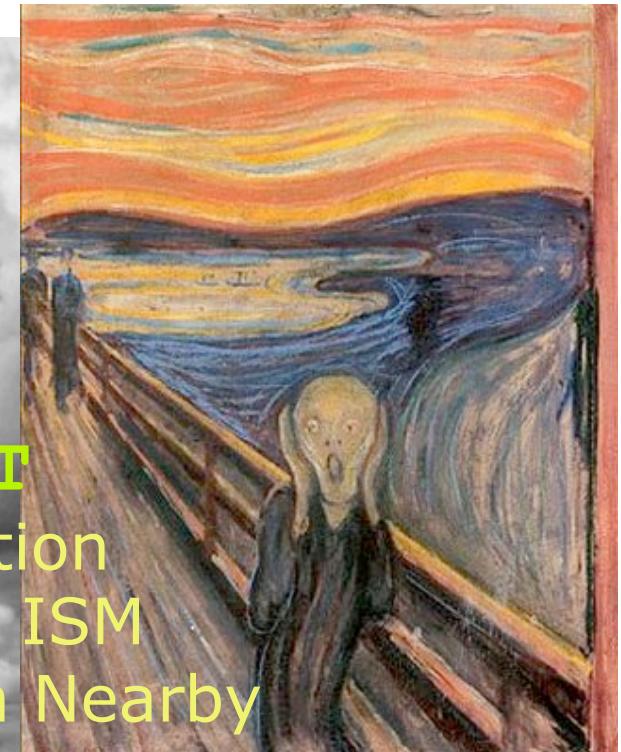




# VLA-ANGST Star Formation History and ISM Feedback in Nearby Galaxies



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Adrienne Stilp (U Washington)

Steven Warren (U Minnesota)

Andrew West (MIT)

Baerbel Koribalski (ATNF)

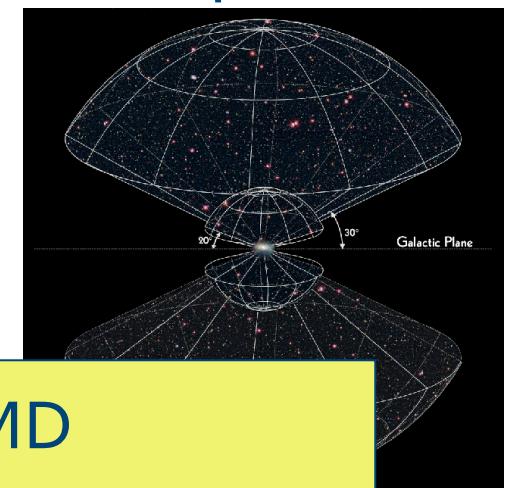


# ANGST

**ANGST**: ACS Nearby Galaxy Survey Treasury  
(PI: J. Dalcanton)



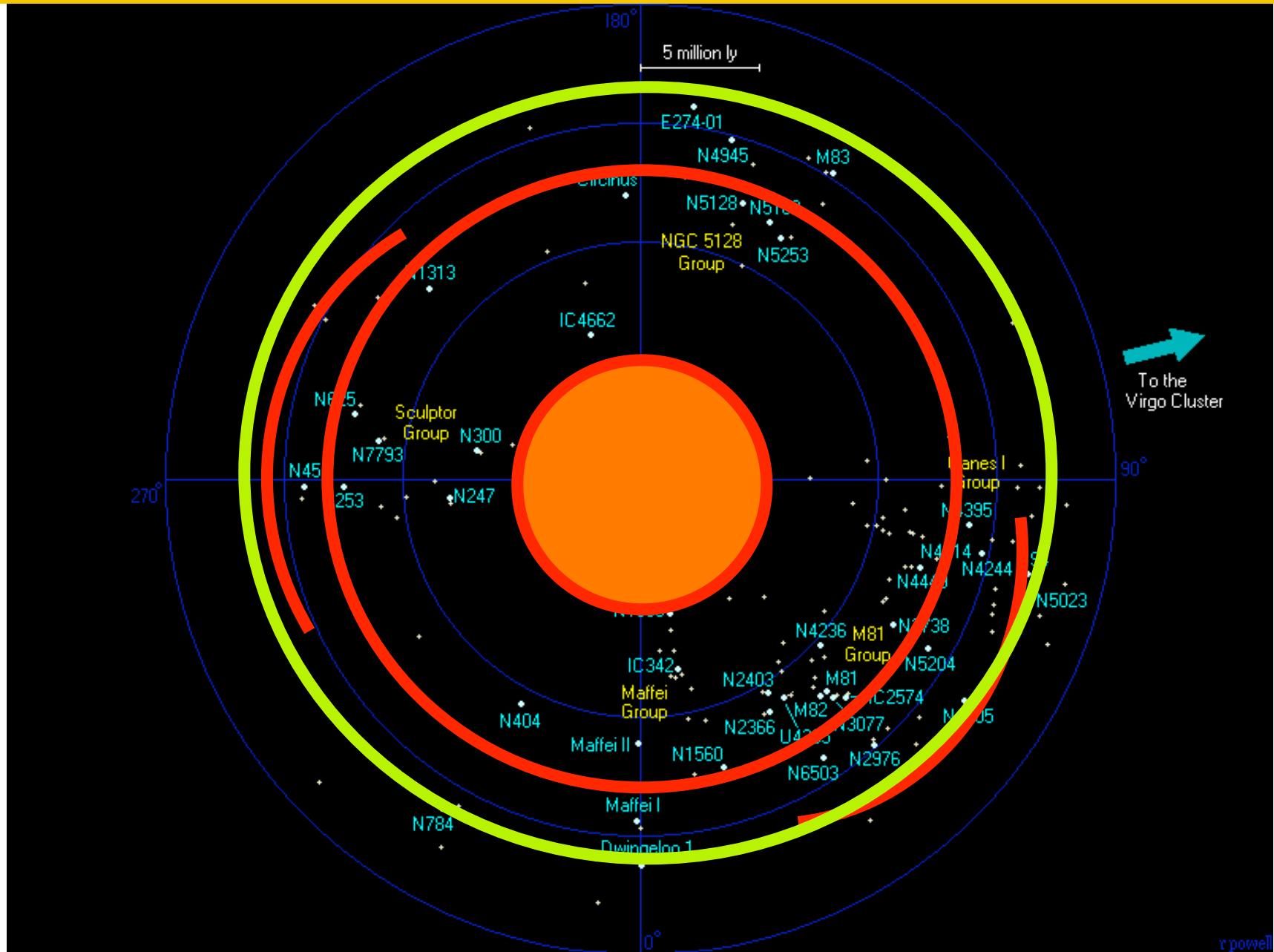
- volume limited ACS 2-band optical survey, of all galaxies up to 3.5 Mpc distance,  $|b| > 20^\circ$  (cones out to 4Mpc) but excluding Local Group
- 69 galaxies of all morphological types
- spanning 10 mag in lum.,  $10^4$  in SFR



Resolved stellar populations through CMD

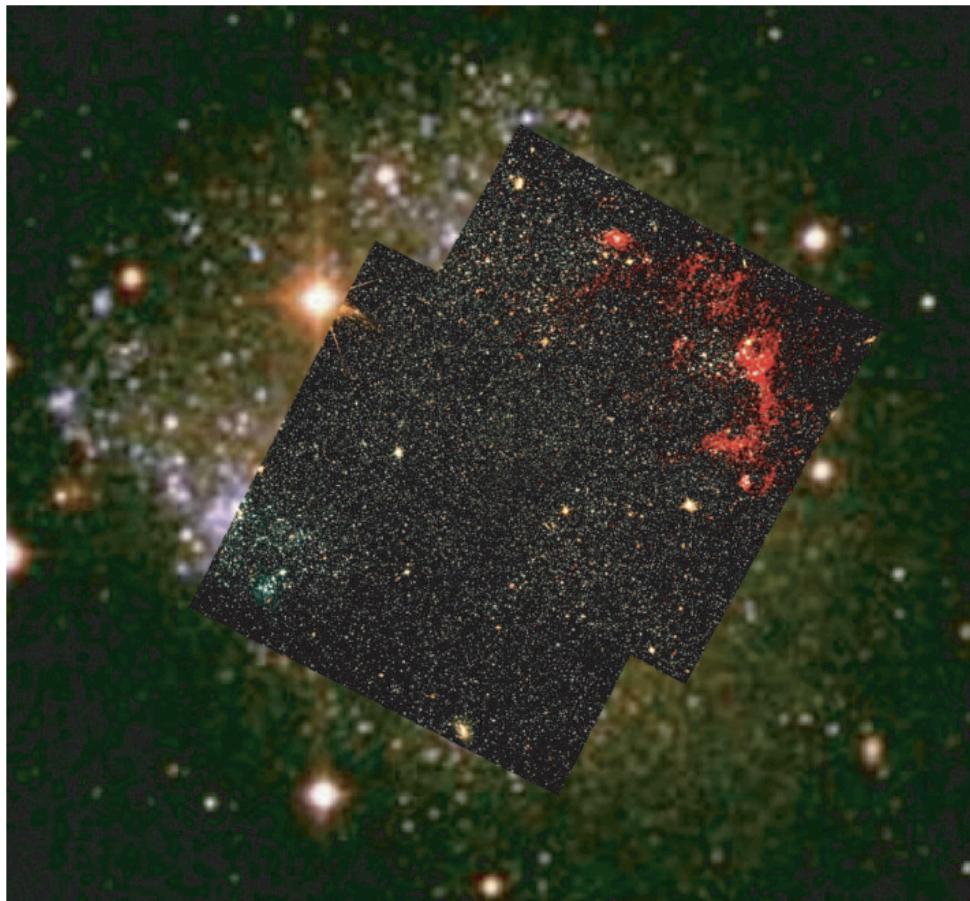
→ spatially resolved star formation histories

