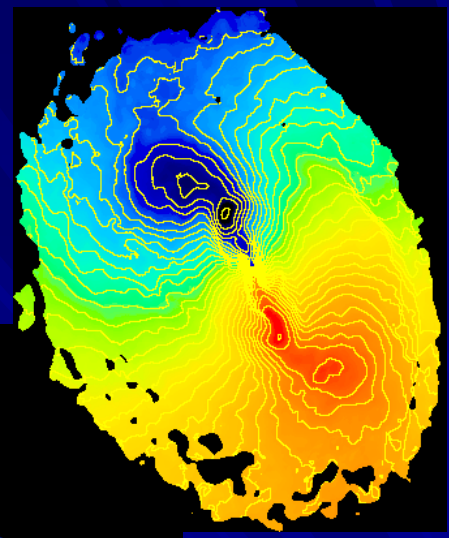
The Circinus Galaxy

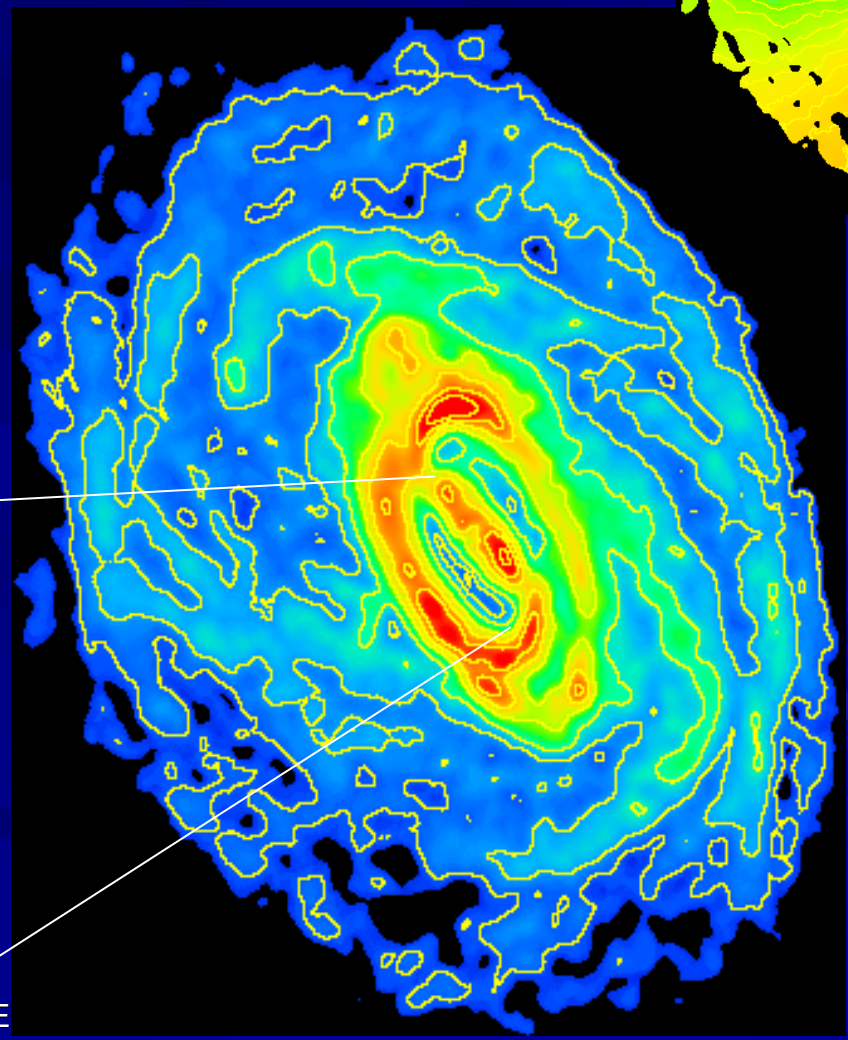
(Jones, Koribalski, Elmouttie & Haynes 1999)

