



Gas-rich tidal features in nearby galaxy groups

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OCE Postdoctoral Fellow

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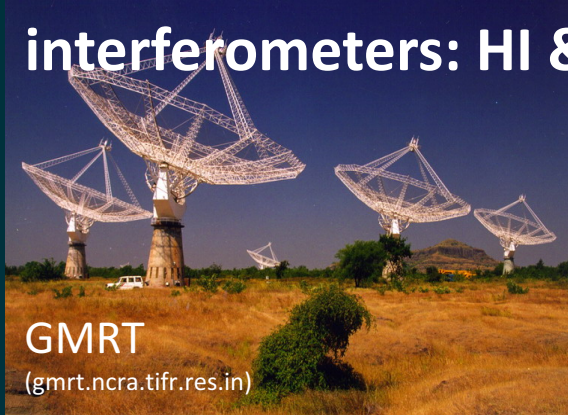
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Multi-wavelength investigations

interferometers: HI & dynamical properties

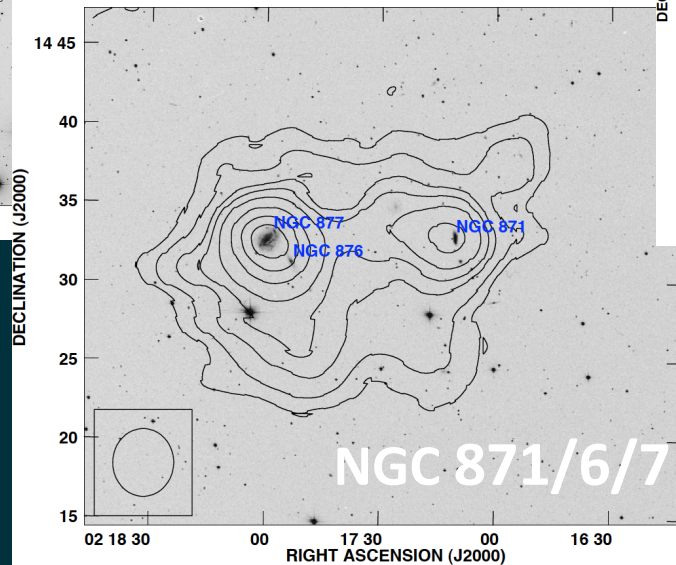
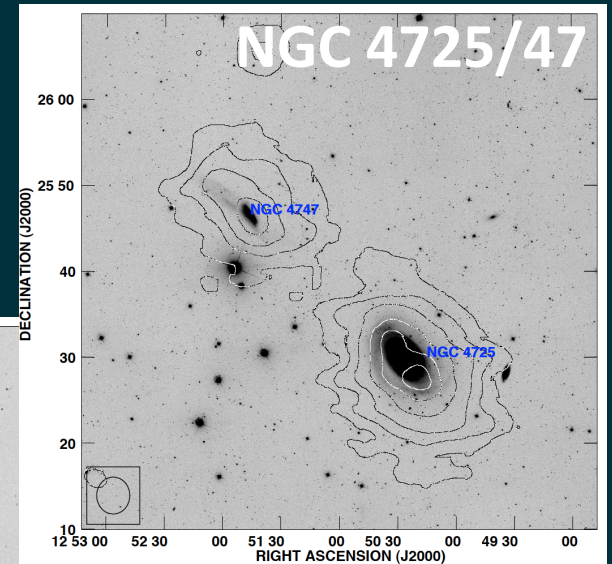
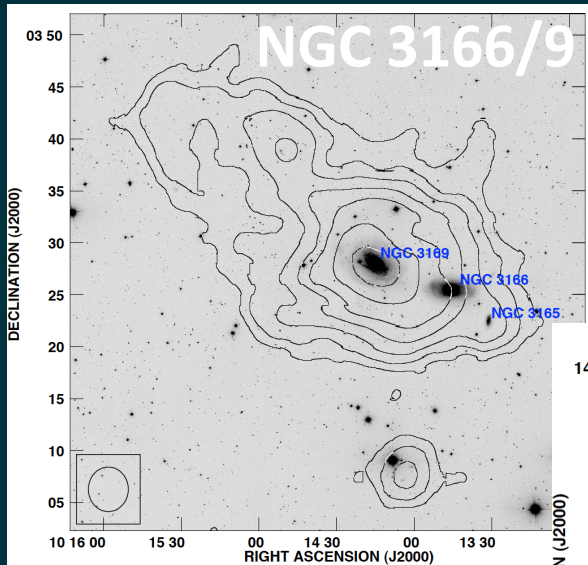


optical observatories: stellar properties

Outline

- (unbiased) survey of HI-rich low-mass features
 - NGC 3166/9 group
 - NGC 871/6/7 group
 - NGC 4725/47 group
- resolving tidal features with ASKAP
 - IC 5270
 - NGC 7232/3 triplet
- tidal feature in the Fornax cluster
 - NGC 1427A