# ANGST

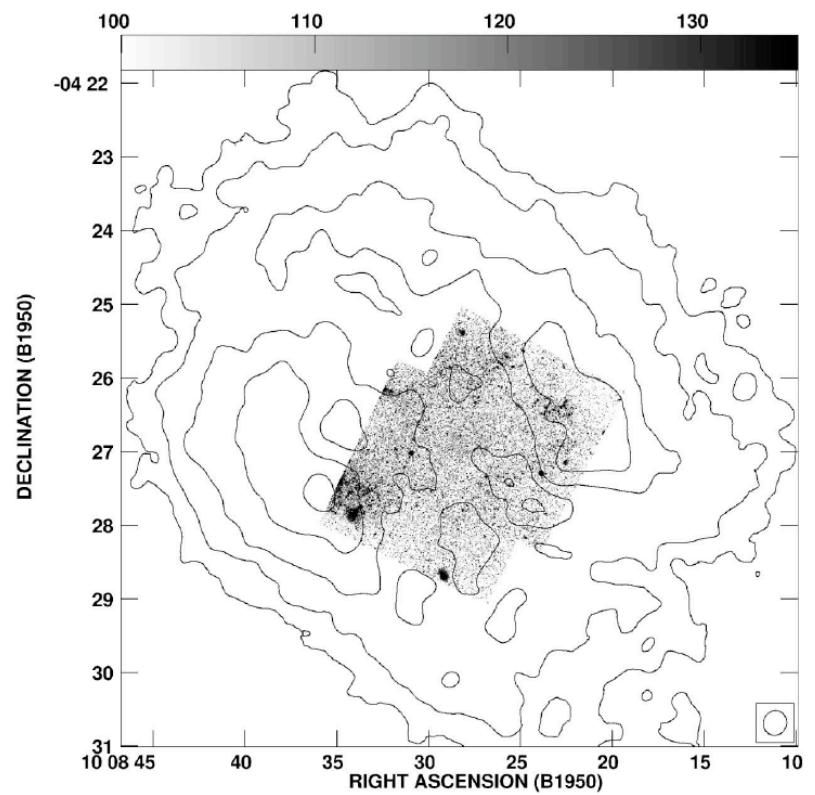


# Sextans A

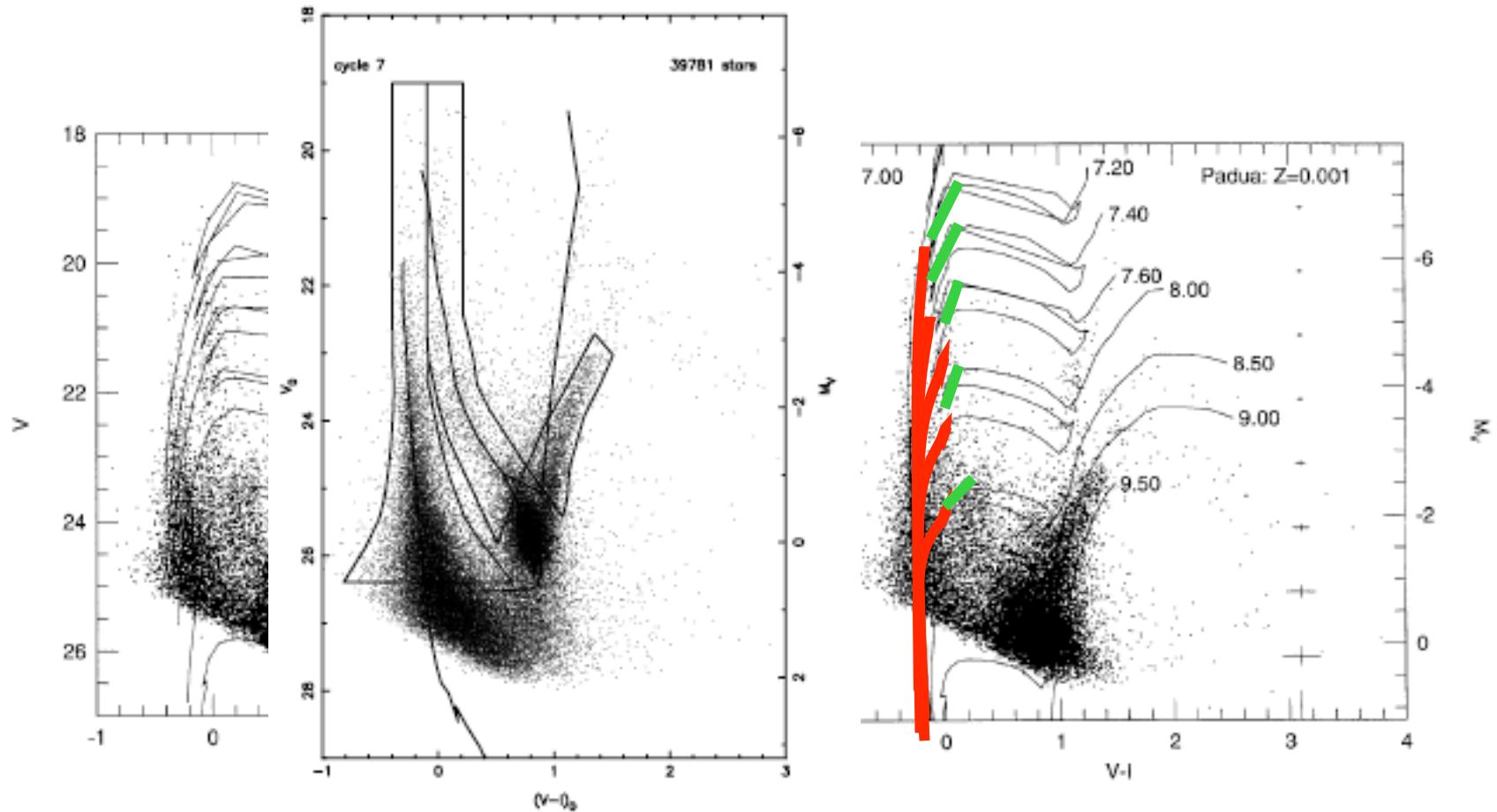
Example: Sextans A (1.4 Mpc distance)



Dohm-Palmer et al. 1997, 2002



# Spatially Derived SFH



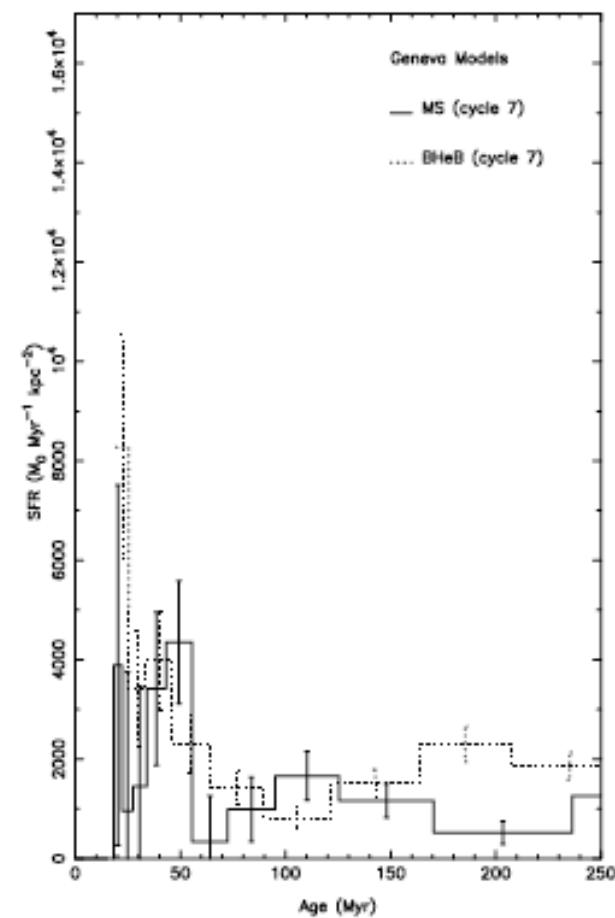
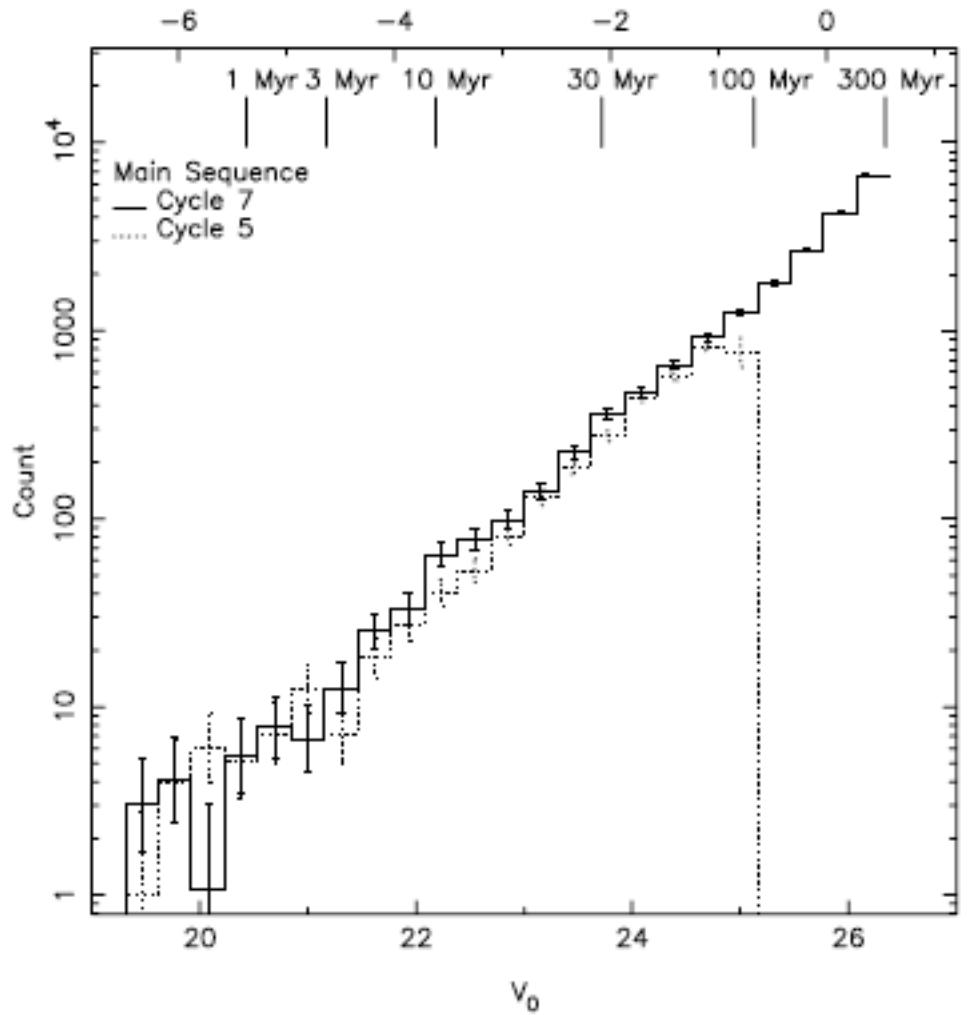
Stellar evolution tracks