D = 4.2 Mpc

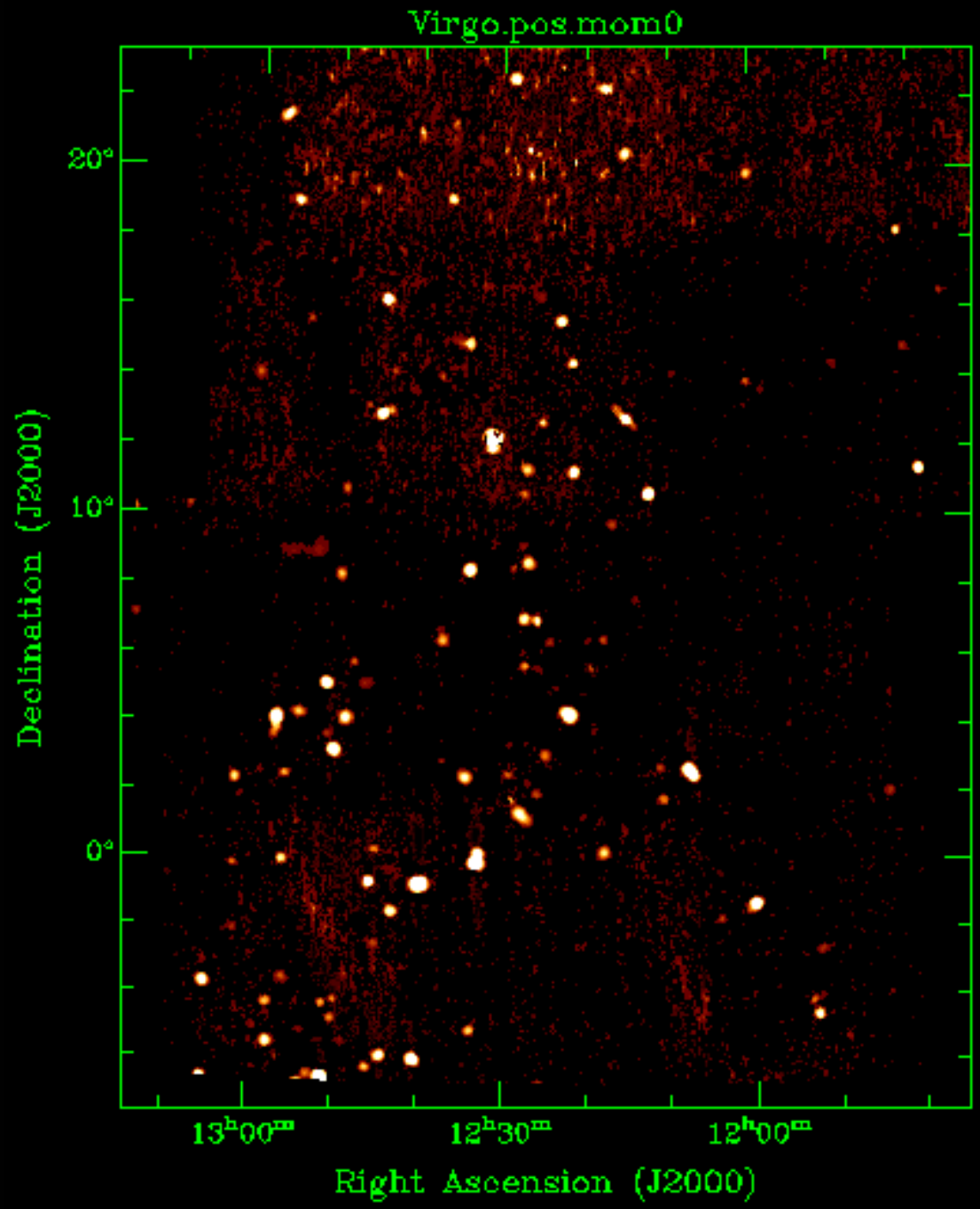
HI extent > 73 kpc
= 4 x R_{Ho}

$M_{HI} = 8 \times 10^9 M_\odot$





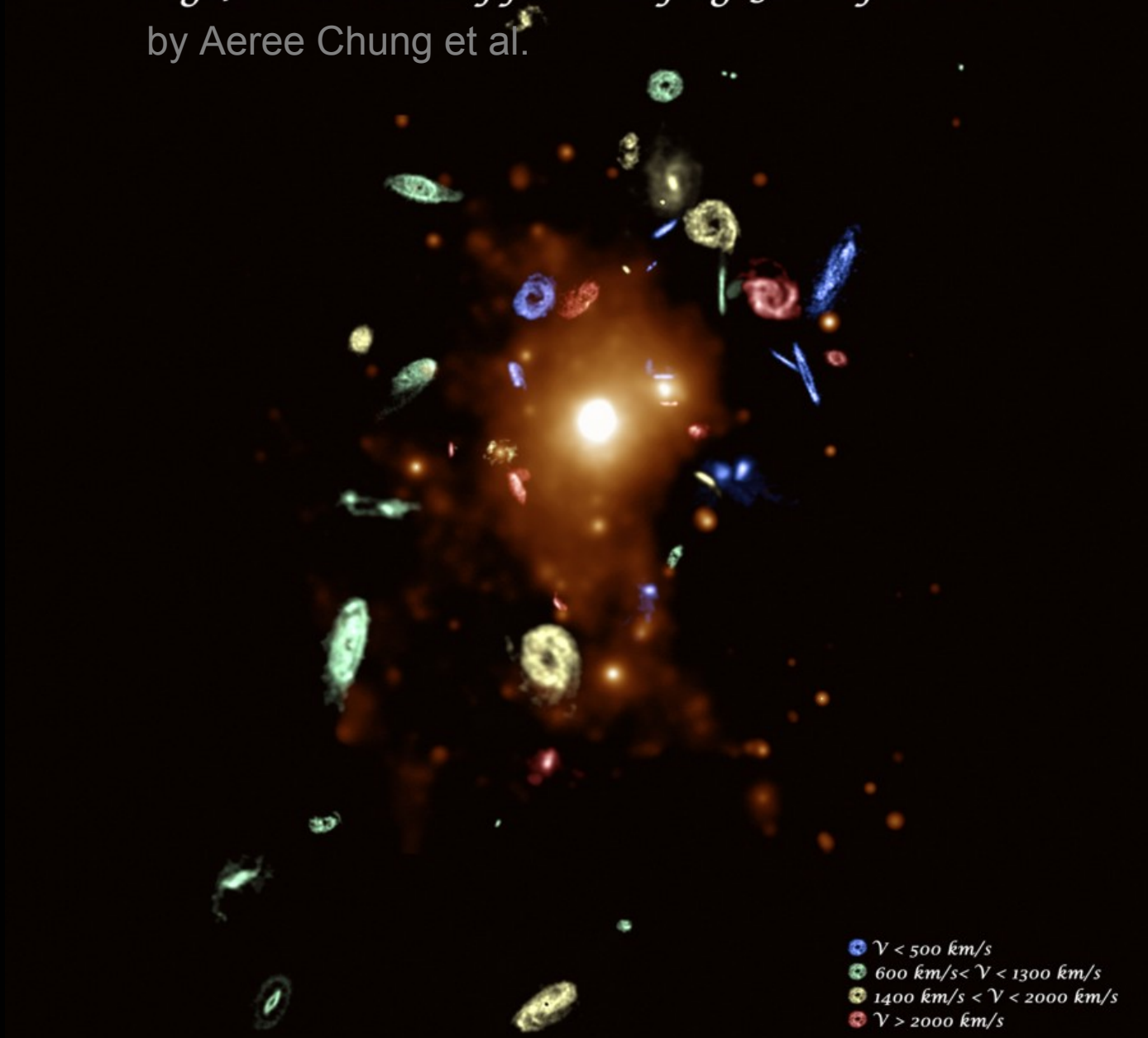
then there are groups of groups,
making galaxy clusters,
the closest of which is
the Virgo cluster



The Virgo Cluster as seen in HIPASS

Virgo, A Laboratory for Studying Galaxy Evolution

by Aeree Chung et al.



What is LVHIS ?

- "The Local Volume HI Survey"

  It comprises

  – deep HI imaging of all nearby, gas-rich galaxies (D < 10 Mpc or v_{LG} < 550 km/s)

  – and deep 20-cm radio continuum imaging

  – initially with the AT Compact Array (for δ < -30°), started in Jan 2005, aim for 3x12h per galaxy

  – expand to Very Large Array (for δ > -30°)

  + accurate distances (TRGB, Karachentsev et al.)

  + deep H-band and Hα imaging (Jerjen, de Blok et al.)

LVHIS Team

- Bärbel Koribalski (ATNF, CSIRO)
- Lister Staveley-Smith (ATNF, CSIRO)
- Jürgen Ott (ATNF, CSIRO)
- Erwin de Blok (RSAA)
- Helmut Jerjen (RSAA)
- Igor Karachentsev (SAO, Russia)
- Katie Kern (Swinburne University; ATNF, CSIRO)
- …

www.atnf.csiro.au/people/bkoribal/LVHIS

Motivation for LVHIS

- some of the most important astrophysical questions are best investigated using sensitive, high-resolution observations of nearby galaxies, e.g.
  - the (baryonic) Tully-Fisher (TF) relation
  - the local Hubble flow
  - the HI mass function
  - SFR in the LV
  - FIR-radio correlation
  - etc.
- important: high-resolution HI velocity fields $\Rightarrow$ rotation curves $\Rightarrow$ dynamical mass
- important: HI distribution on all scales $\Rightarrow$ galaxy environment $\Rightarrow$ neighbours, tidal tails, warps, etc.

ok, let’s zoom-in to M83

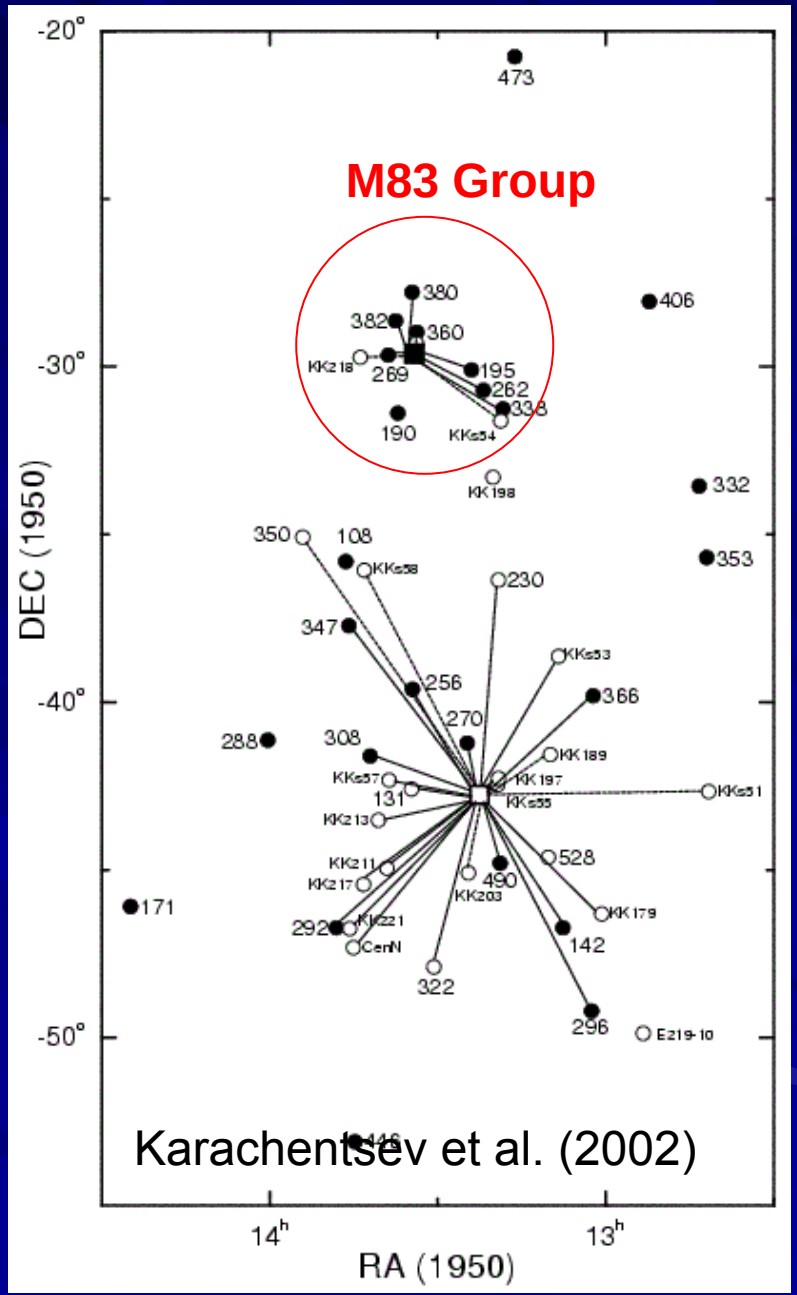
CenA Group

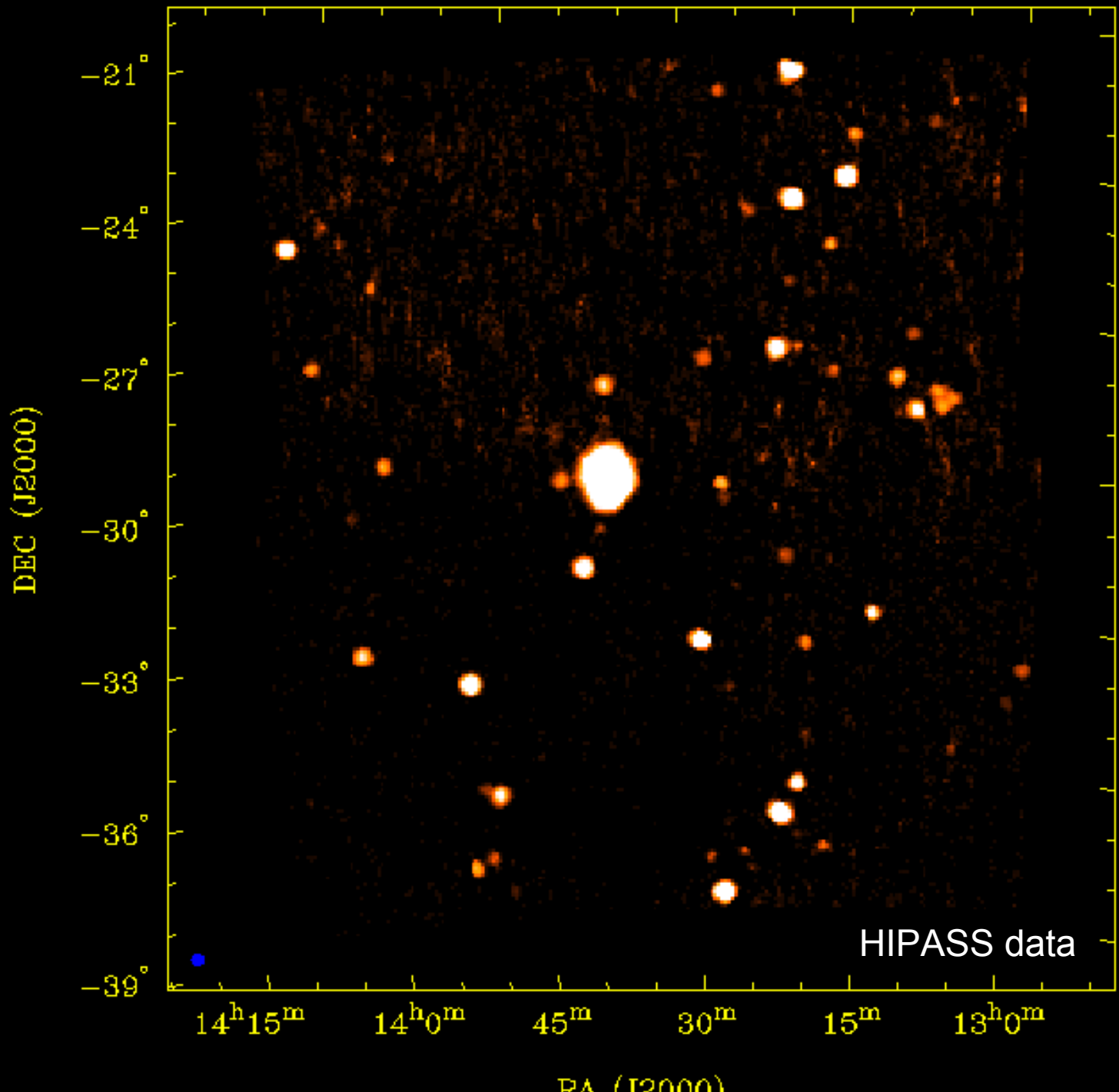
two subgroupings ?