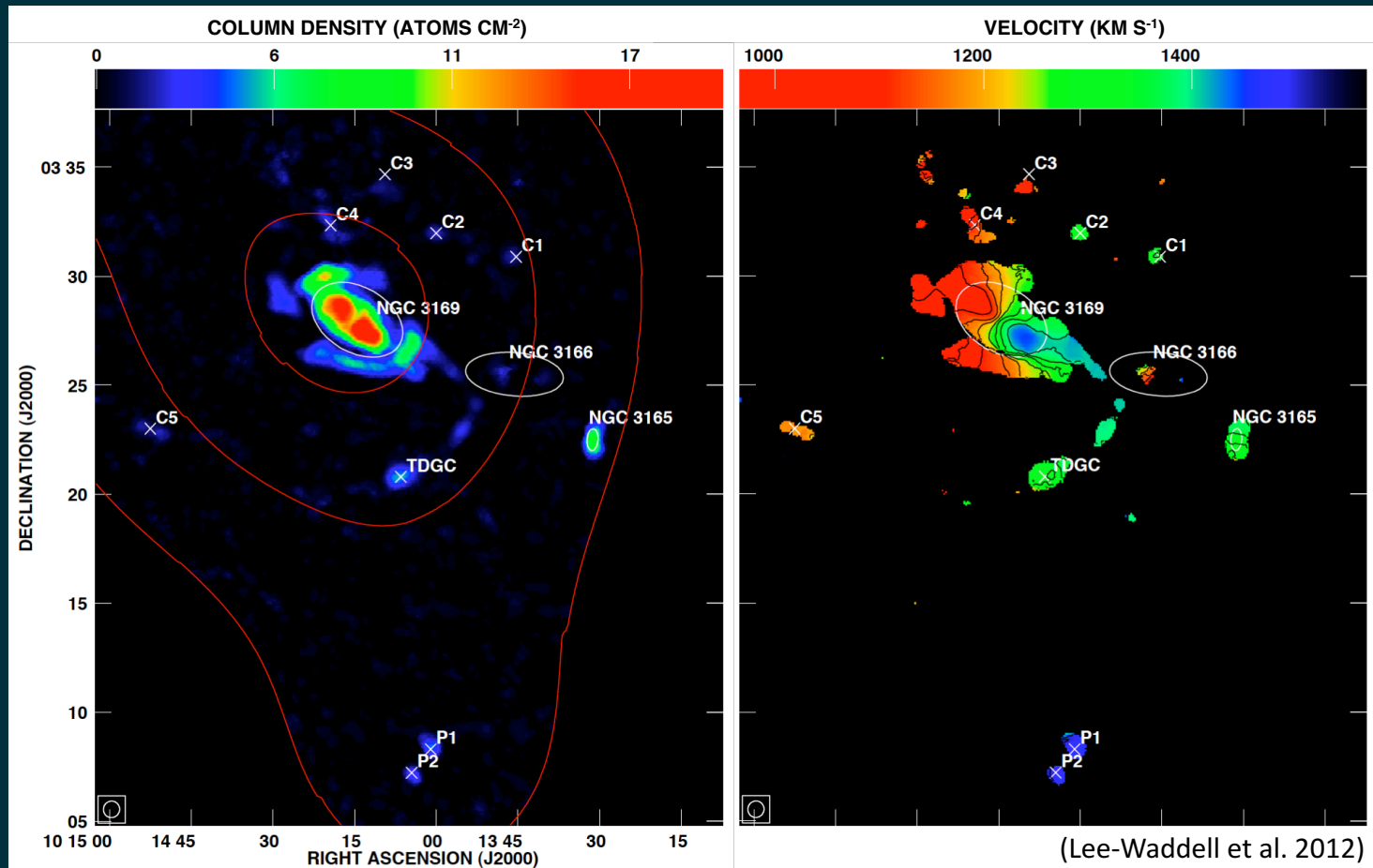
HI selected groups



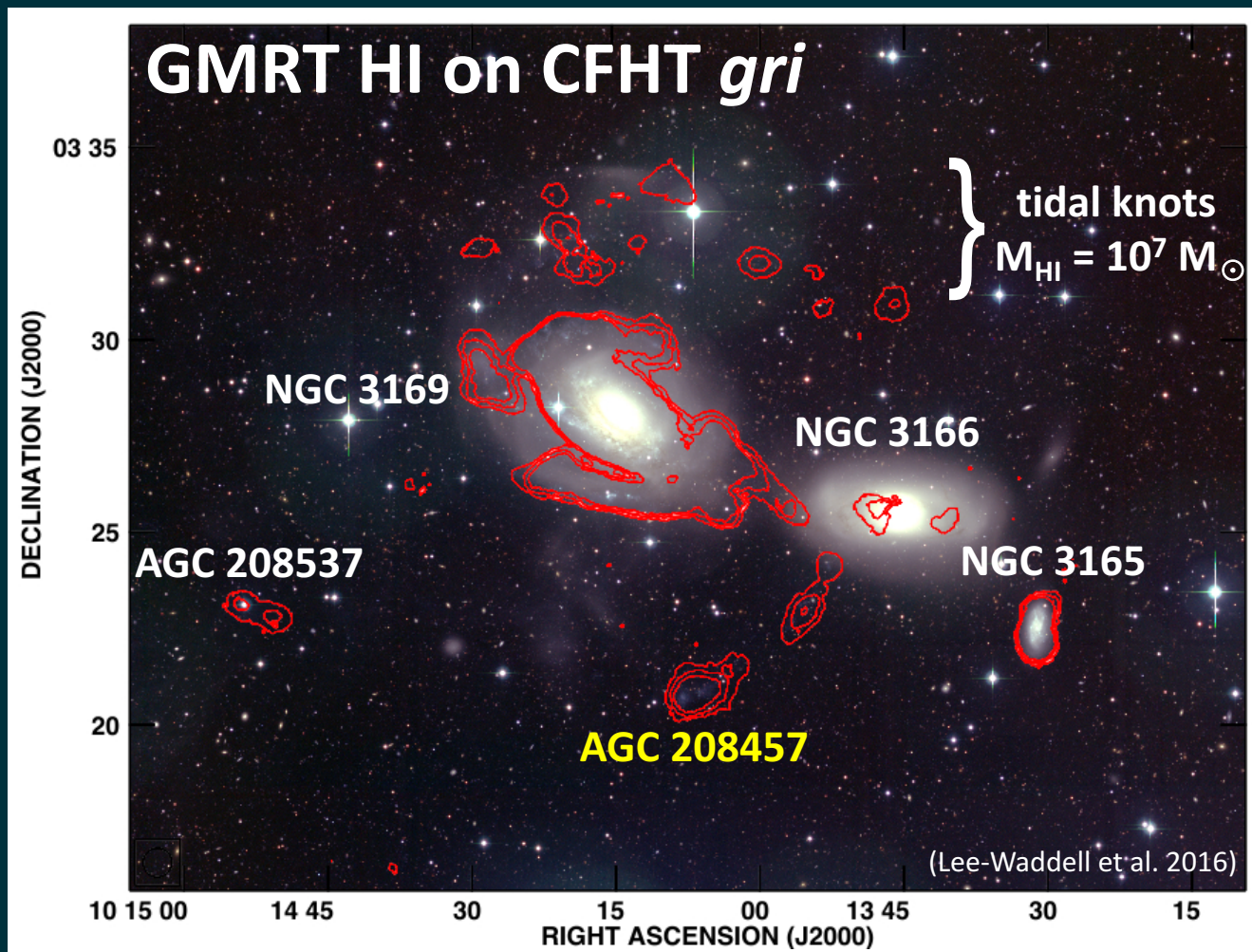
ALFALFA HI on SDSS/DSS2 *r*-band



NGC 3166/9 group: high-resolution HI maps



NGC 3166/9 group

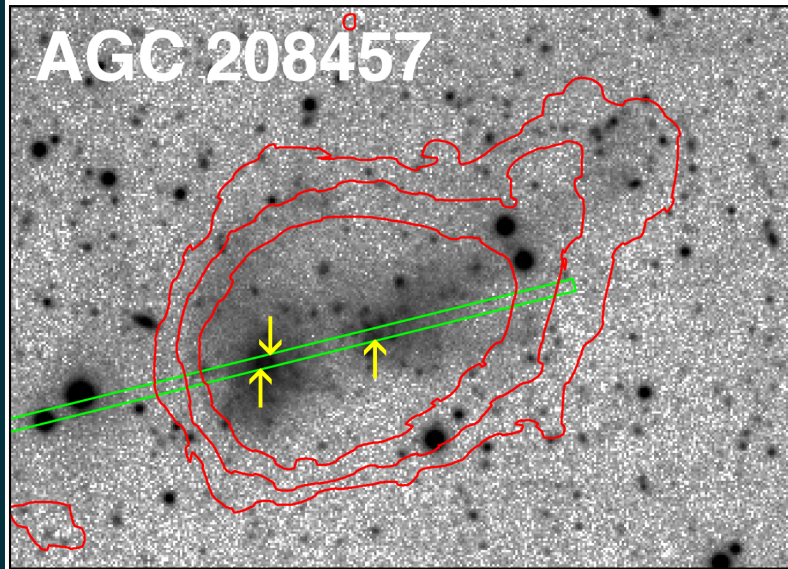


NGC 3166/9: selected group members

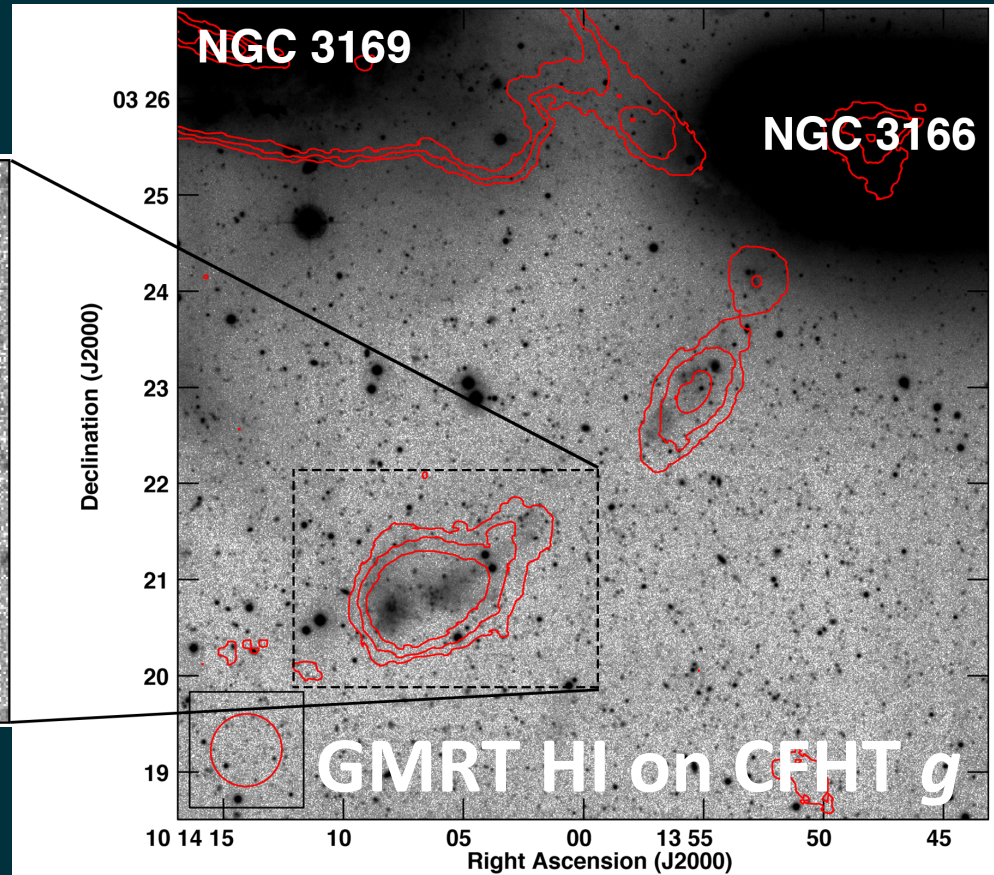
Source	M_{HI} ($10^8 M_{\odot}$)	M_{stellar} ($10^8 M_{\odot}$)	$M_{\text{dyn}}/$ M_{baryon}	Age (10^9 yr)	SFR ($M_{\odot} \text{ yr}^{-1}$)
NGC 3165	1.8 ± 0.3	8.6 ± 0.1	7 ± 1	7.5 – 8.0	~ 0.06
NGC 3166	--	590 ± 10	--	4.0 – 5.0	~ 0.06