Stellar isochrones

Dohm-Palmer et al. 1997, 2002

# Spatially Derived SFH

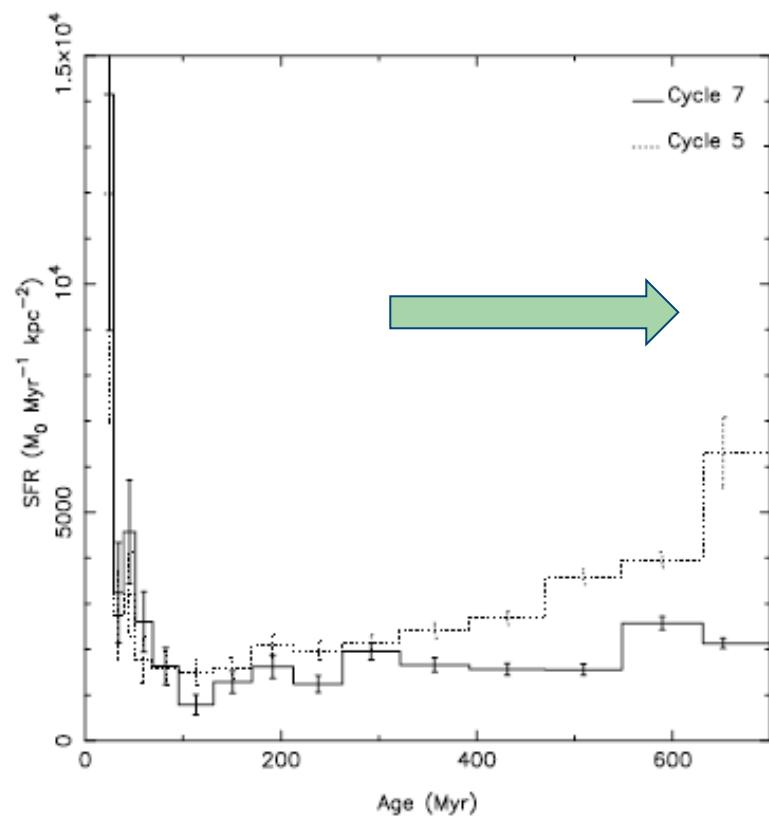
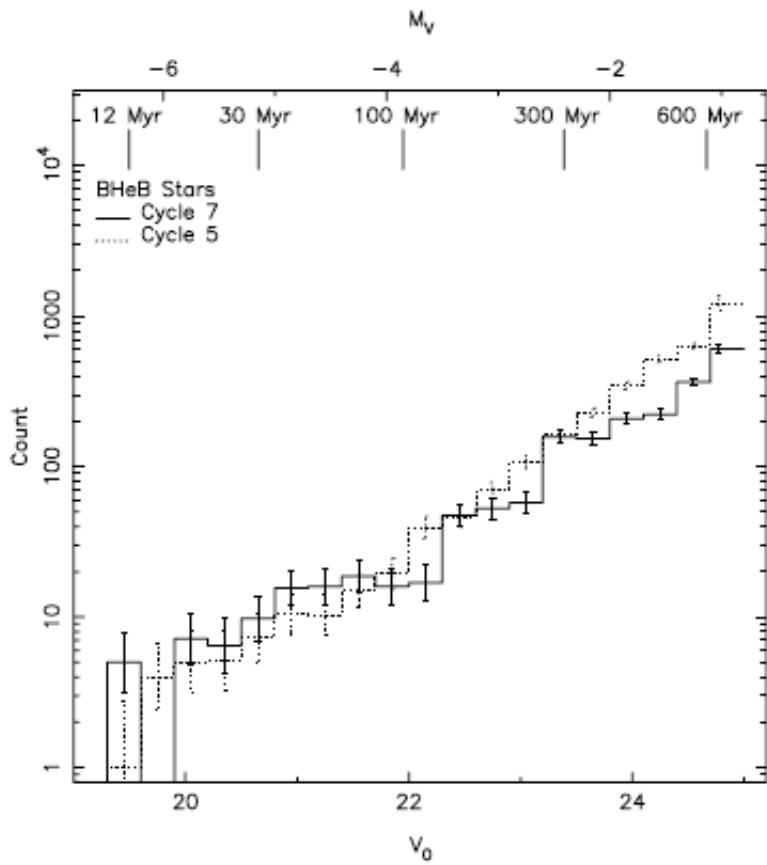
## Main Sequence Luminosity Function