1) around M83
(D = 3.6 Mpc)

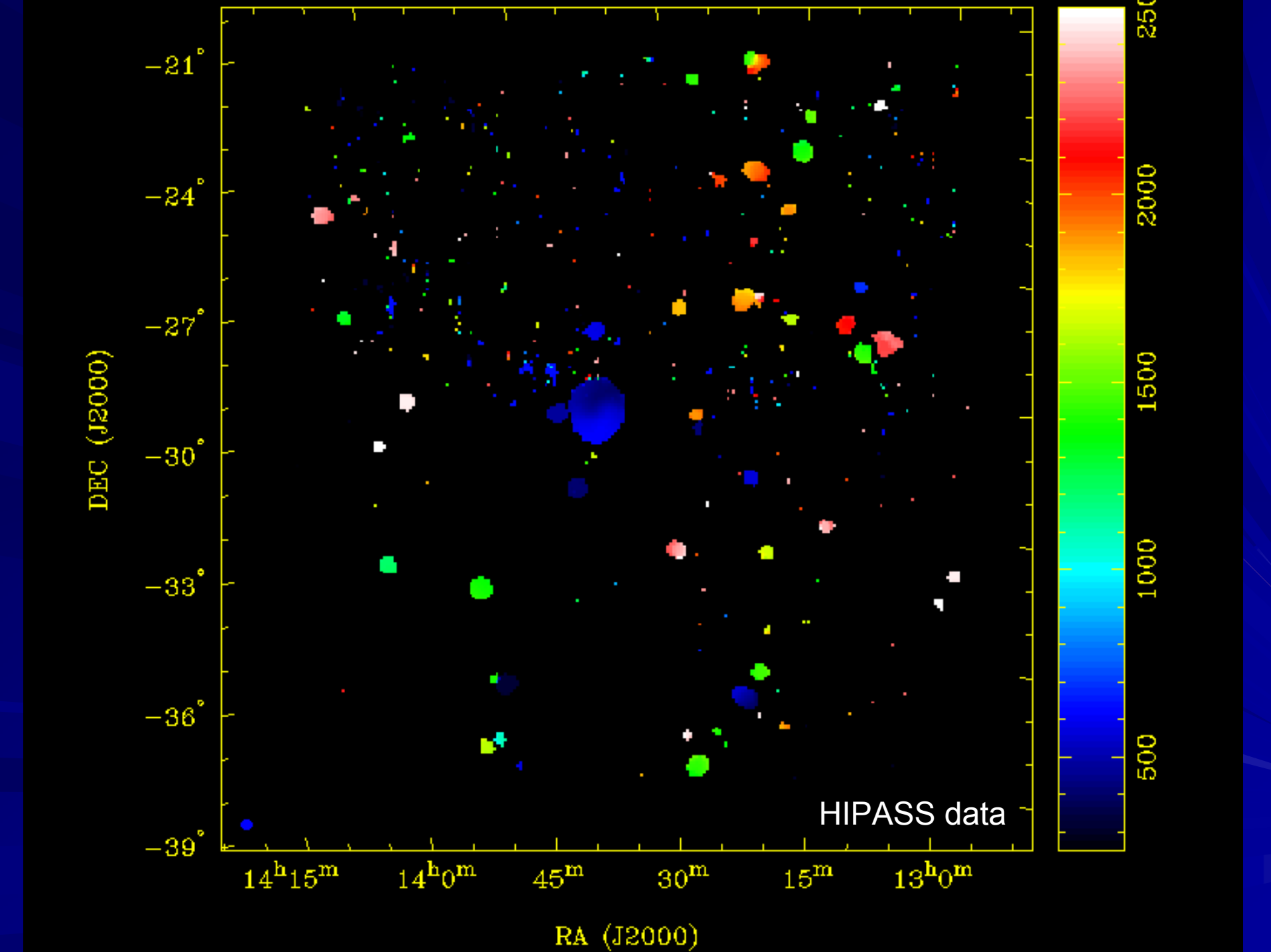
2) around CenA
(D = 4.6 Mpc)

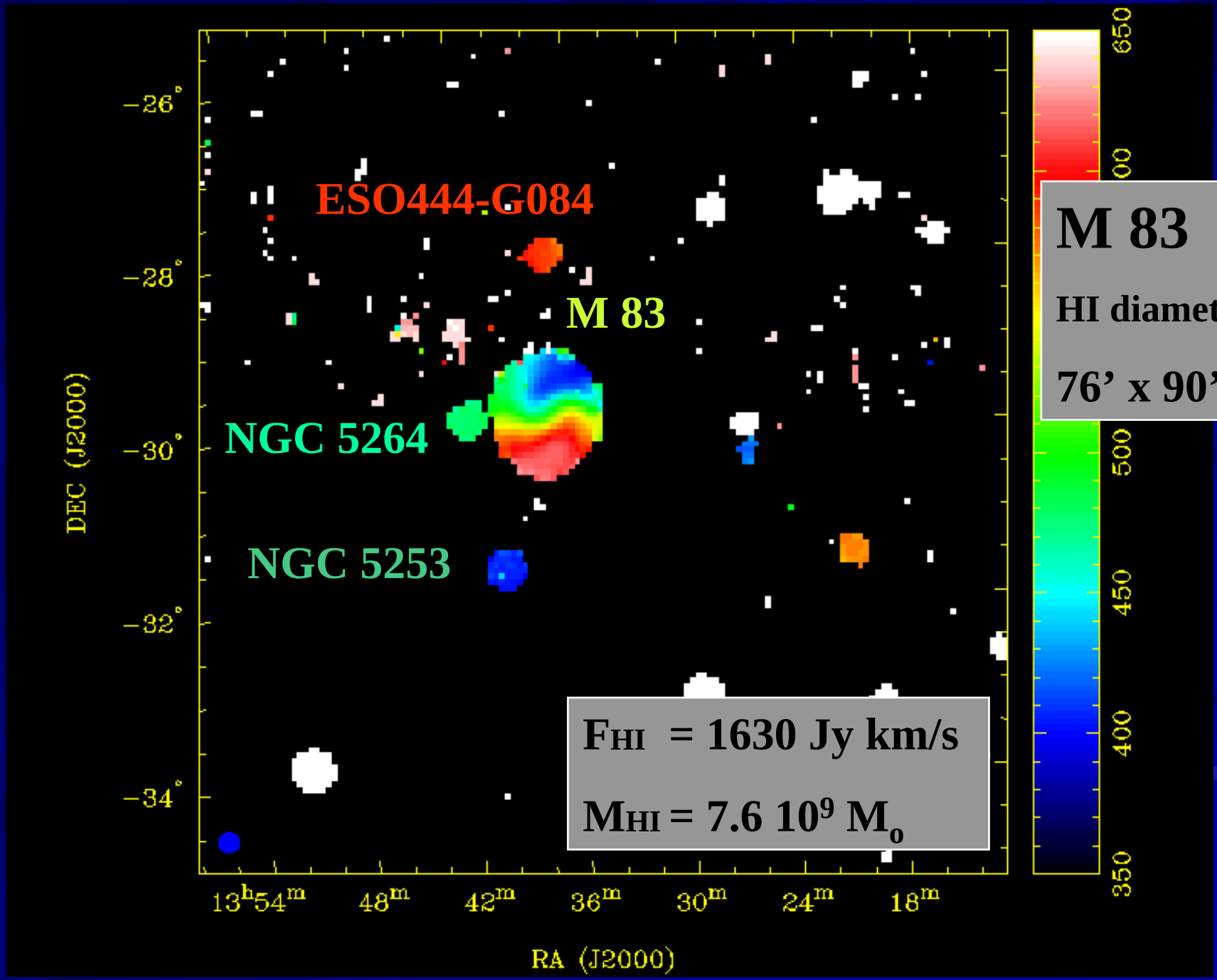
1’ = 1 kpc (D=3.5 Mpc)




−21°
−24°
−27°
−30°
−33°
−36°
−39°
DEC (J2000)
14h15m
14h0m
45m
30m
15m
13h0m
RA (J2000)
HIPASS data

M83
et al.