AGC 208443	1.0 ± 0.2	~ 0.2	9 ± 2	--	~ 0.02
AGC 208444	0.7 ± 0.1	~ 0.2	8 ± 3	--	~ 0.004
AGC 208457	2.3 ± 0.3	0.16 ± 0.02	1.4 ± 0.4	0.006 – 2.2	~ 0.008
NGC 3169	42 ± 5	650 ± 10	4.3 ± 0.3	10.5 – 11.5	~ 0.6
AGC 208537	0.6 ± 0.1	--	--	--	< 0.001

(Lee-Waddell et al. 2012, 2016)

AGC 208457: tidal dwarf galaxy (?)

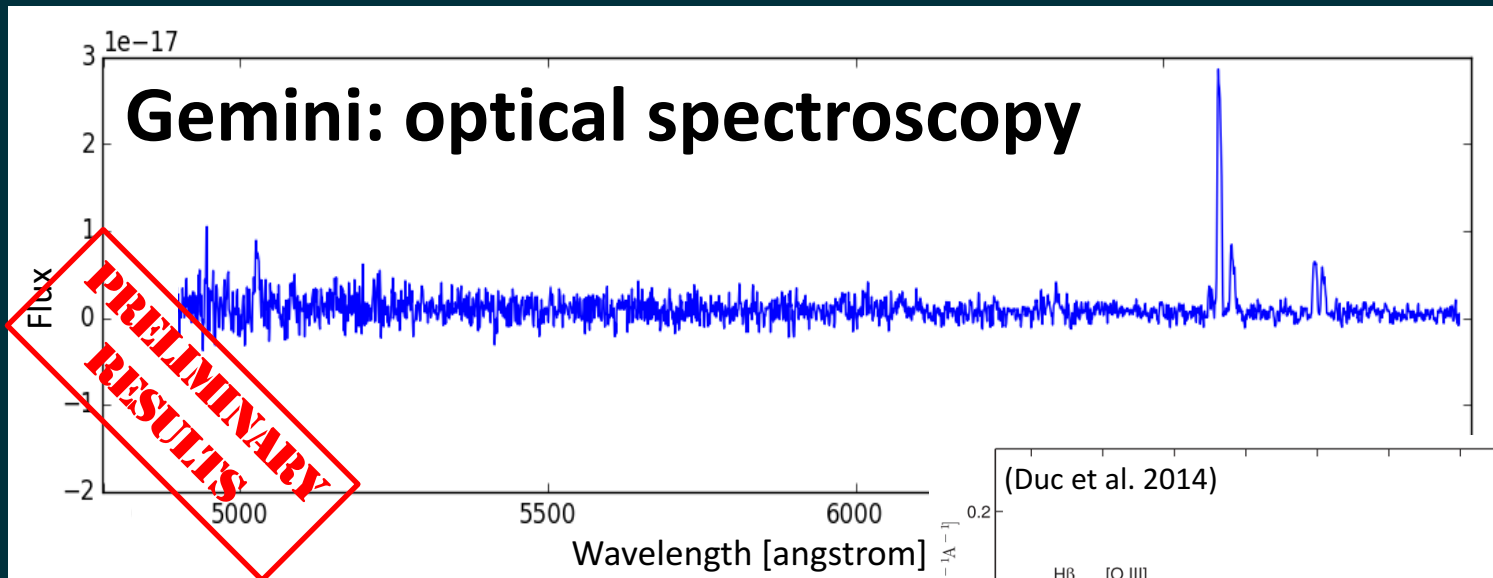


optical detection limit =
 $28.4 \text{ mag / arcsec}^2$



(Lee-Waddell et al., in prep)

AGC 208457: tidal dwarf galaxy (?)



$$12 + \log(\text{O}/\text{H}) = 8.5$$

(Lee-Waddell et al., in prep)