Dohm-Palmer et al. 1997, 2002

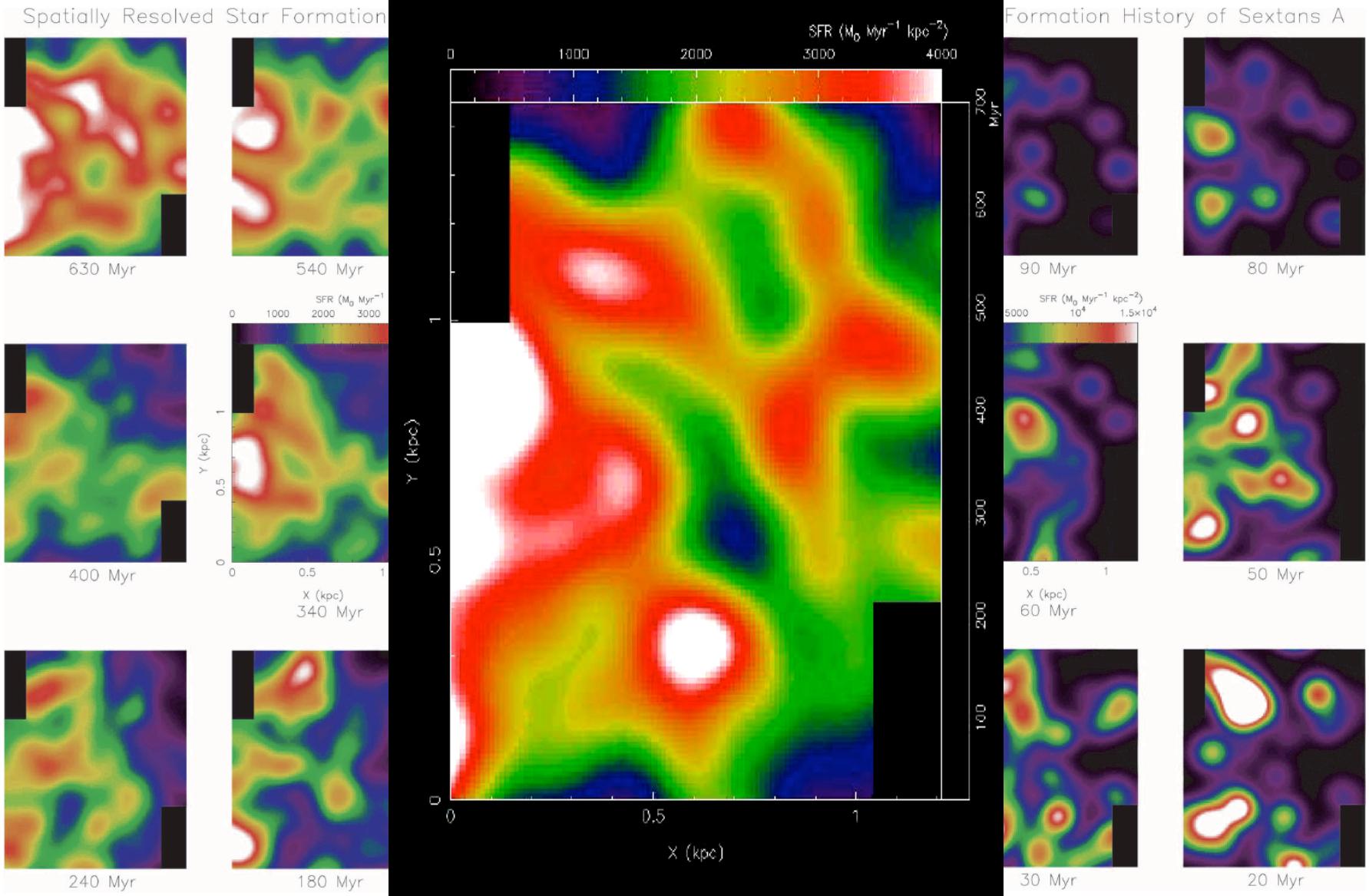
# Spatially Derived SFH

## HeB Blue Loop Luminosity Function



Dohm-Palmer et al. 1997, 2002

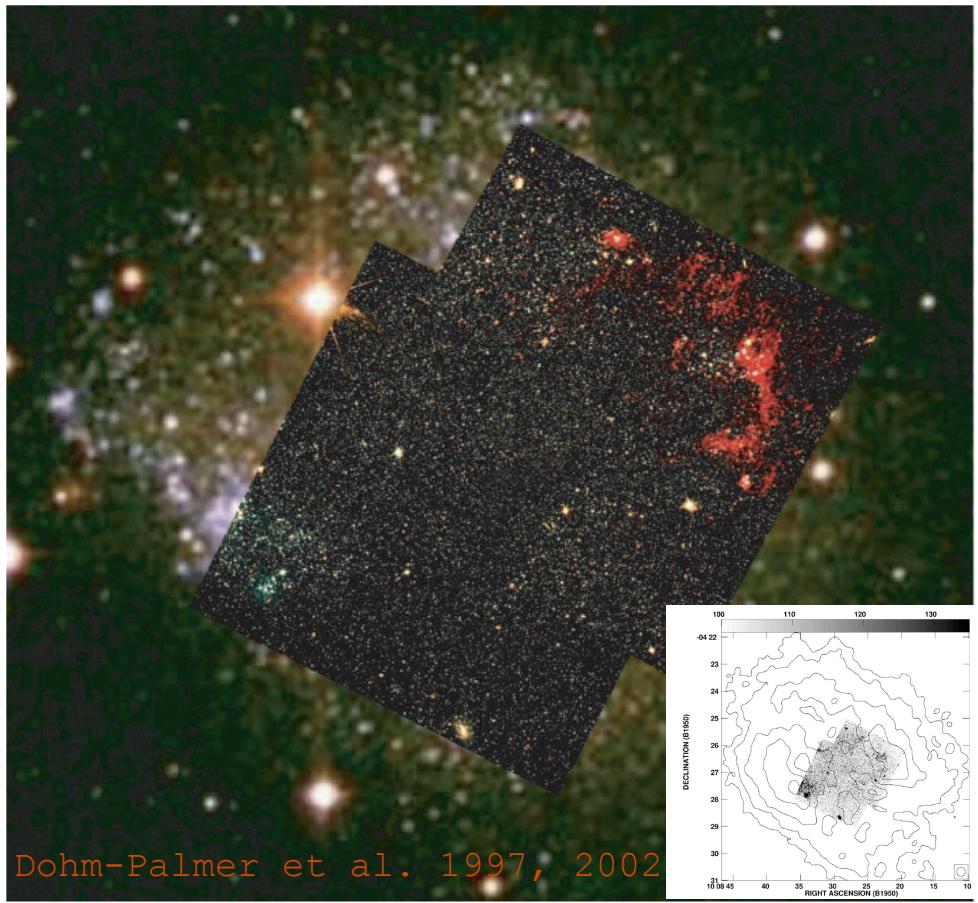
# Spatially Derived SFH



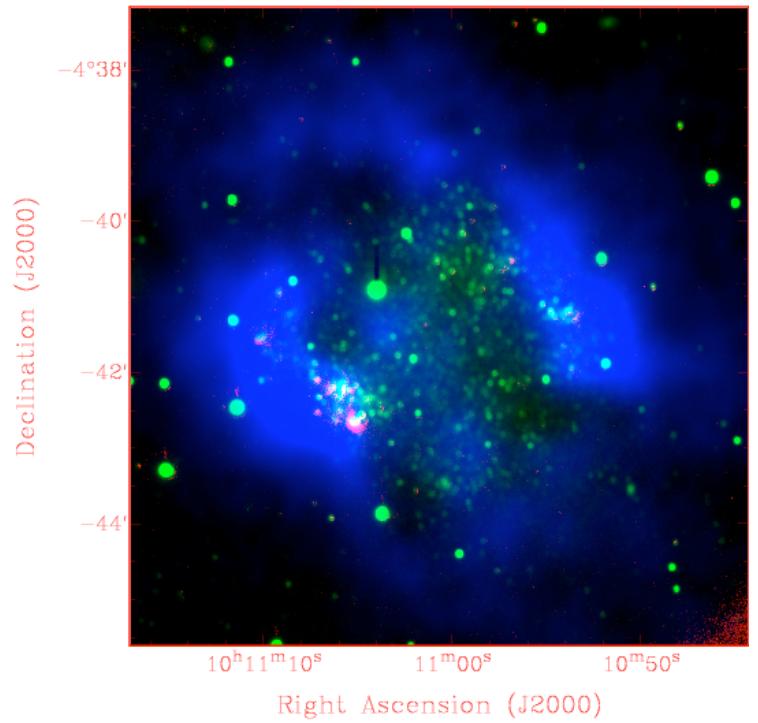
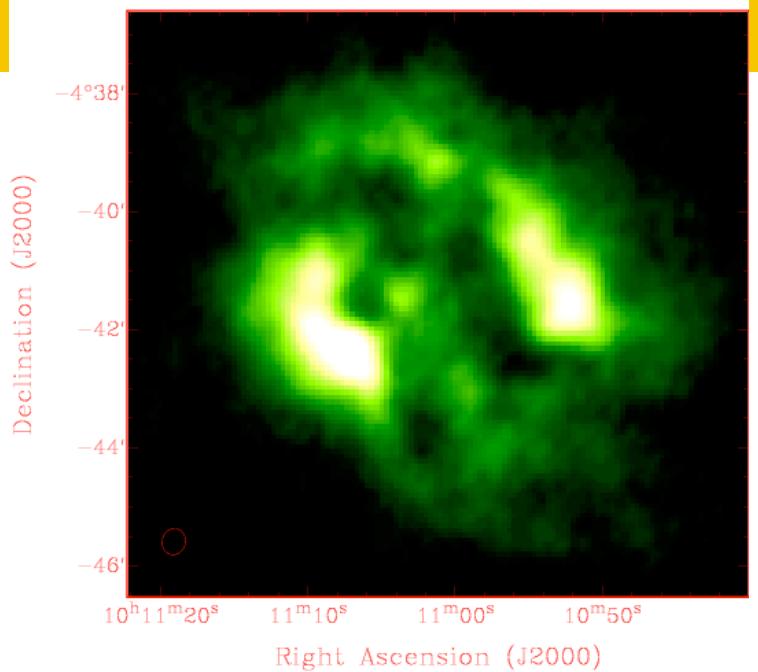
Dohm-Palmer et al. 1997, 2002

# Sextans A

Example:  
Sextans A (1.4 Mpc distance)



Dohm-Palmer et al. 1997, 2002

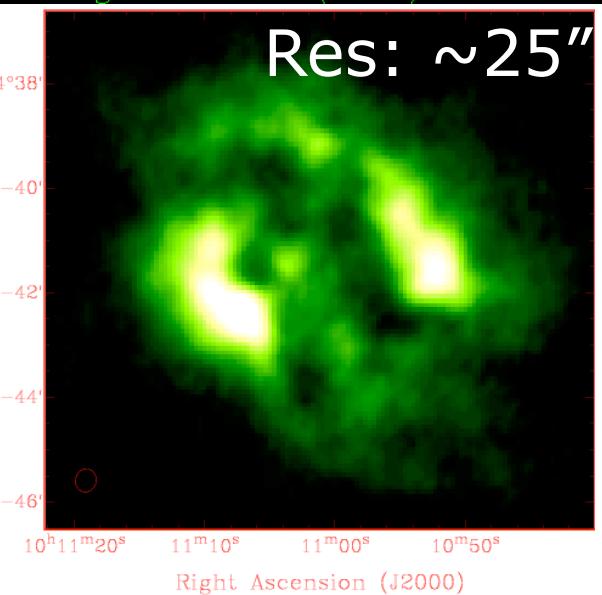
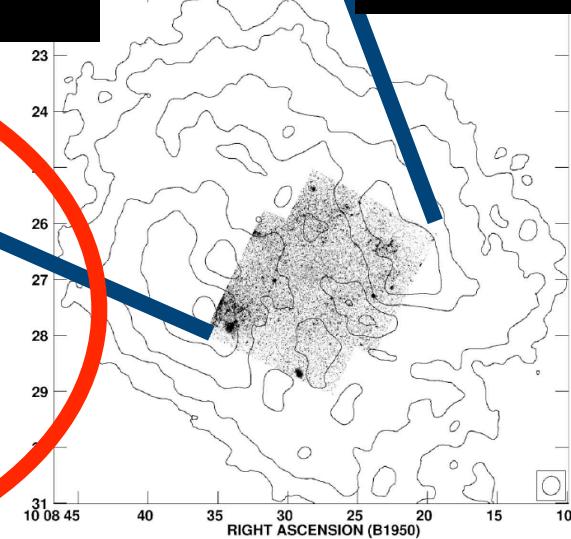
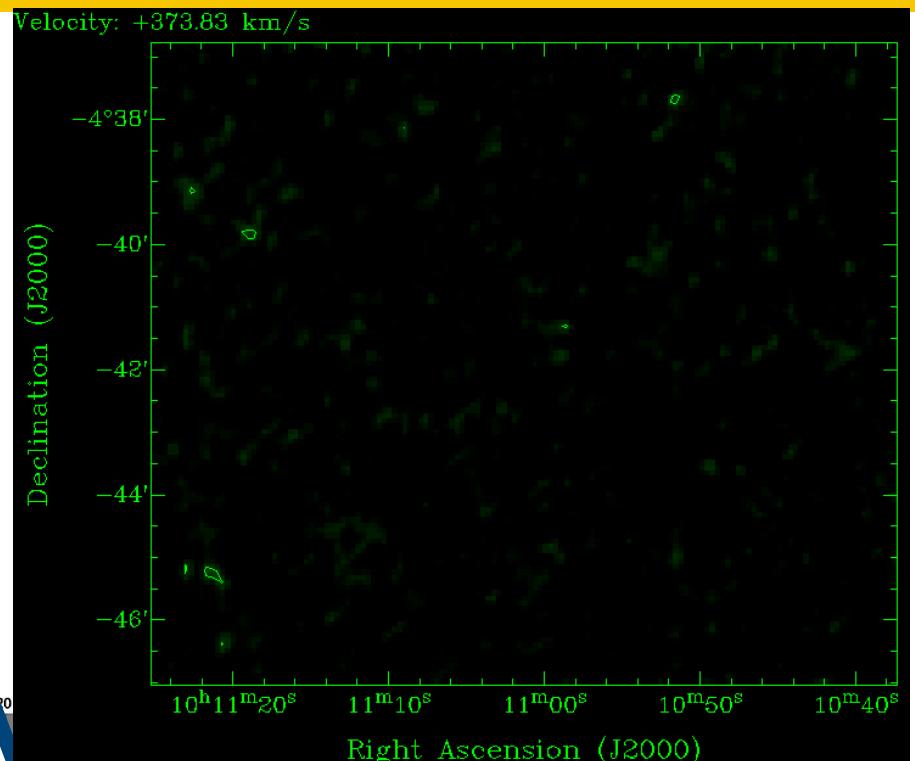
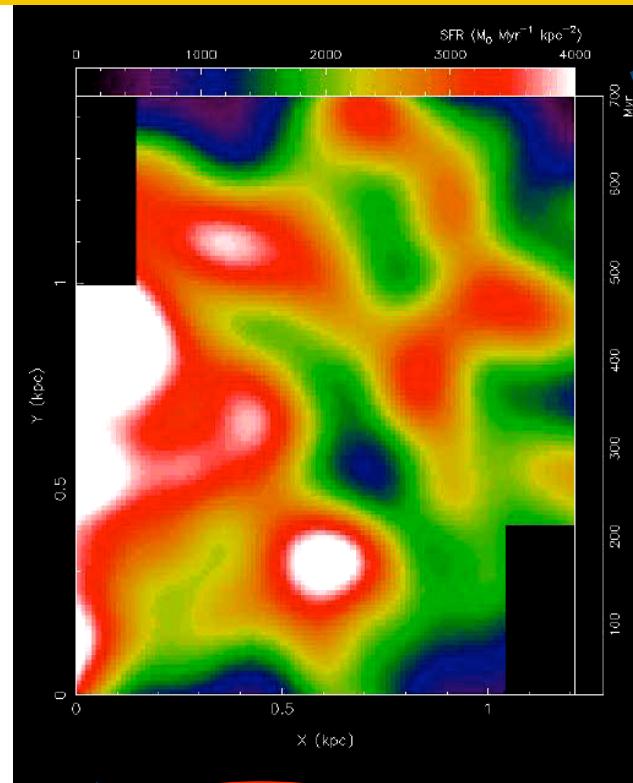