−21°
−24°
−27°
−30°
−33°
−36°
−39°
DEC (J2000)
14h15m
14h0m
45m
30m
15m
13h0m
RA (J2000)
HIPASS data
500
1000
1500
2000
250


ESO444-G084
M 83
NGC 5264
NGC 5253
M 83
HI diameter:
76’ x 90’
FHI = 1630 Jy km/s
MHI = 7.6 10^9 Mo
DEC (J2000)
RA (J2000)
−26°
−28°
−30°
−32°
−34°
13h54m
48m
42m
36m
30m
24m
18m
650
600
500
450
400
350

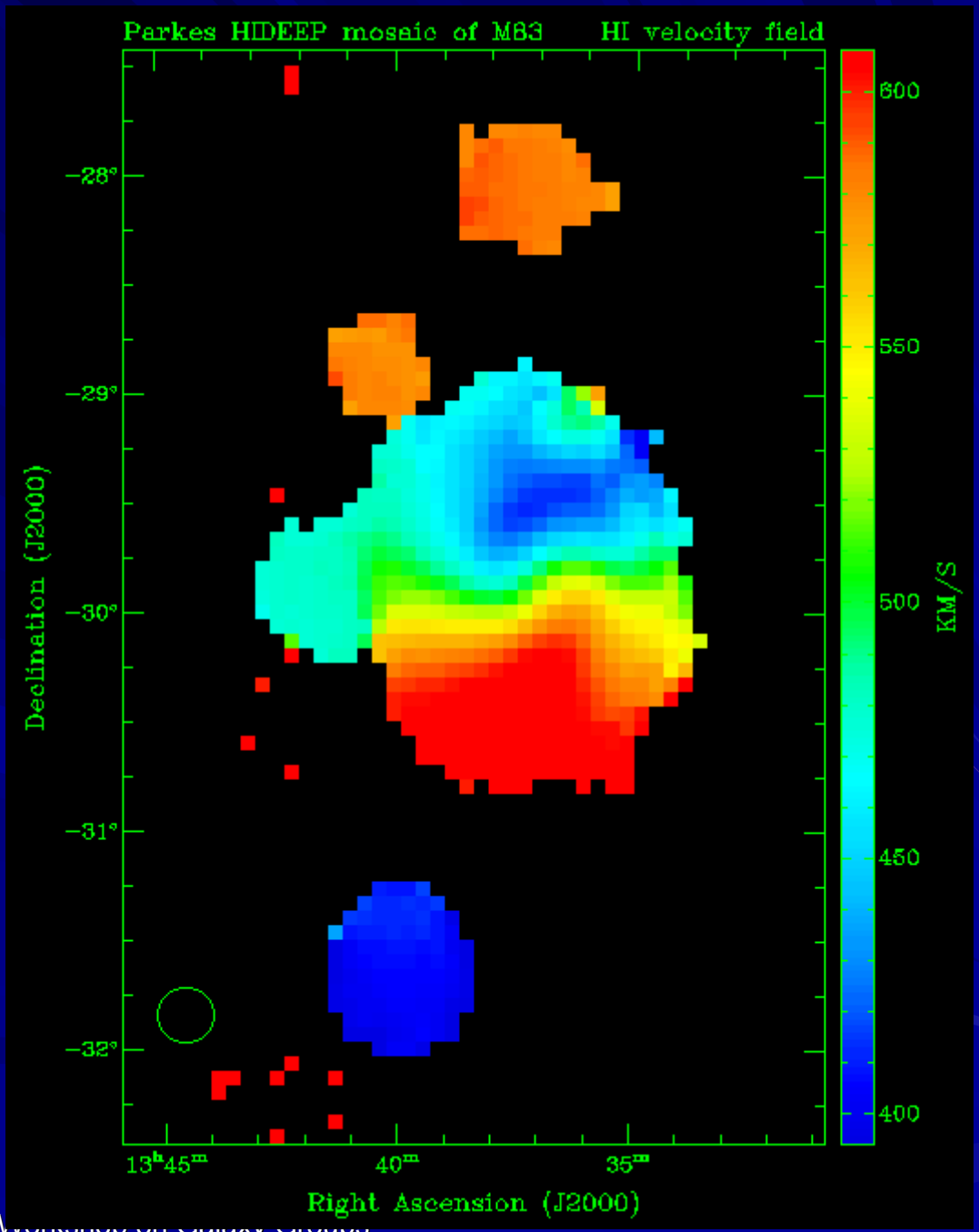
HIDEEP

re-reduced Parkes HI multibeam data (using minmed5)

20x HIPASS integration time

first contour:
0.7 x 10^{18} atoms/cm^2

No HI filaments !!



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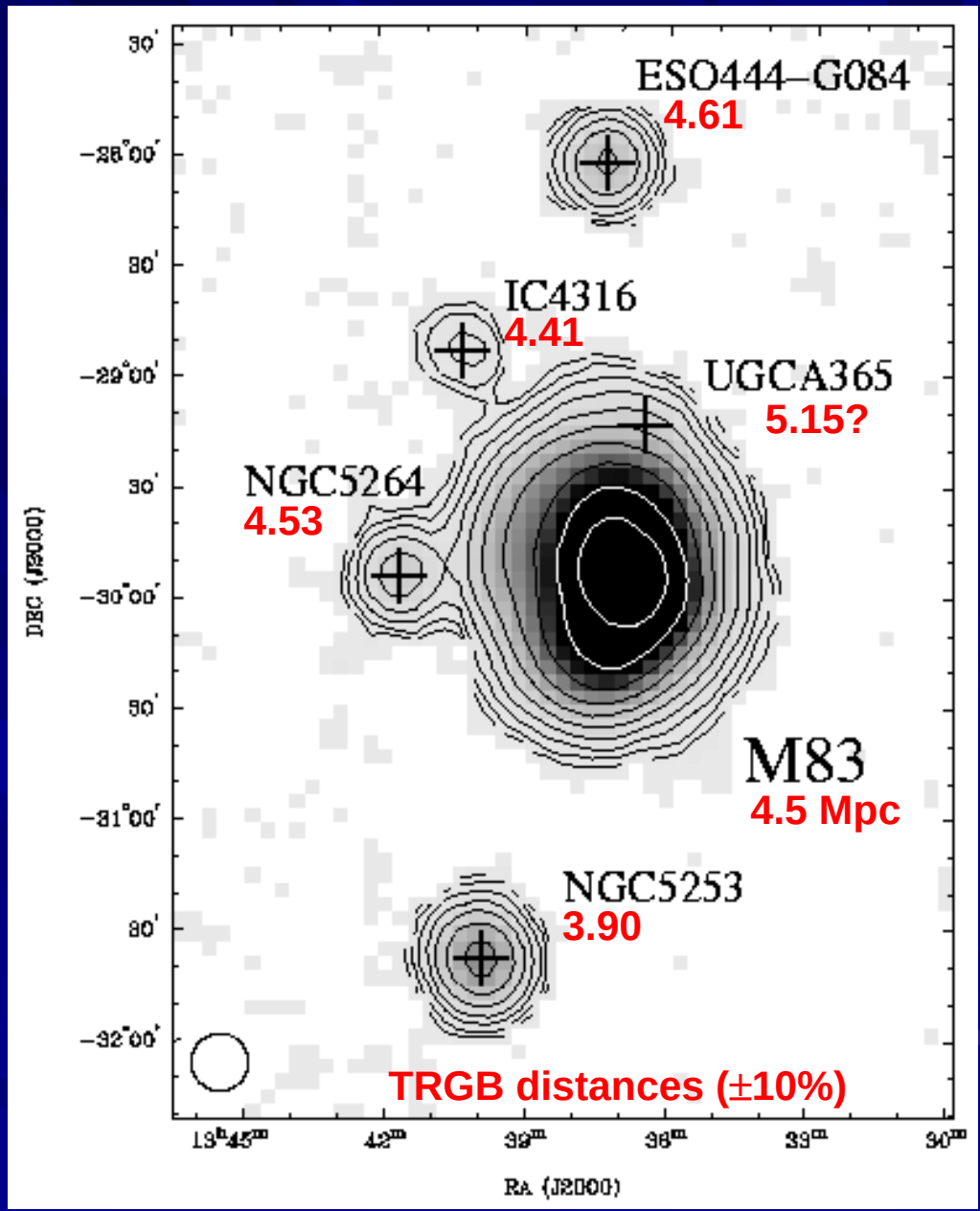