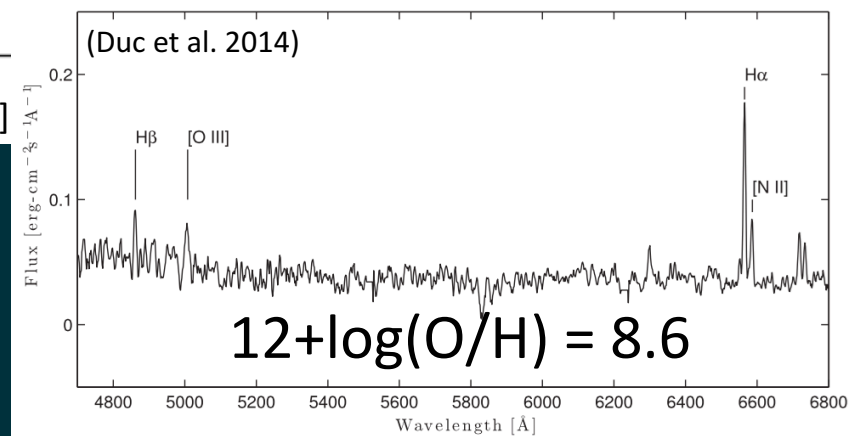
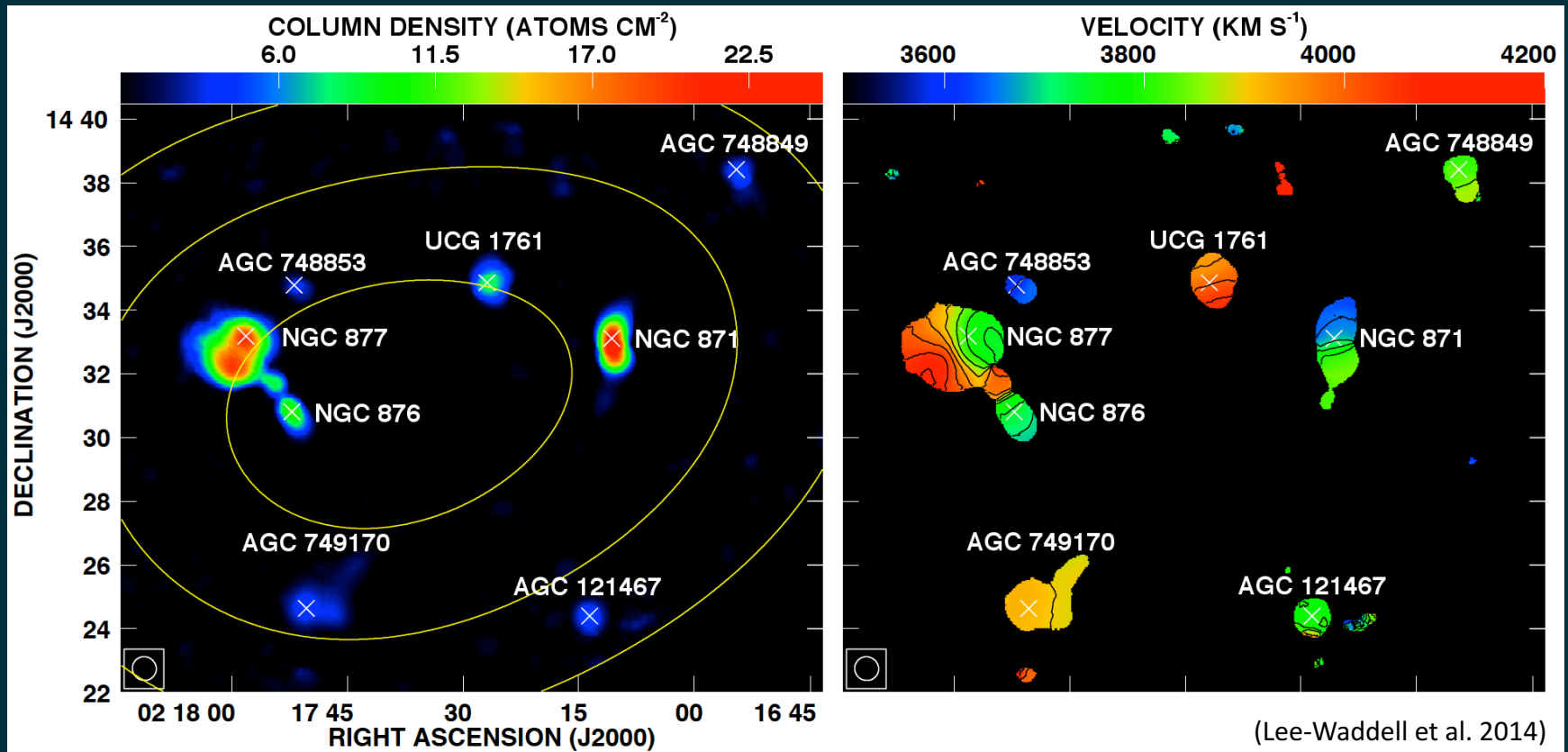
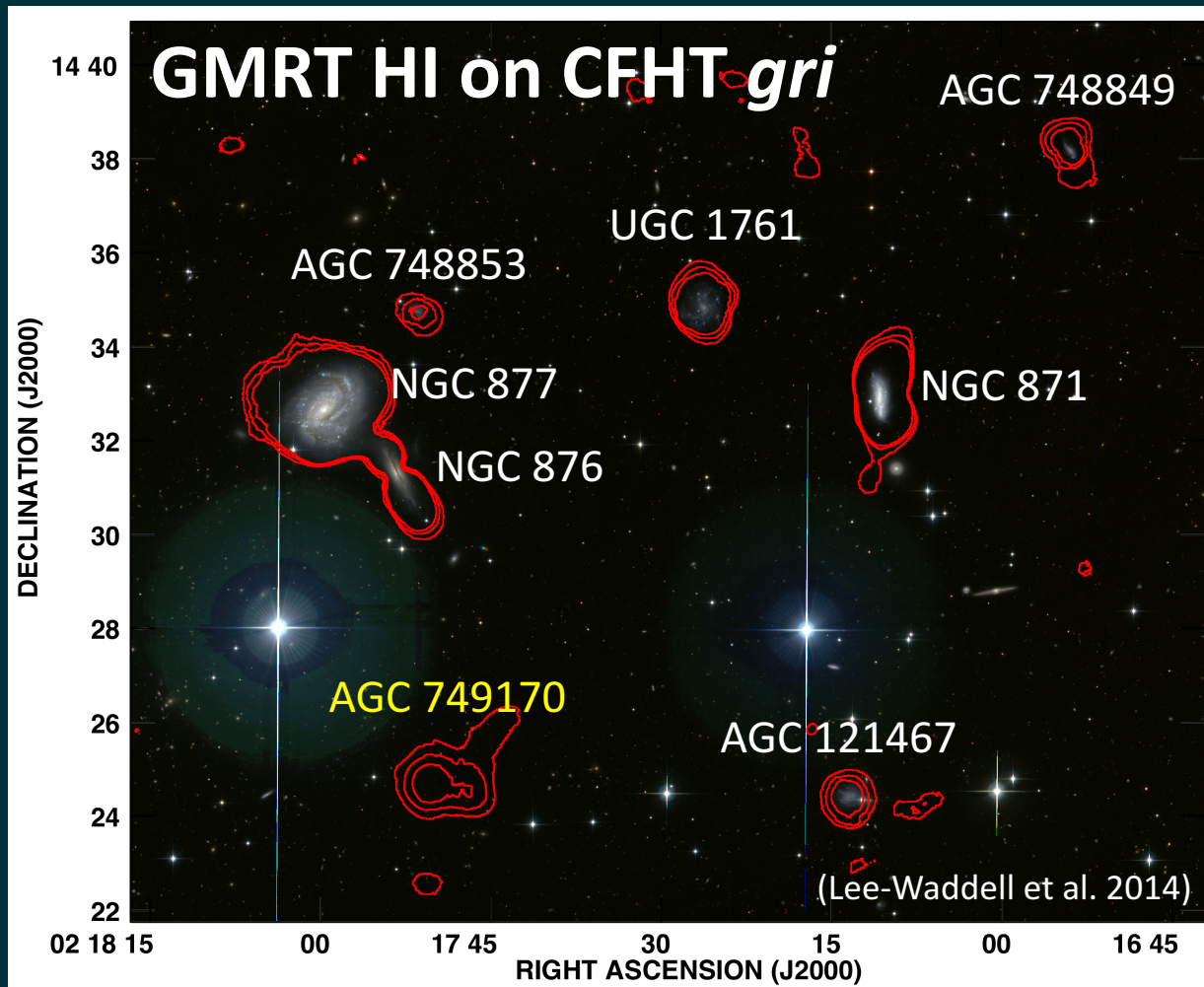


Figure 3. GMOS optical spectrum of the spectroscopically confirmed TDG NGC 5557-E1.