# Sextans A

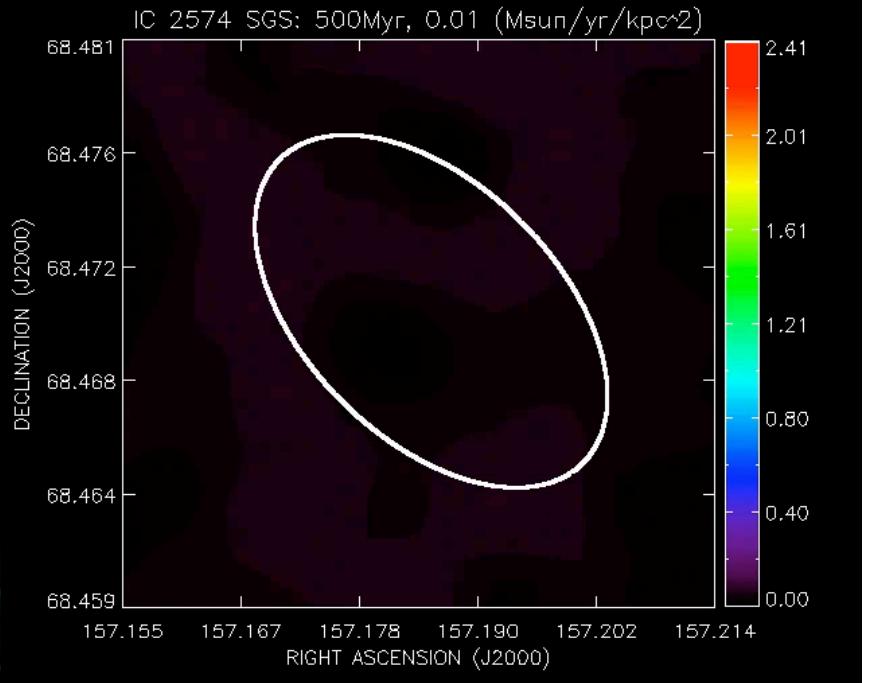
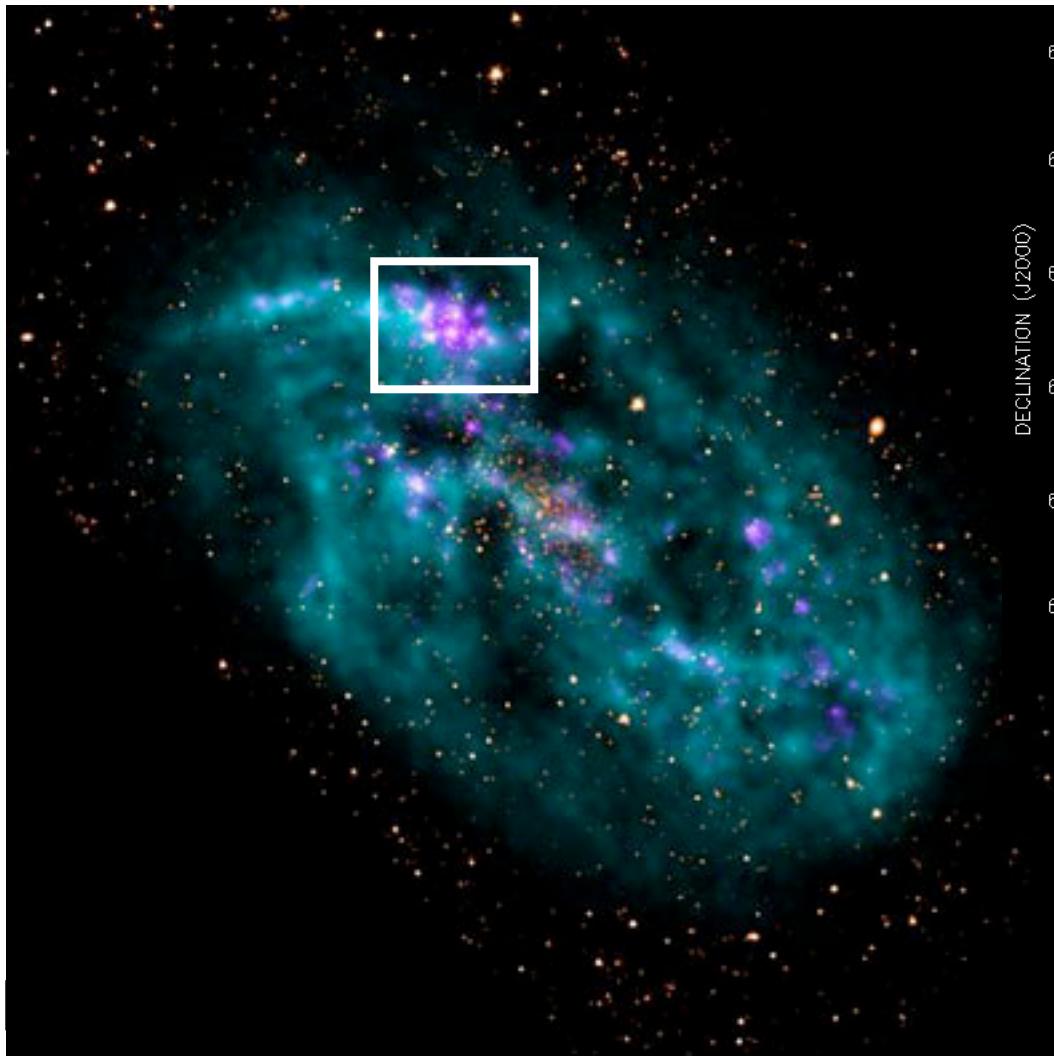
The EVLA vision: Galaxies through Cosmic Time

Jürgen Ott

VLA-ANGST



# Science Goals



Kinetic energy of shell:  
 $\sim 2 \times 10^{53}$  erg  
Of SNe:  
 $\sim 3 \times 10^{55}$  erg

Weisz et al. 2008

# VLA-ANGST

- All ANGST targets with detected HI or recent star formation
- excluding galaxies covered in THINGS, galaxies too far south
- 36 galaxies
- $\sim 500\text{h}$  ( $=1.8\text{Ms}$ ) B, C, D array VLA observations  
9/3/2h + archival data if appropriate
- Resolution  $\sim 6''$
- data (almost) complete, data reduction E/VLA issues