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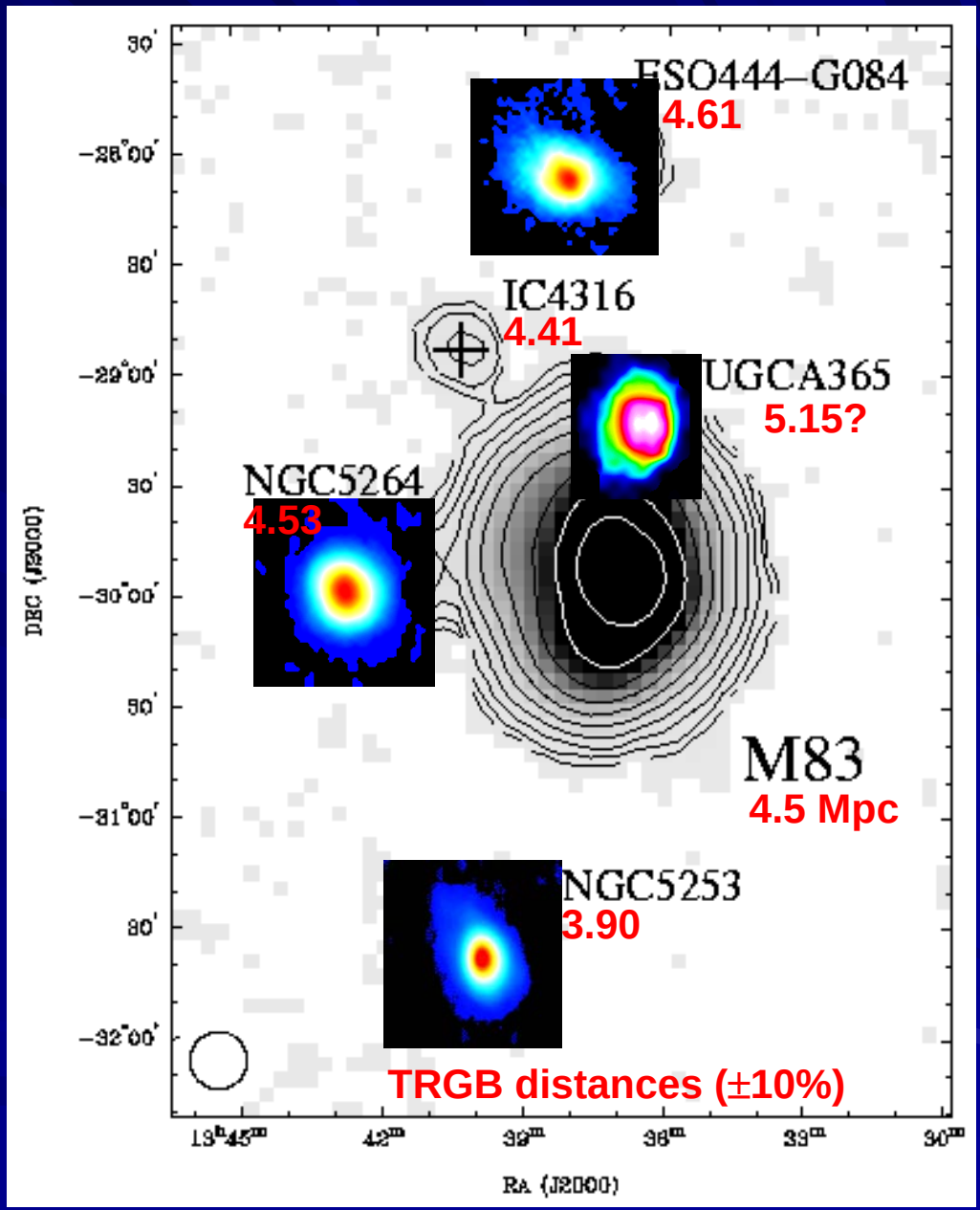
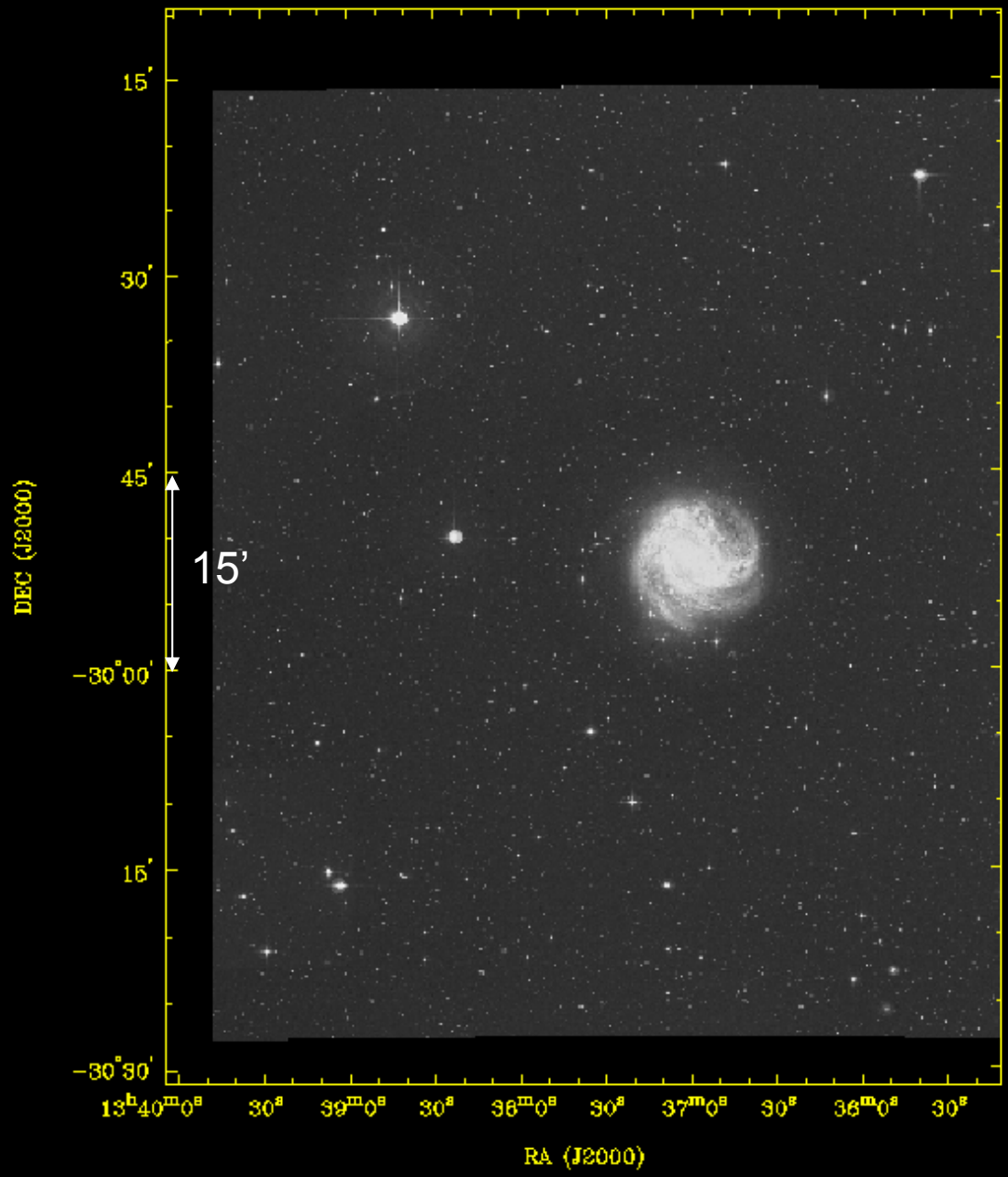


M83: optical image

B_{25} diameter ~ 12’

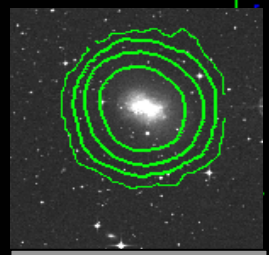
$B_{26.5}$ diameter ~ 14.6’

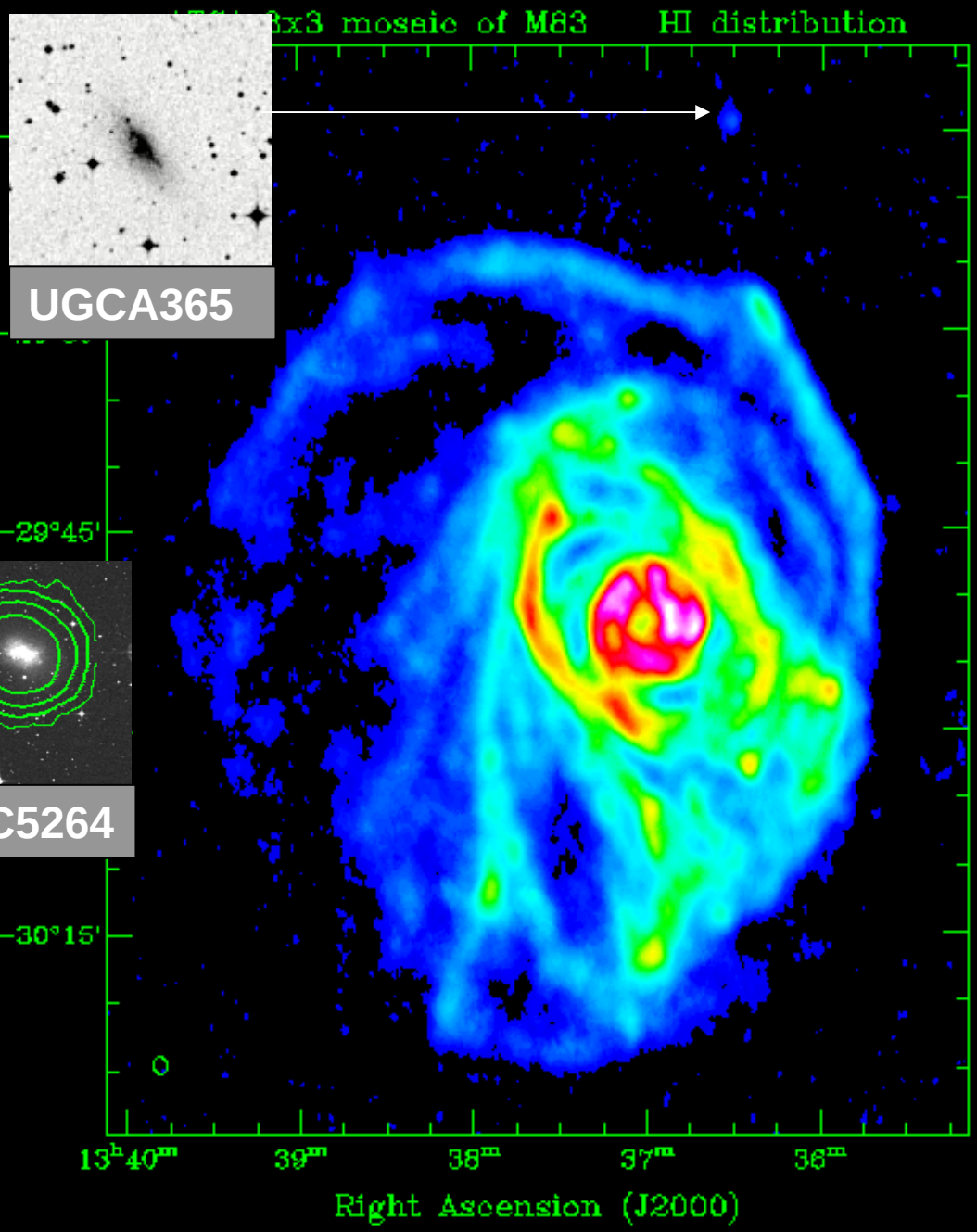
(Holmberg diameter)