NGC 871/6/7 group: high resolution HI maps



NGC 871/6/7 group

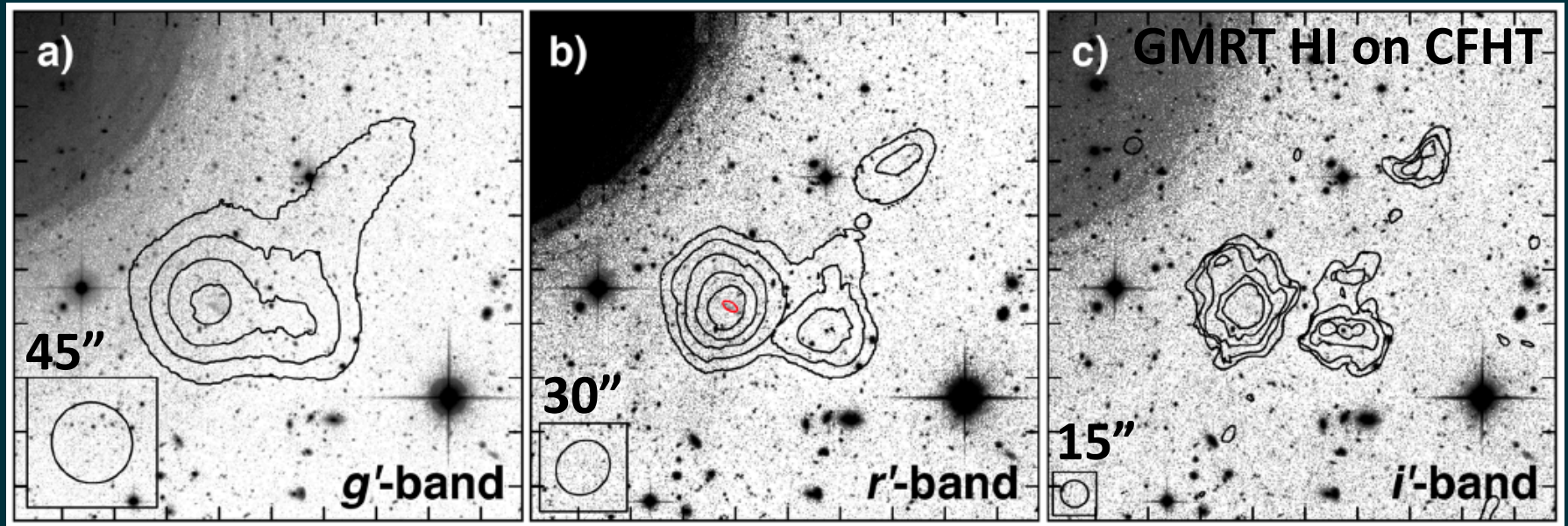


NGC 871/6/7: low-mass group members

Source	M_{HI} ($10^8 M_{\odot}$)	M_{stellar} ($10^8 M_{\odot}$)	$M_{\text{dyn}}/$ M_{baryon}	Age (10^9 yr)	SFR ($M_{\odot} \text{ yr}^{-1}$)
AGC 748849	9 ± 2	2.4 ± 0.7	6 ± 2	0.81	~ 0.05
AGC 121467	5 ± 1	--	--	--	~ 0.05
UGC 1761	16 ± 4	12 ± 4	21 ± 4	3.2 – 4.8	~ 0.2
AGC 749170	14 ± 4	<0.01	1.7 ± 0.5	≤ 0.012	<0.007
AGC 748853	8 ± 2	3.1 ± 0.9	9 ± 3	0.72 – 6.8	~ 0.04

(Lee-Waddell et al. 2014)

AGC 749170: optically dim tidal feature

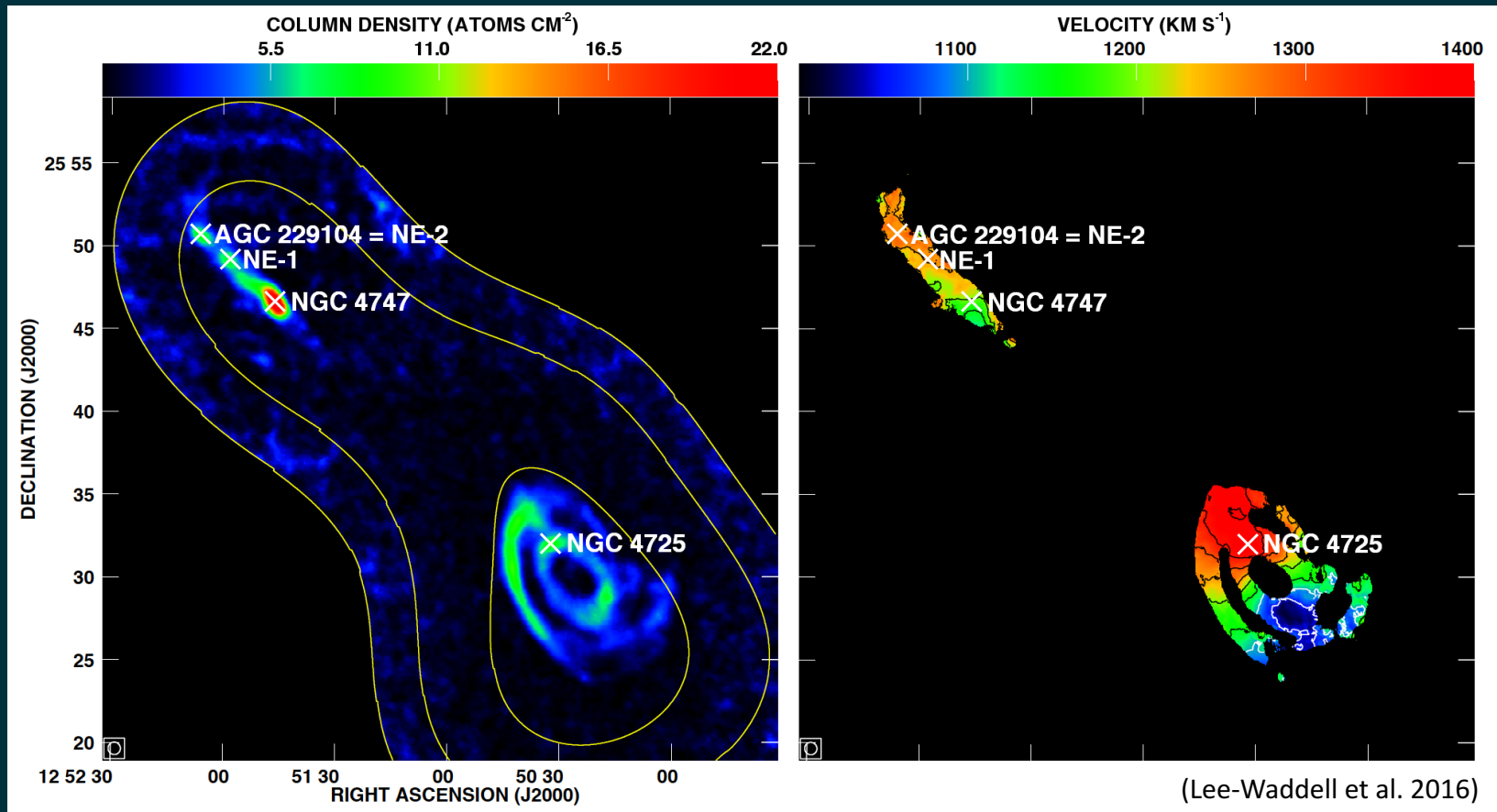


$$M_{\text{HI}} = 10^9 M_{\odot} \quad \bullet \quad M_{\text{dyn}}/M_{\text{gas}} = 1.7 \quad \bullet \quad M_* < 10^6 M_{\odot}$$

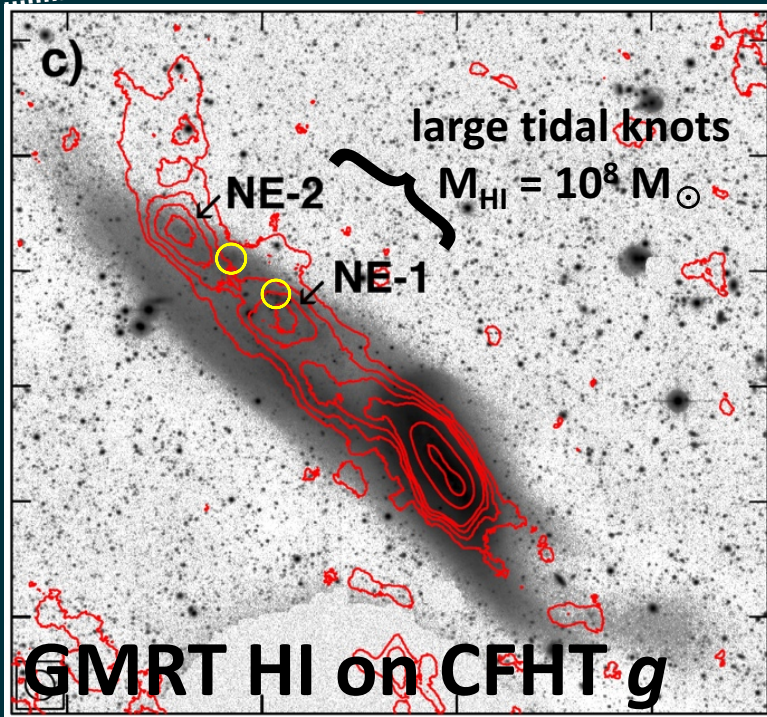
optical detection limit = 28.4 mag / arcsec²