## Sample Selection

Name	D Mpc	RA (J2000) <i>h : m : s</i>	DEC(J2000) <i>° : ′ : ″</i>	d arcmin	$M_B$ mag	Type	$V_c$ $\text{km}\text{s}^{-1}$	B	C	D
Galaxies with HI detections and recent SF, brighter than -13										
N3109	1.3	10:03:07.2	-26:09:36	17.0	-15.18	9	116	yh	yh	yh
SexA	1.3	10:11:00.8	-04:41:34	5.5	-13.71	10	63	y	y	y
SexB	1.4	10:00:00.1	05:19:56	5.1	-13.88	10	38	y	n	n
DDO125	2.5	12:27:41.8	43:29:38	4.3	-14.04	10	30	y	y	y
DDO146	2.6	12:27:43.1	38:26:56	4.4	-13.37	10	37	y	y	y
DDO190	2.8	14:24:43.5	44:31:35	1.8	-14.14	10	45	y	n	y
N3741	3.0	11:36:06.4	45:17:07	2.0	-13.01	10	81	y	y	y
DDO148	3.0	12:12:08.9	36:10:10	1.9	-13.76	10	18	y	y	n
N4190	3.5	12:13:44.6	36:38:00	1.7	-14.20	10	46	y	y	y
N247	3.6	00:47:08.3	-20:45:36	15.4	-17.92	7	210	yh	yh	yh
N253	3.9	00:47:34.3	-25:17:32	26.7	-20.04	5	410	yh	yh	yh
Galaxies with HI detections and recent SF, fainter than -13 mag										
Antennae	2.0	10:04:21.0	77:19:55	2.0	-9.38	10	22	yh	nh	yh
KKH80	1.5	14:07:10.7	35:33:31	6.6	-8.49	10	21	y	y	y
GR8	2.1	12:58:40.4	14:13:03	1.1	-12.00	10	26	y	n	y
DDO187	2.3	14:15:56.5	23:03:19	1.7	-12.43	10	34	y	y	y
KKH98	2.5	23:45:34.0	38:43:04	1.1	-10.29	10	22	y	y	y
U8508	2.6	13:30:44.4	54:54:36	1.7	-12.95	10	49	y	y	y
DDO181	3.0	13:39:53.8	40:44:21	2.3	-12.94	10	39	y	y	y
UA292	3.1	12:38:40.0	32:46:00	1.0	-11.36	10	27	y	n	y
U8833	3.1	13:54:48.7	35:50:15	0.9	-12.31	10	28	y	n	y
U4483	3.2	08:37:03.0	69:46:31	1.2	-12.58	10	33	y	n	y
DDO6	3.3	00:49:49.3	-21:00:58	1.7	-12.40	10	22	yh	yh	yh
KKH37	3.4	06:47:45.8	80:07:26	1.2	-11.26	10	20	y	y	y
KDG73	3.7	10:52:55.3	69:32:45	0.6	-10.75	10	18	y	y	y
US117	4.0	10:21:25.2	77:06:33	1.5	-11.51	10	13	y	y	y
KK3N	4.0	09:13:18.8	68:58:27	1.5	-11.51	10	15	y	y	y
Galaxies with HI detections but little evidence for recent SF										
PLW15	1.5	13:13:57.1	41:20:14	1.1	-9.94	10	15	y	y	y
KKH6	2.0	13:54:30.3	04:14:23	1.1	-10.19	10	14	y	y	y
Galaxies with HI detections and dE morphology										
N404	3.1	01:09:26.9	35:43:03	2.5	-16.25	-1	78	y	n	y
KDG63	3.5	10:05:07.3	66:33:18	1.7	-11.71	-3	19	y	y	y
Galaxies with no reported single-dish detection/observation, but dIrr/Sm morphology										
DDO113	2.9	12:14:57.9	36:13:08	1.5	-11.61	10	?	y	y	y
DDO183	3.2	13:50:51.1	38:01:16	2.2	-13.08	9	?	y	y	y
MCG9-20-131	3.4	12:15:46.7	52:23:15	1.2	-12.36	10	?	y	y	y
A0952+69	3.9	09:57:29.0	69:16:20	1.8	-11.16	10	?	y	y	y
DDO82	4.0	10:30:35.0	70:37:10	3.4	-14.44	9	?	y	y	y
KDG77	3.5	09:50:10.0	67:30:24	2.4	-11.42	-3	?	y	y	y

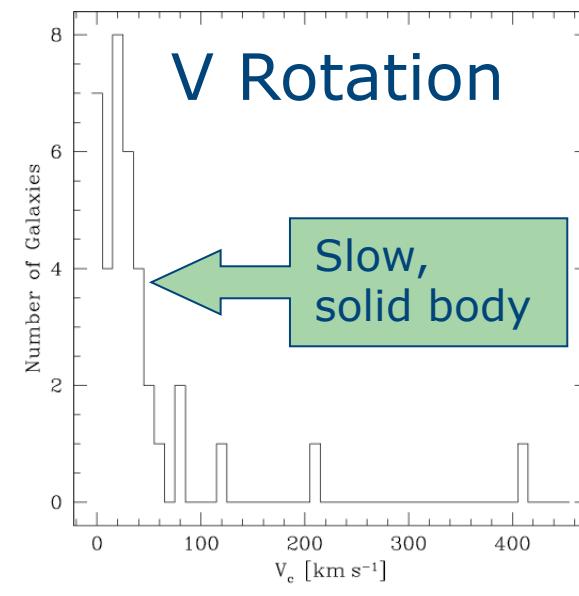
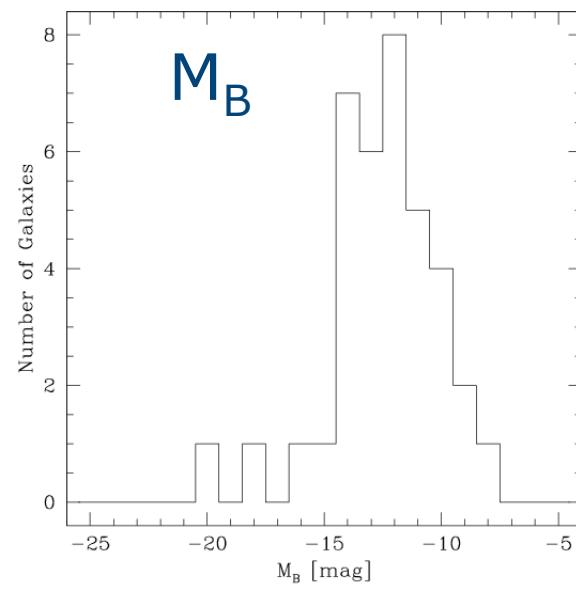
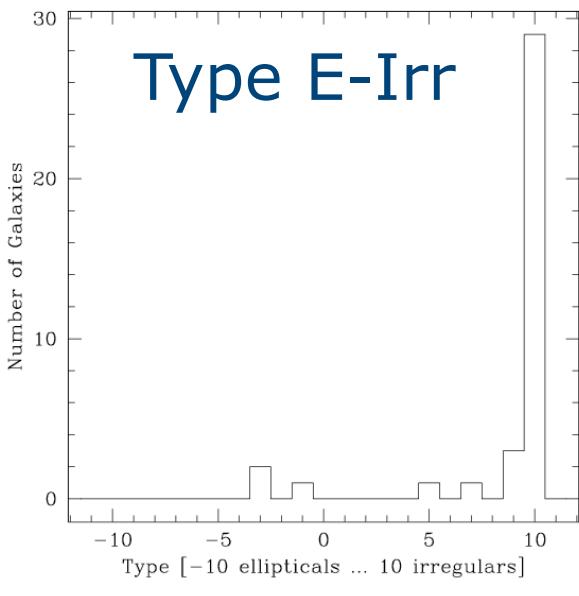
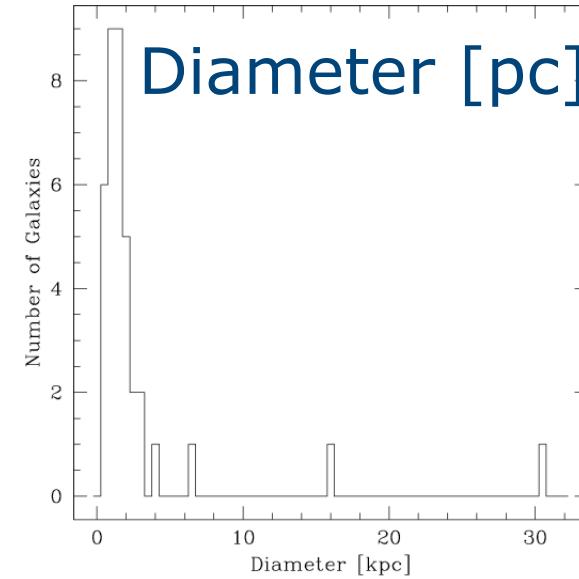
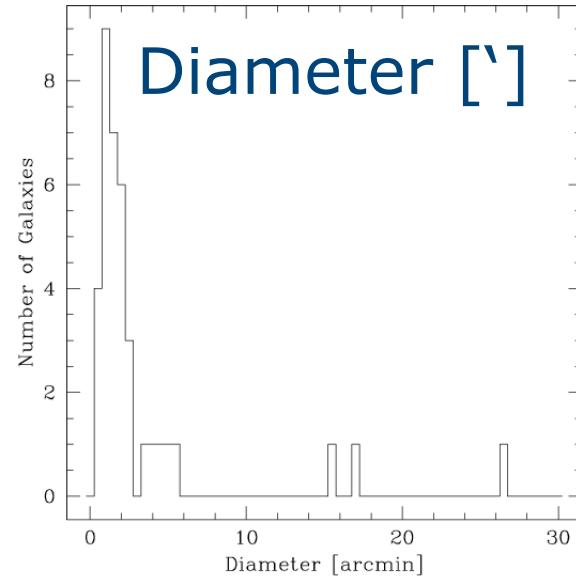
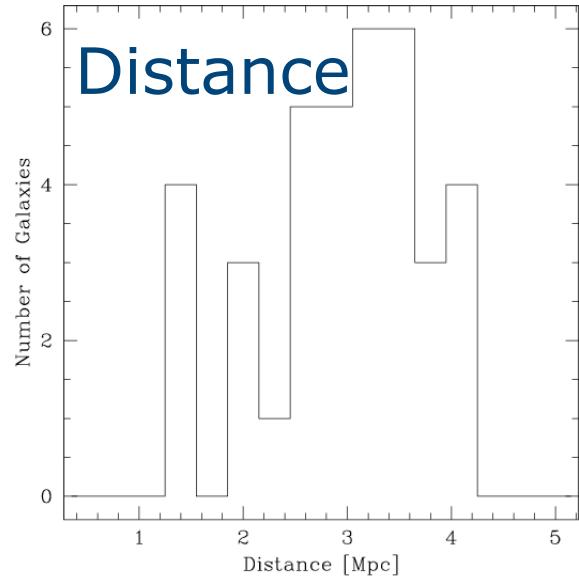
Table 1: ANGST targets for which we request multi-configuration (BCD) VLA data within the proposed VLA survey. The galaxies were selected to have detected HI or show signs of recent SF. Red line = no reported single-dish detection/observation and dE morphology, but dIrr/Sm morphology. Blue line = no reported single-dish detection/observation and dIrr/Sm morphology, but dE morphology. Magenta line = no reported single-dish detection/observation and dE morphology, but dIrr/Sm morphology.