M83: HI distribution

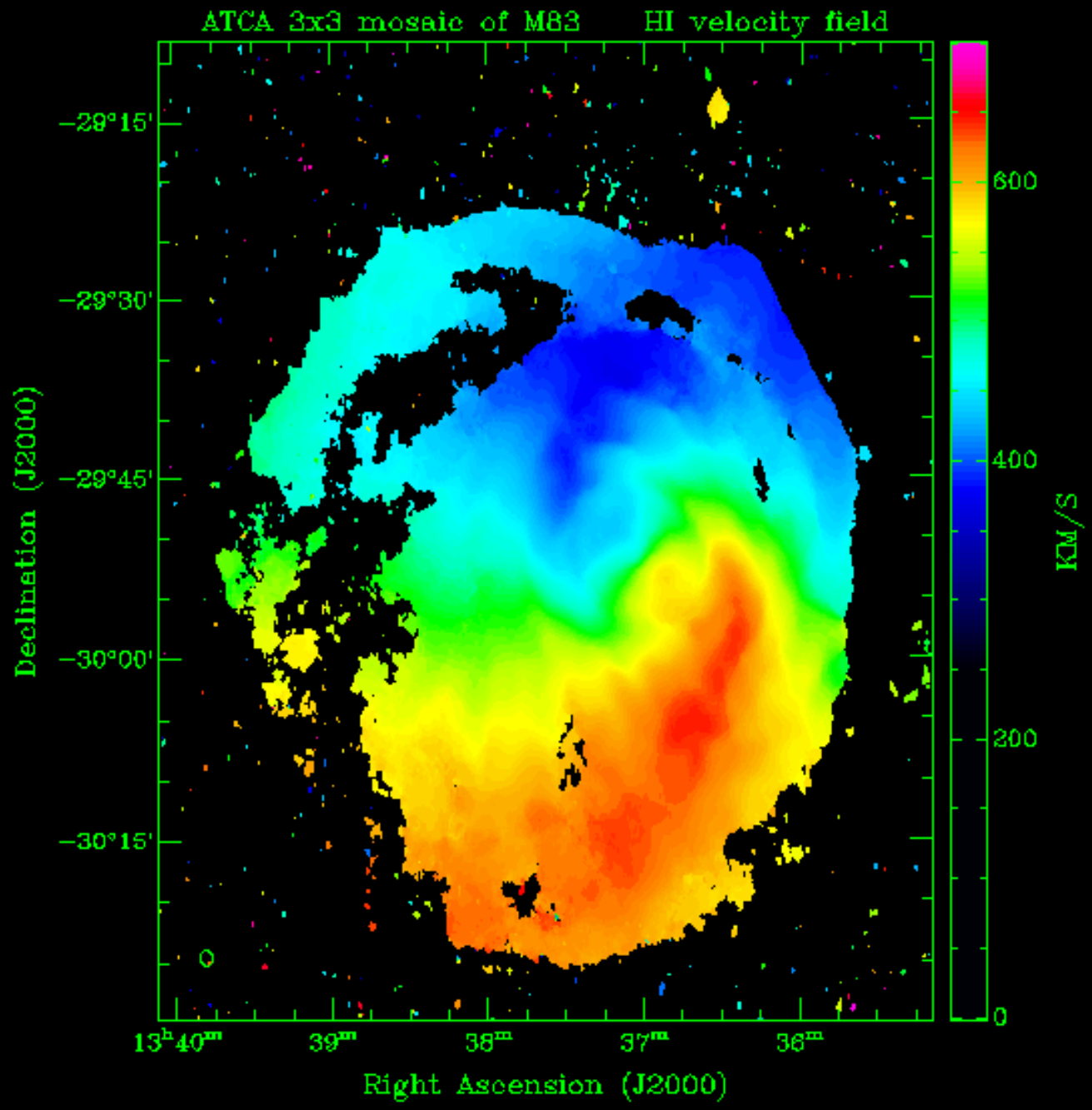
- huge gas envelope (~5 x Holmberg diameter)
- ~80 kpc diameter
- asymmetric
- peculiar
- prominent tidal arm
- ⇒ interacting galaxy
- M_{HI} = 8 x 10^9 $M_\odot$
- ATCA mosaic (180 h) + Parkes narraow-band HI data)





M83: HI velocity field

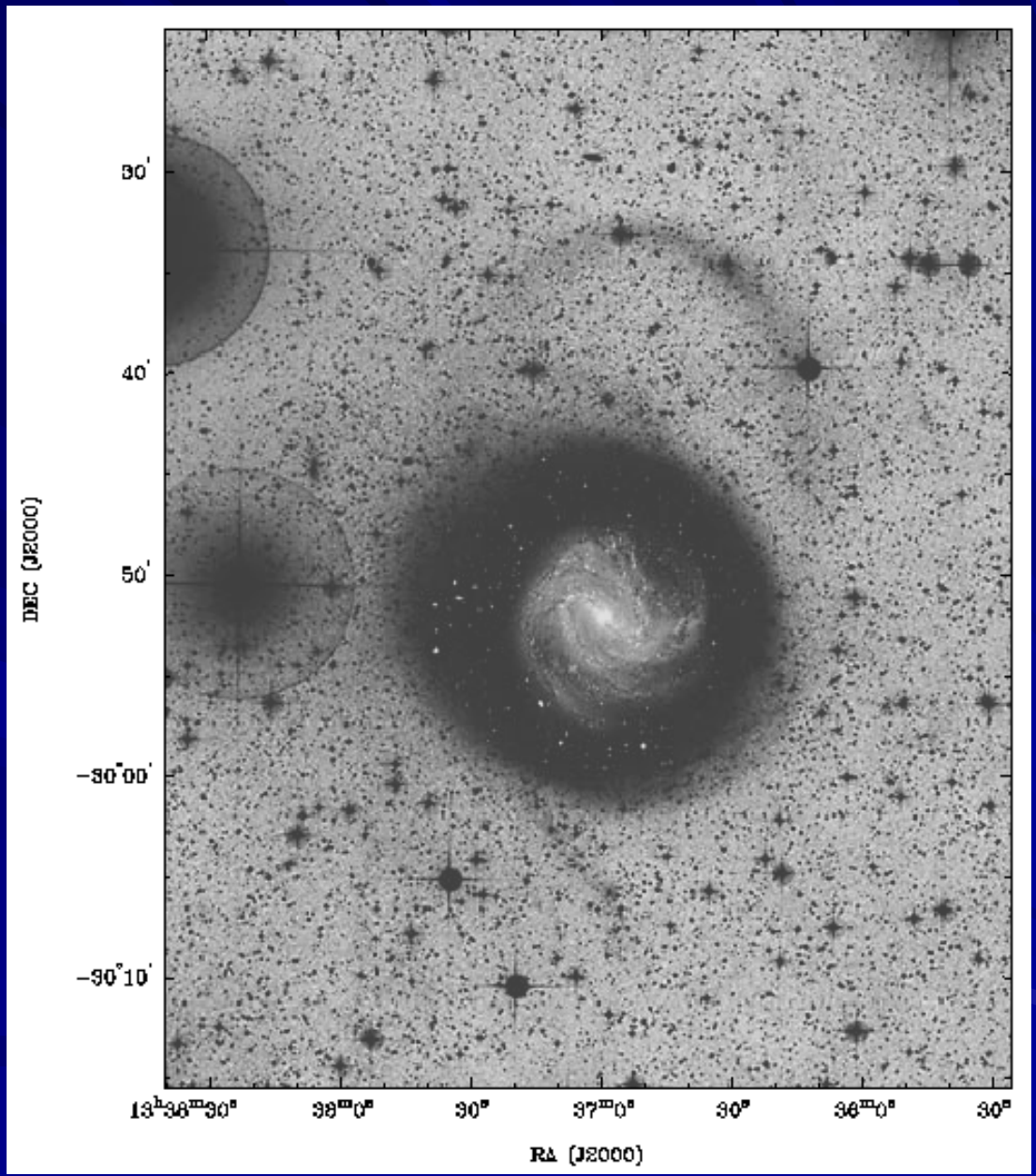
- regular within B_{25}
- warped, tilted, …
- peculiar
- total dynamical mass ~ 5 x 10^{11} $M_{\odot}$
- …