(Lee-Waddell et al. 2014)

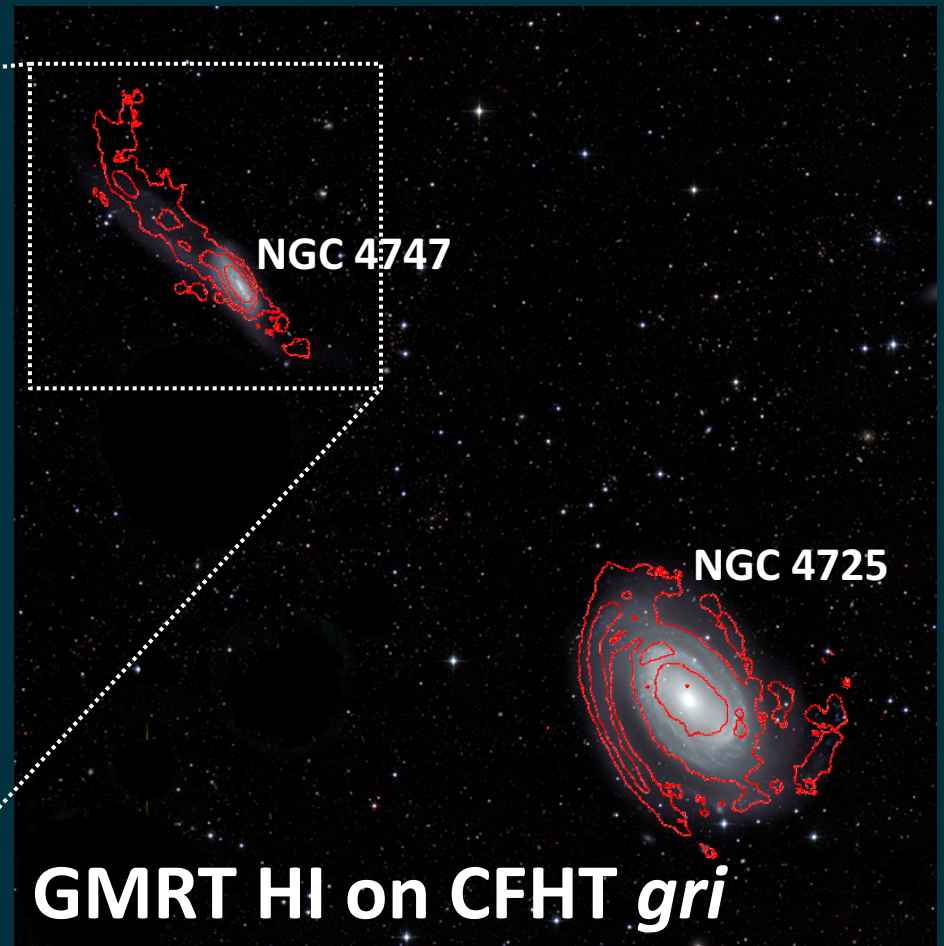
NGC 4725/47 group: HI maps



NGC 4725/47 group



(Lee-Waddell et al. 2016)

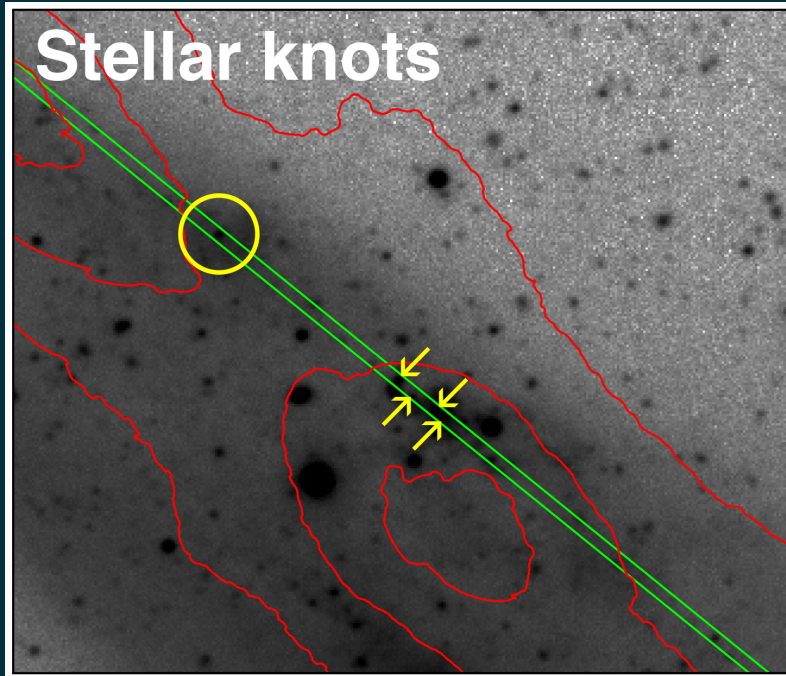


NGC 4725/47: group members & features

Source	M_{HI} ($10^8 M_{\odot}$)	M_{stellar} ($10^8 M_{\odot}$)	$M_{\text{dyn}}/$ M_{baryon}	Age (10^9 yr)	SFR ($M_{\odot} \text{ yr}^{-1}$)
NGC 4725	30 ± 6	400 ± 20	11 ± 1	9.5 – 9.8	~ 0.6
KK 167	0.7 ± 0.2	0.58 ± 0.02	5 ± 2	0.64 – 1.4	~ 0.01
NGC 4747	9 ± 2	14.7 ± 0.6	6 ± 1	1.1 – 12.0	~ 0.05
NE knot - 1	0.9 ± 0.3	< 0.3	> 3	--	~ 0.001
NE knot - 2	1.1 ± 0.3	$< .2$	> 3	--	~ 0.0007
Stellar knot - 1	--	$0.089 \pm$ 0.004	--	0.004 – 0.51	~ 0.002
Stellar knot - 2	--	$0.061 \pm$ 0.003	--	0.51 – 1.8	~ 0.0005