# Sample Selection

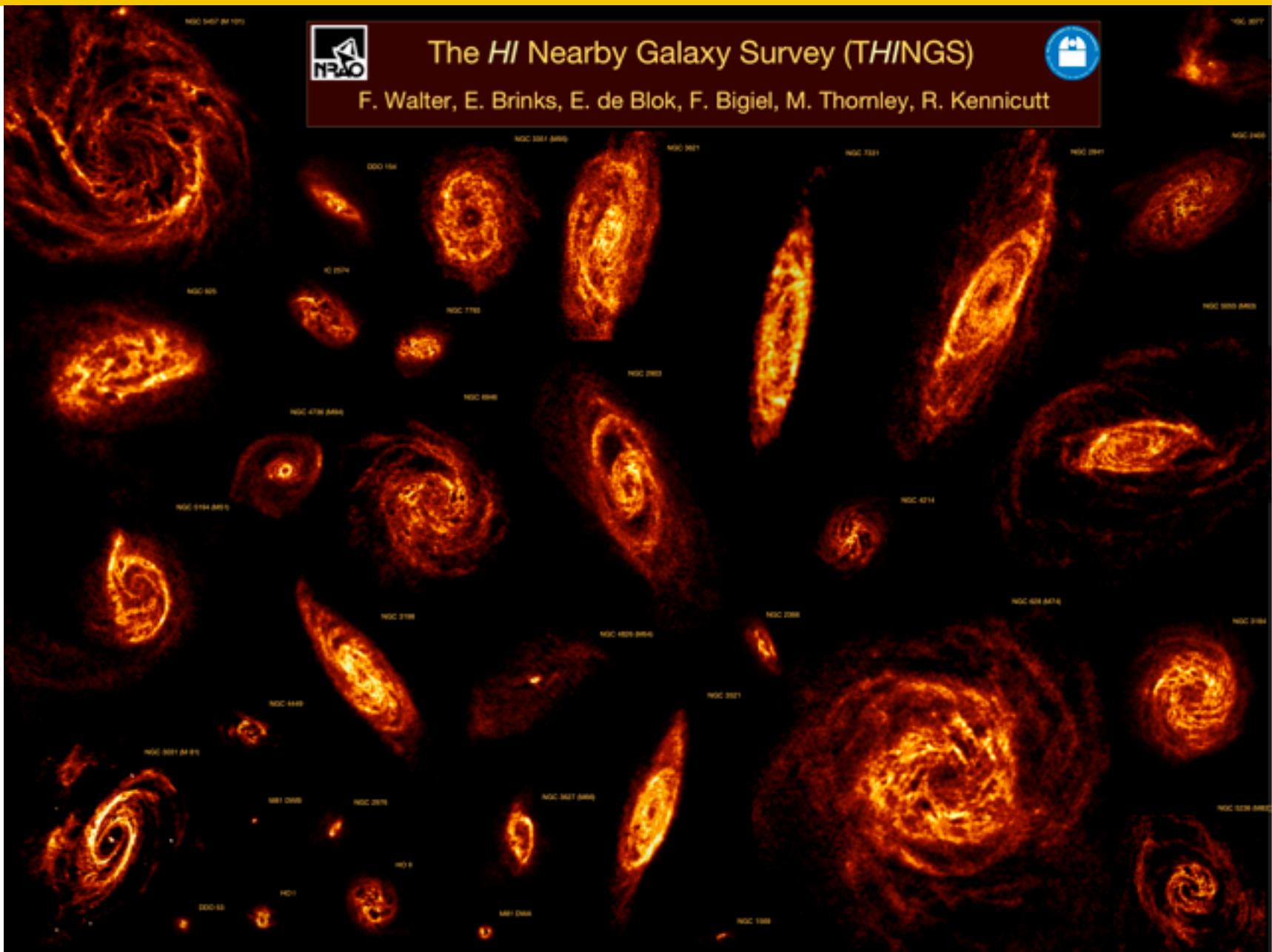
The EVLA vision: Galaxies through Cosmic Time

Jürgen Ott

VLA-ANGST



# Science Goals



# Science Goals

*What causes gas to collapse into stars?  
What are the triggers of star formation?*



- : compare maps of resolved star formation history to features in HI
- : test models of star formation, e.g.,  
stochastic, breathing, external triggers, propagating, turbulent
- : SF efficiency
- : influence of rotation curve on SF triggering

*What is the role, efficiency and impact of feedback  
on the ISM?*

- : energy dumped into the ISM by massive stars, SNe
- : formation and energetics of shells, holes, bubbles, ...
- : fraction of triggered SF by such events
- : thresholds for which additional energy may inhibit SF
- : metallicity effects



# Science Goals

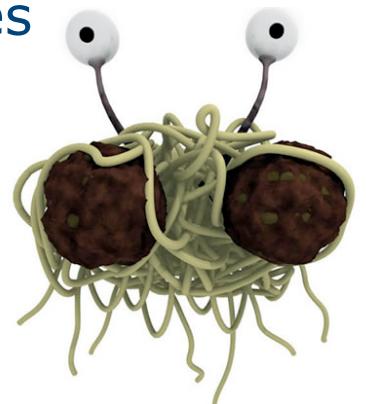
## *What is the structure and dynamics of the ISM?*

- : gas densities, velocities, wrt features in optical/H $\alpha$ , HI, CO, dust
- : energy balance of the ISM
- : warm and cold ISM phases and their interaction
- : fractality of the ISM



## *How do galaxies evolve?*

- : gas consumption as function of stellar ages and galaxy type
- : differences in density and dynamics for different types
- : timing of stellar population and gas morphologies, structure formation (e.g. bars, spiral arms, )
- : dark matter profiles,  $\Lambda$ CDM tests



# Recent VLA HI Legacy Projects

THINGS (PI: F. Walter)



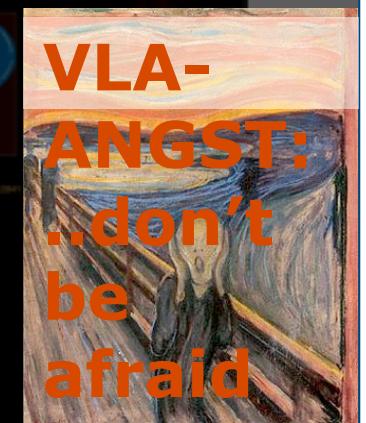
Nearby Galaxy Survey (THINGS)

F. Walter, E. Brinks, E. de Blok, F. Bigiel, M. Thornley, R. Kennicutt

VLA-ANGST (PI: J. Ott)

<http://www.cv.nrao.edu/~jott/VLA-ANGST>

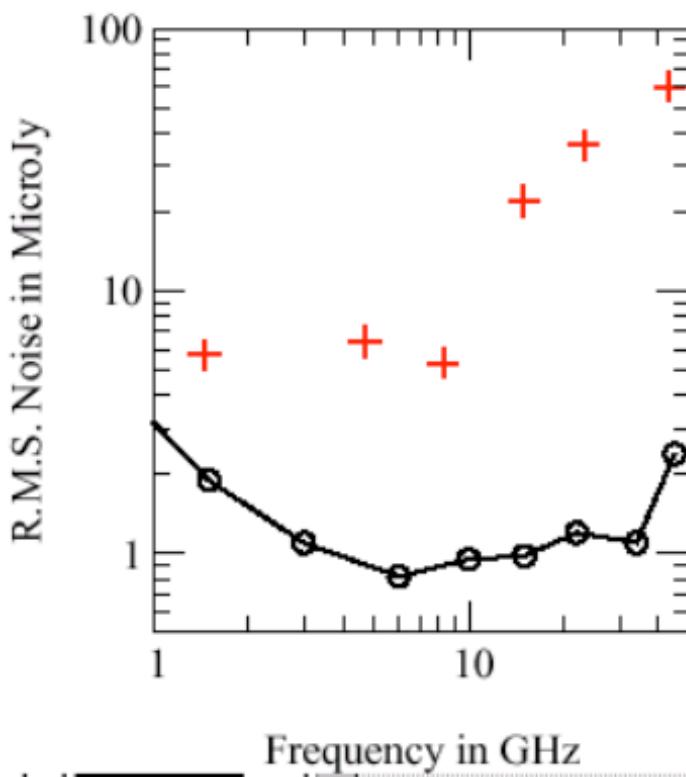
Little THINGS (PI: D. Hunter)



- ~100+ nearby galaxies with B&C&D array VLA HI observations  
similar depth, similar data reduction
- Many other ongoing surveys of nearby galaxies in many wavelengths: IR, optical, mm, radio, ...  
+ future L-band EVLA observations
- goldmine for studies of ISM-stars interplay,  
galaxy dynamics, evolution, ...

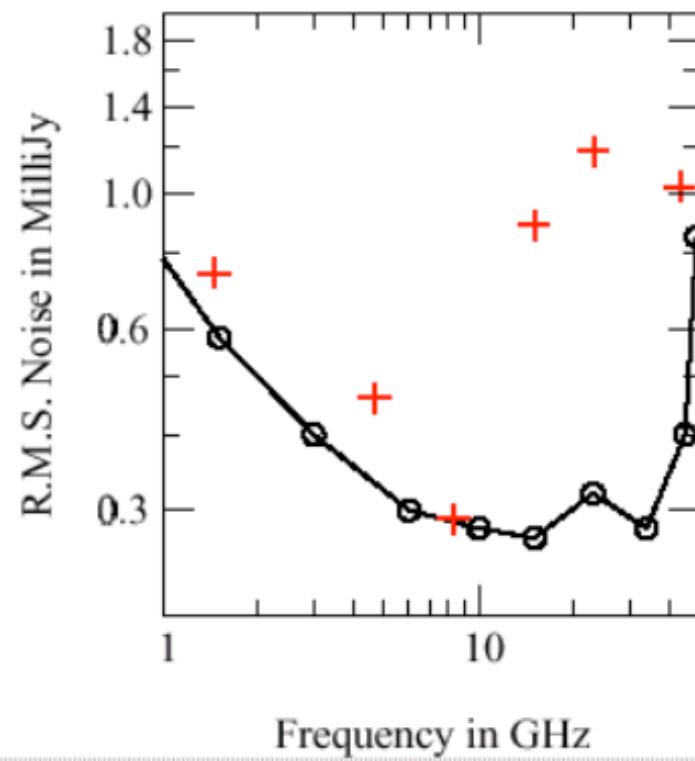
# EVLA: HI in Nearby Galaxies

Continuum Sensitivity



Red: Current VLA,

Spectral Line Sensitivity



Black: EVLA Goals

## EVLA: HI in Nearby Galaxies

*The VLA correlator was optimized for HI*

External galaxies:  $1\text{-}5 \text{ km s}^{-1}$  velocity resolution over  
~tens to hundreds  $\text{km s}^{-1}$  bandwidth

Cf. typical HI velocity dispersion  $5\text{-}10 \text{ km s}^{-1}$

Narrower BW for Galactic HI self-absorption etc.