M83: deep optical image by D. Malin

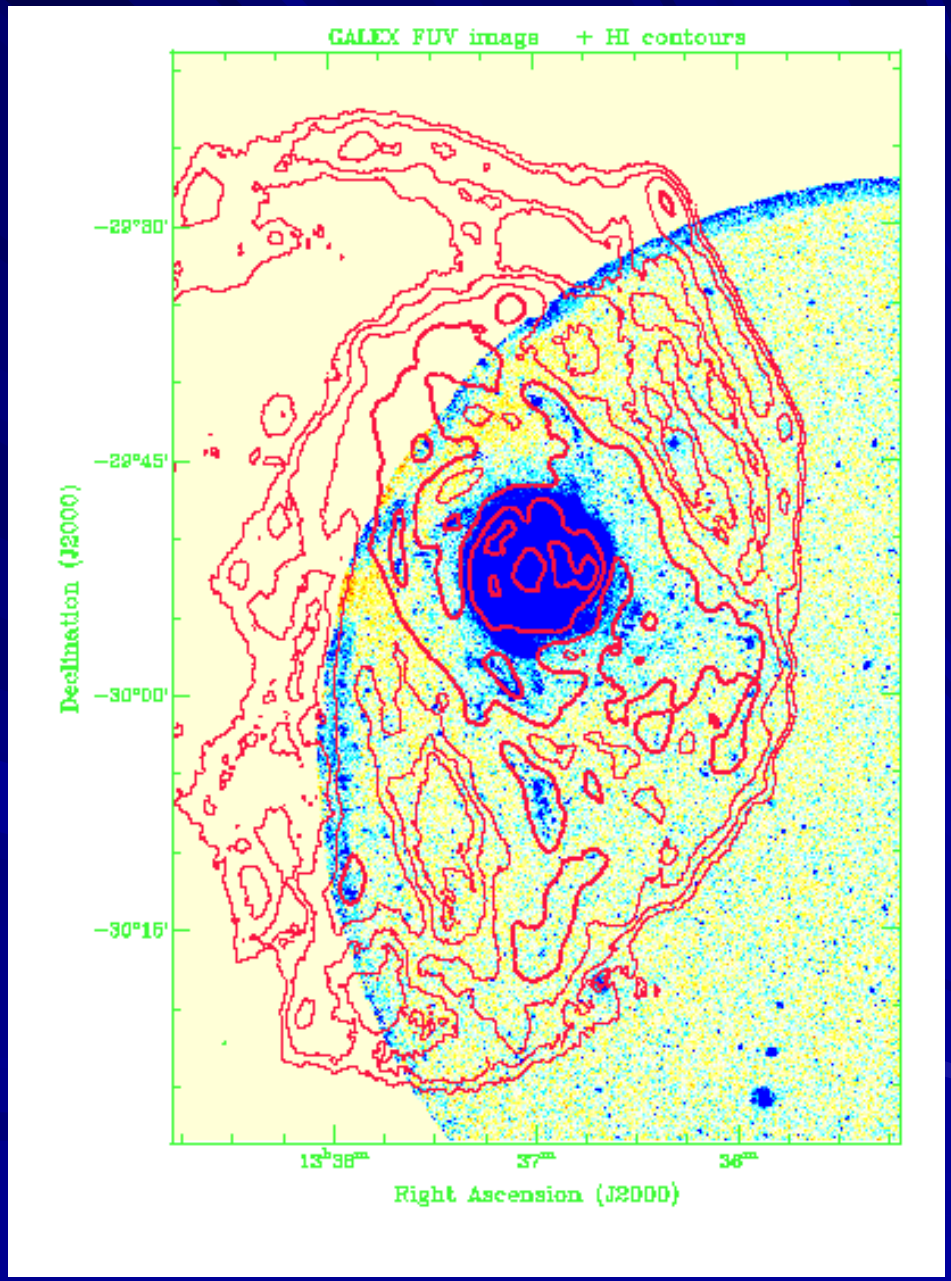
Three peculiar stellar features:

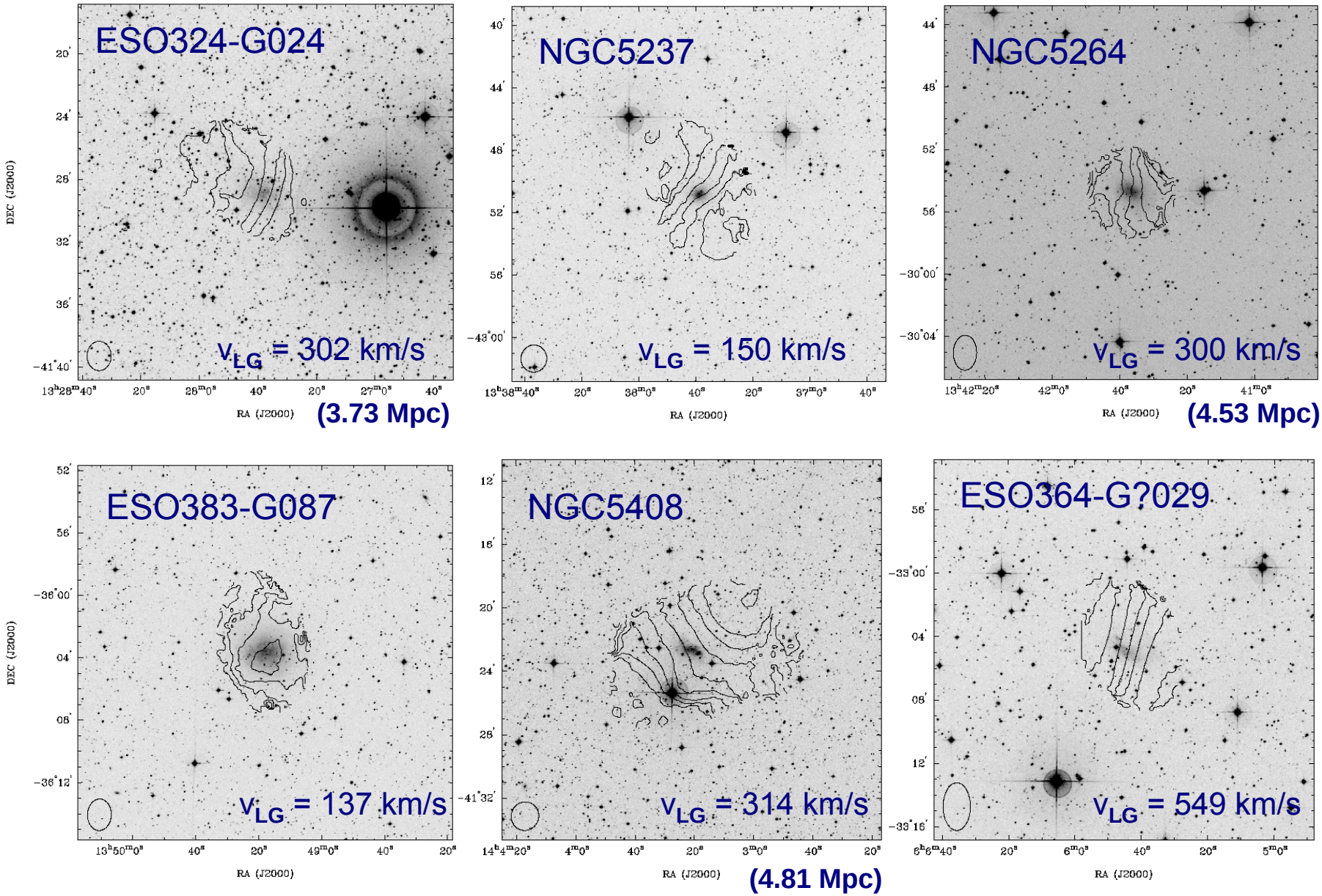
- prominent northern stellar stream (containing mainly old red stars)
- faint northern loop
- southern ridge



M83

Galex image overlaid with ATCA HI contours



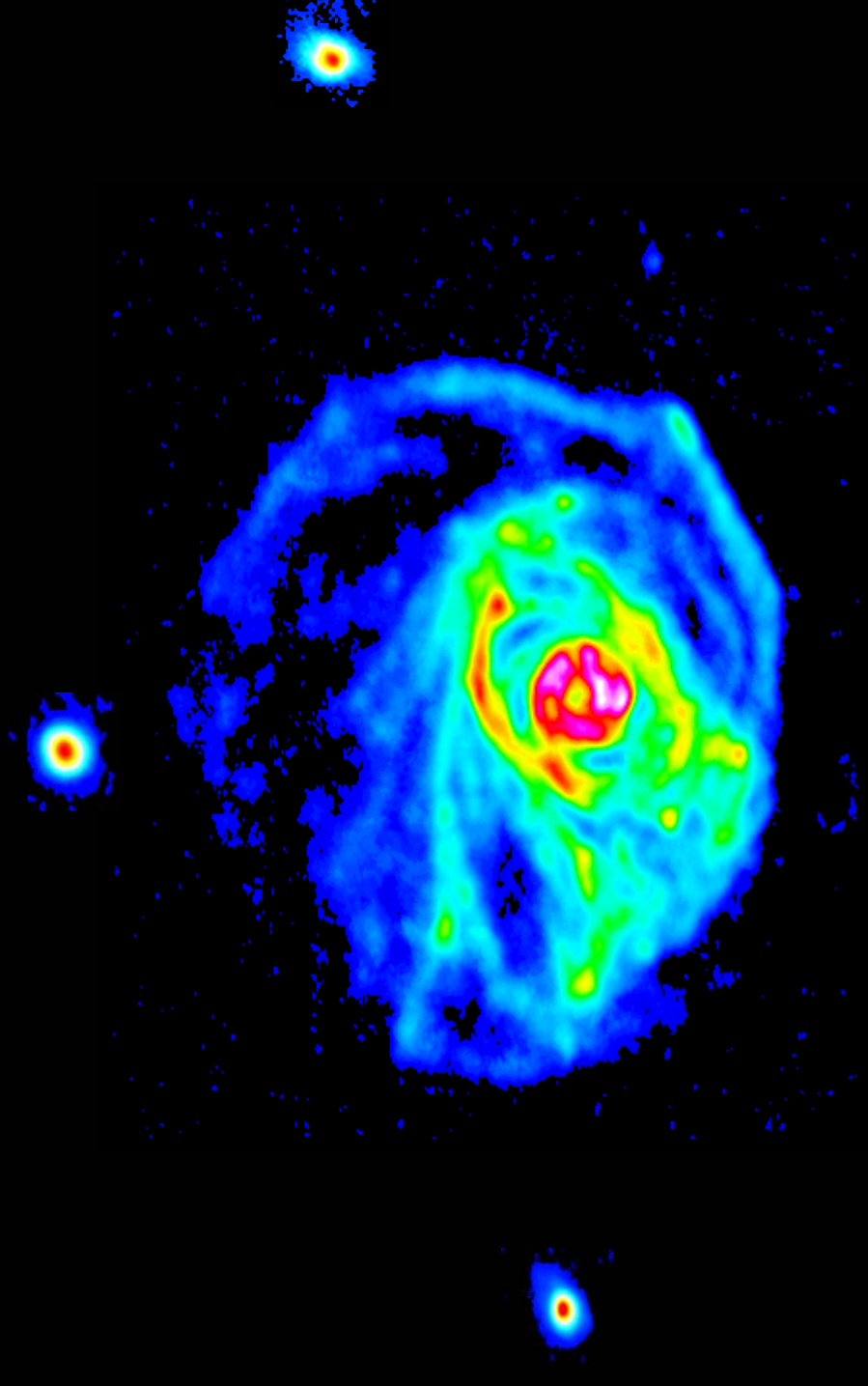

ESO324-G024
v_{LG} = 302 km/s
(3.73 Mpc)
NGC5237
v_{LG} = 150 km/s
NGC5264
v_{LG} = 300 km/s
(4.53 Mpc)
ESO383-G087
v_{LG} = 137 km/s
NGC5408
v_{LG} = 314 km/s
(4.81 Mpc)
ESO364-G?029
v_{LG} = 549 km/s
DEC (J2000)
RA (J2000)