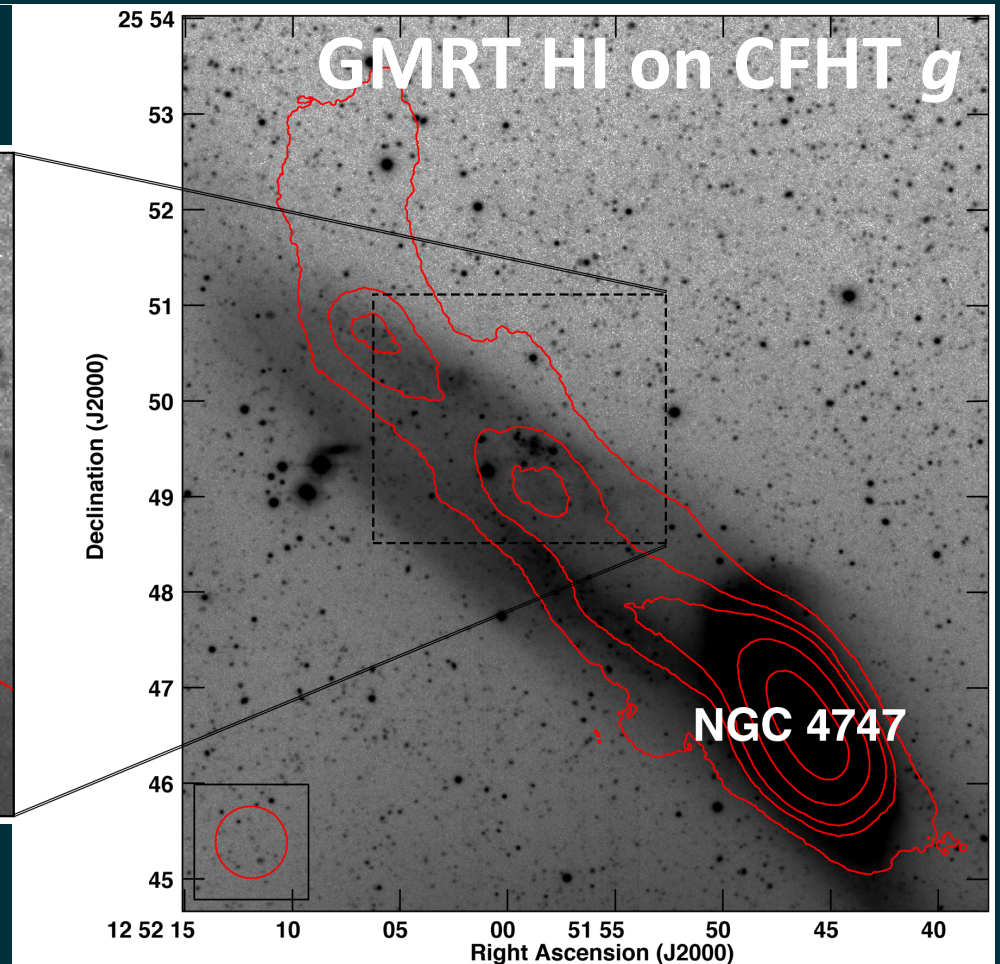
(Lee-Waddell et al. 2016)

NGC 4747: optical spectroscopy

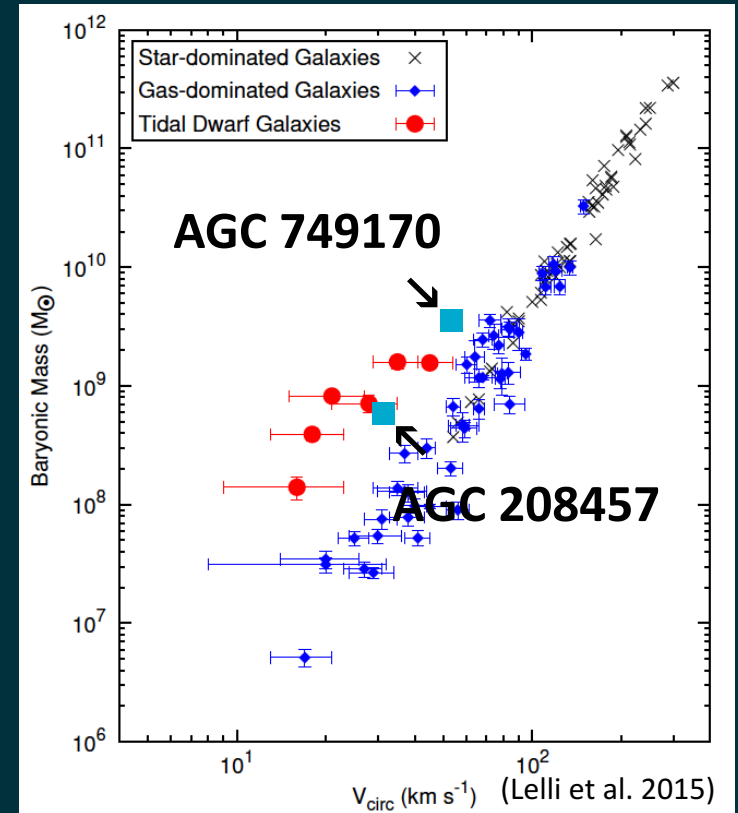
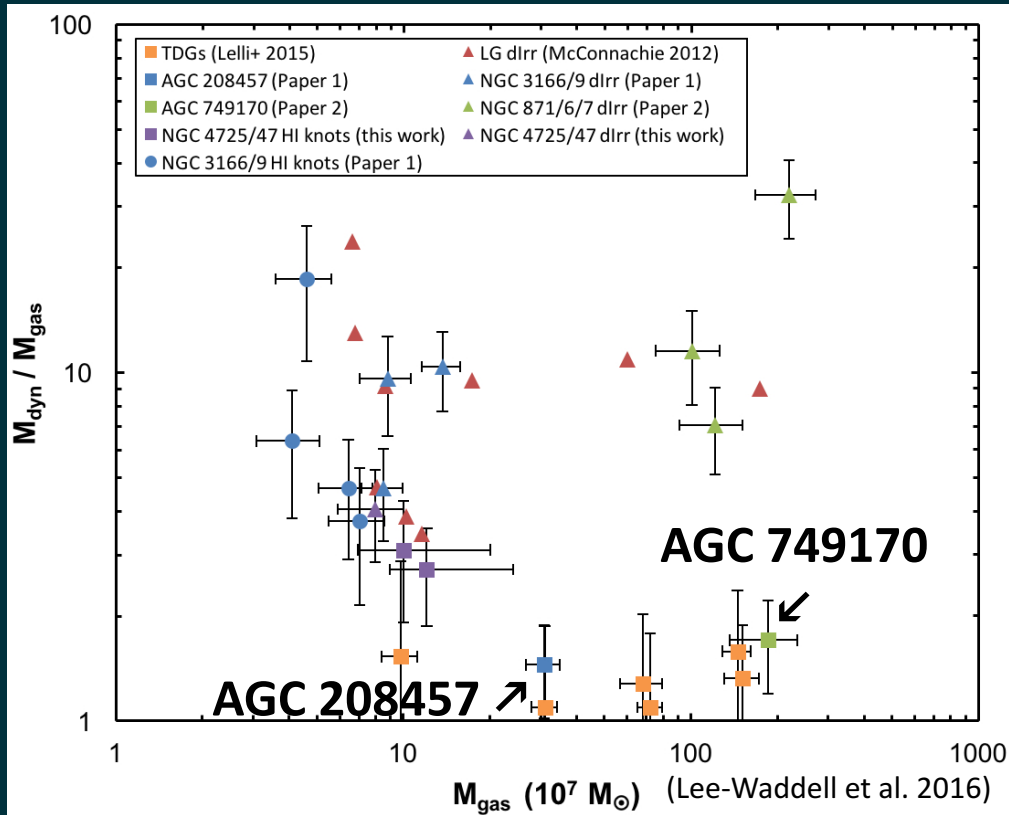


$$12 + \log(\text{O}/\text{H}) = 8.5$$

(Lee-Waddell et al., in prep)