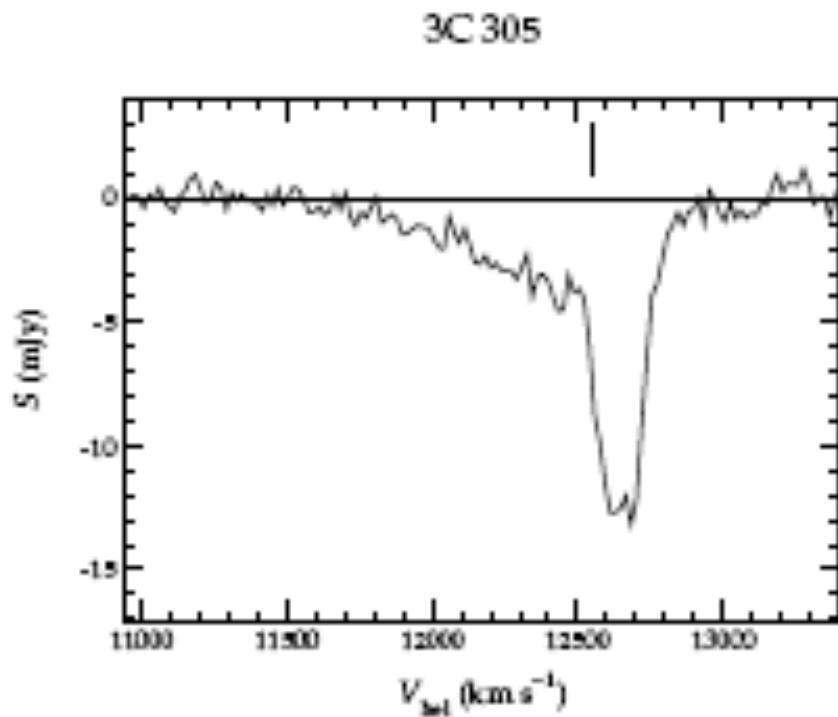
*The VLA was and still proves to be essential for HI studies*

But: correlator capabilities are a limitation for extreme Galaxies

not much serendipitous spectral ‘discovery space’

tough to do large mosaics

## Discovery Space



Morganti et al. (2007)

WSRT, ATCA

e.g. 3C305:  
Linewidth  $1500 \text{ km s}^{-1}$

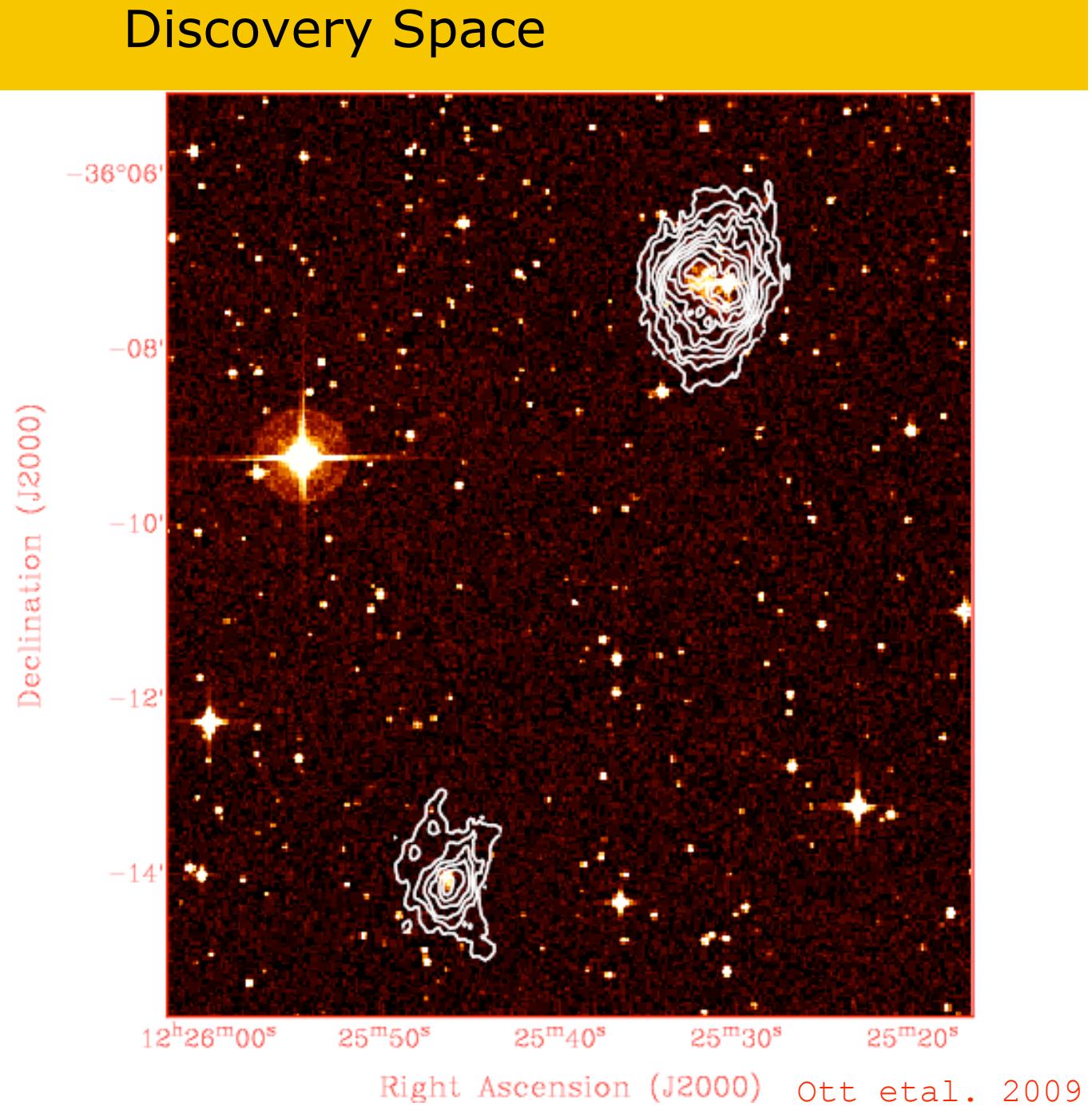
Suitable VLA correlator  
mode:

12.5 MHz BW, 32 channels  
=  $82 \text{ km s}^{-1}$  resolution

# Tololo 65

# Blue Compact Dwarf Galaxy

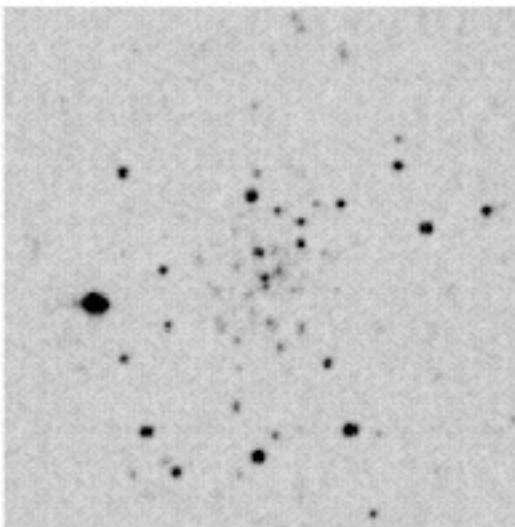
# ATCA observations



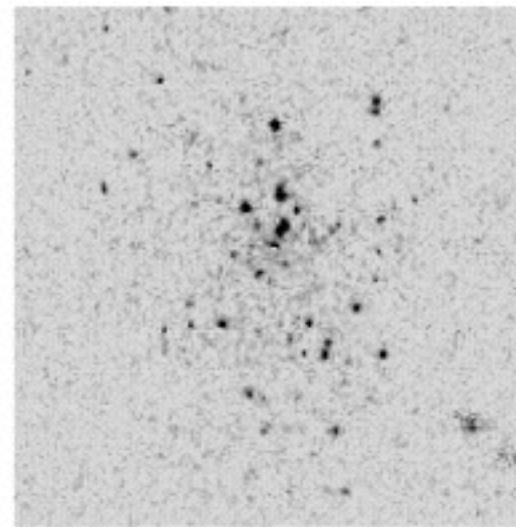
## Discovery Space

Serendipitous detection of Galaxies in Deep Fields  
e.g., Apples 1 w/ HST

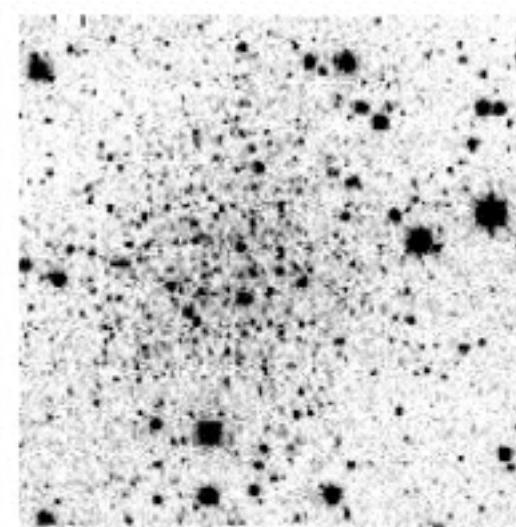
Can we find 'dark HI galaxies' w/ EVLA?



Apples 1



globular cluster



nearby dE

Pasquali et al. 2005

## EVLA HI in Nearby Galaxies

EVLA improvement is not as dramatic for nearby HI as it is for higher redshifts. But:

- Higher velocity resolution allows better kinematic studies
- larger 'discovery' space. More possibilities to find the unexpected
- excellent 21cm continuum sensitivity for free!
  - Star formation rates, magnetic fields, etc.
- Possibility to observe a second line, like OH in parallel
- Deep HI surveys and any 21cm continuum observation will provide free nearby HI searches, too.
  - (Un)expected Galaxies along the line of sight
  - Intergalactic HI not bound to galaxies ('Dark Galaxies')
- free sightlines through the Galactic HI