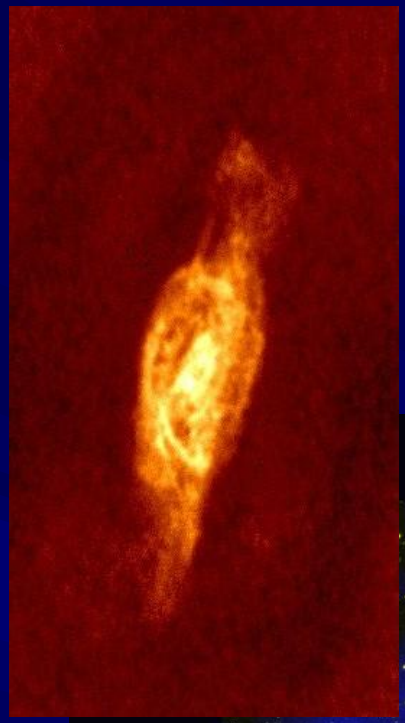
Summary

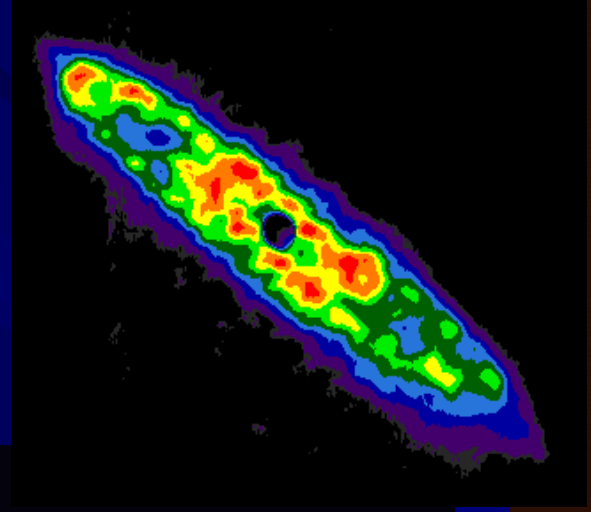
Galaxy Groups are important and provide environments where galaxies slowly evolve.

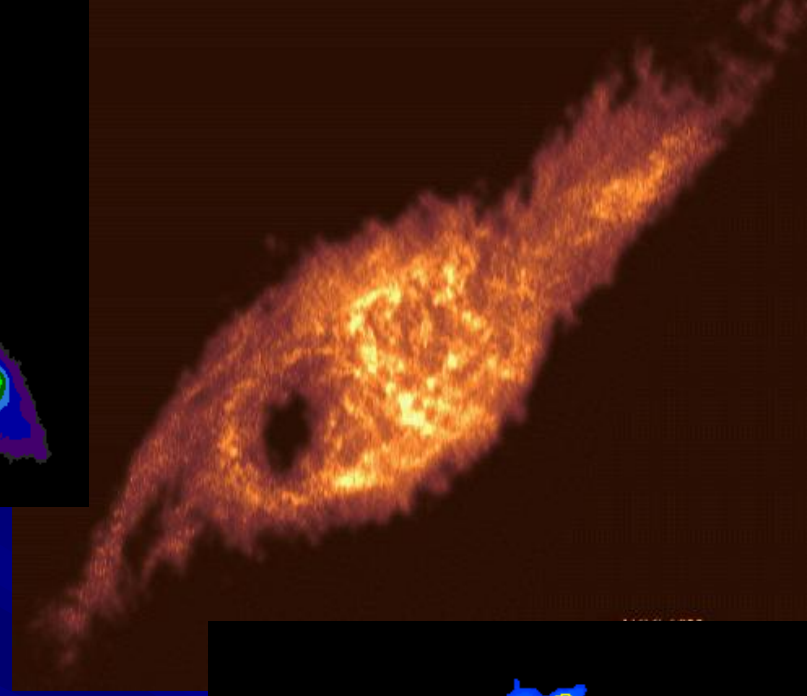
The spiral galaxy M83, for example, appears to grow by regularly accreting neighboring dwarf galaxies.

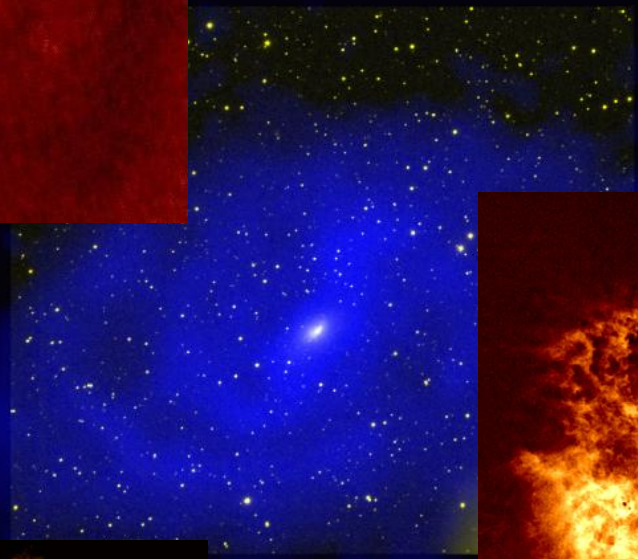
Gaseous tails and stellar streams tell us about the group evolution.

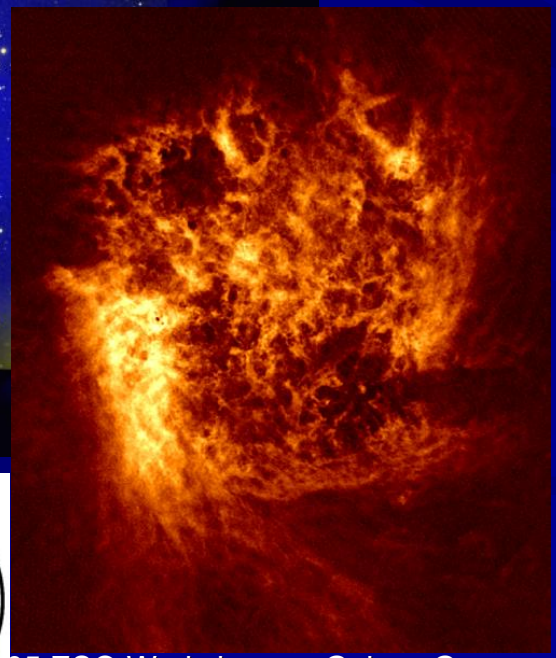


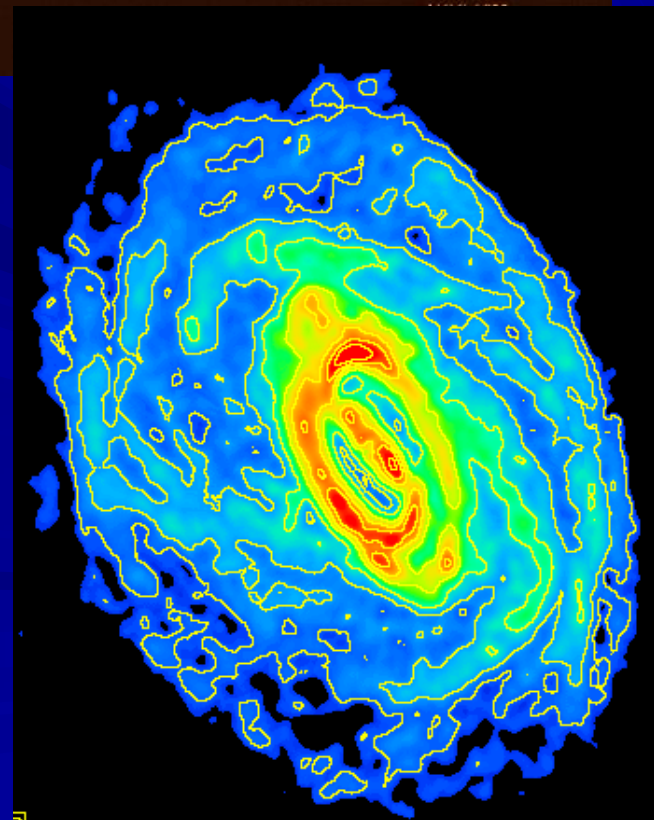


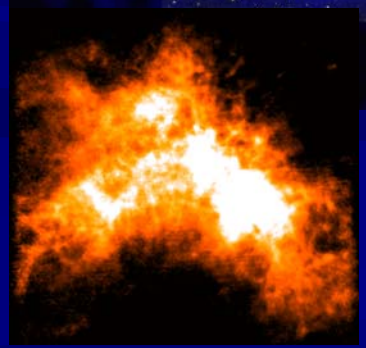












LVHIS