Summary of HI-rich group survey

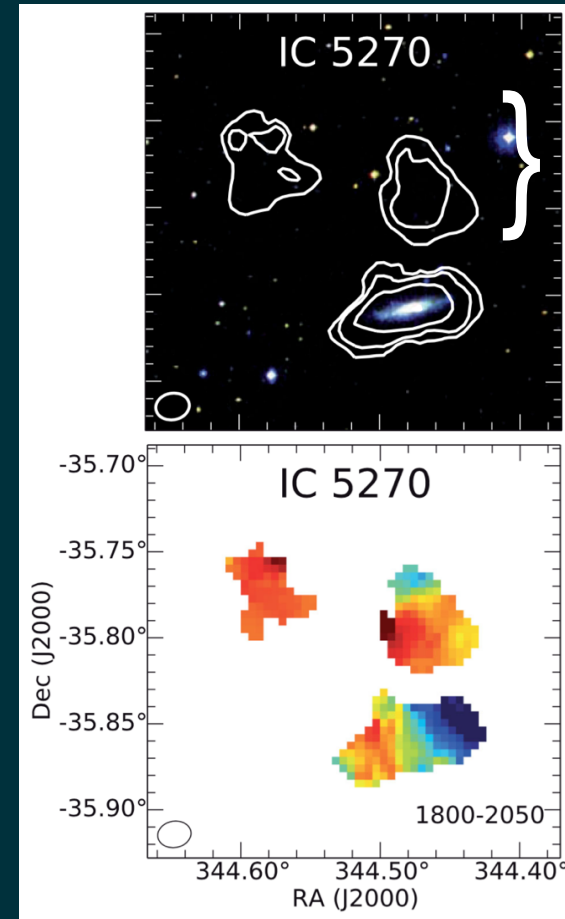
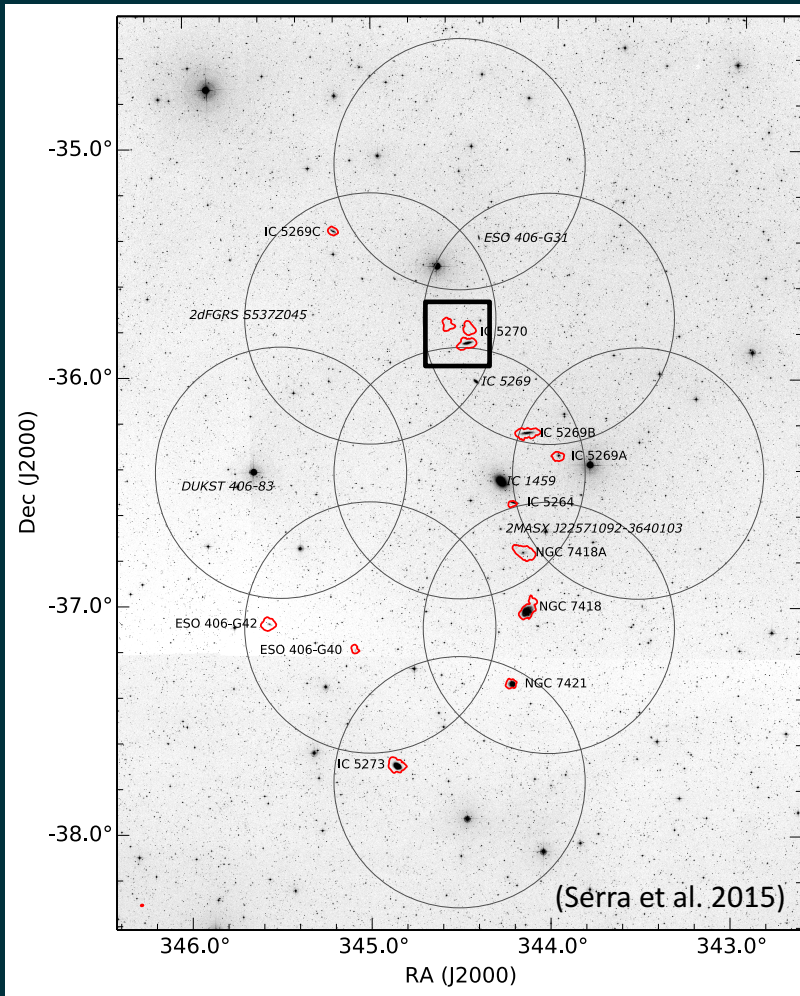


Australian Square Kilometre Array Pathfinder (ASKAP)

- 36 x 12 m antennas ($\sim 4000 \text{ m}^2$ collecting area)
- 6 km max baseline
- frequency range = 700 MHz – 1.8 GHz
- 300 MHz instantaneous bandwidth



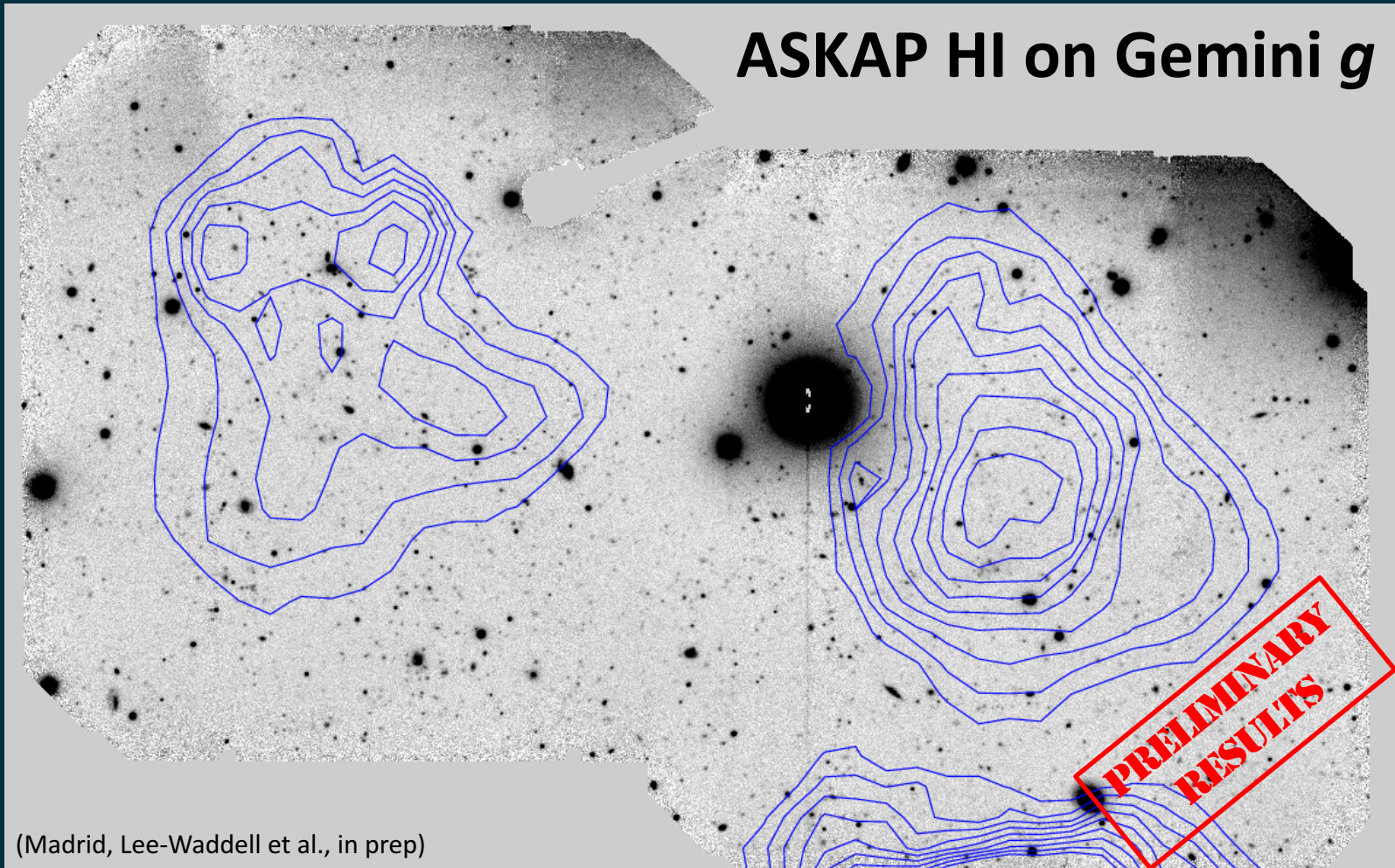
ASKAP-BETA observations: IC 1459 group



$M_{\text{HI}} = 10^9 M_{\odot}$

IC 5270: optically dark tidal feature

ASKAP HI on Gemini *g*



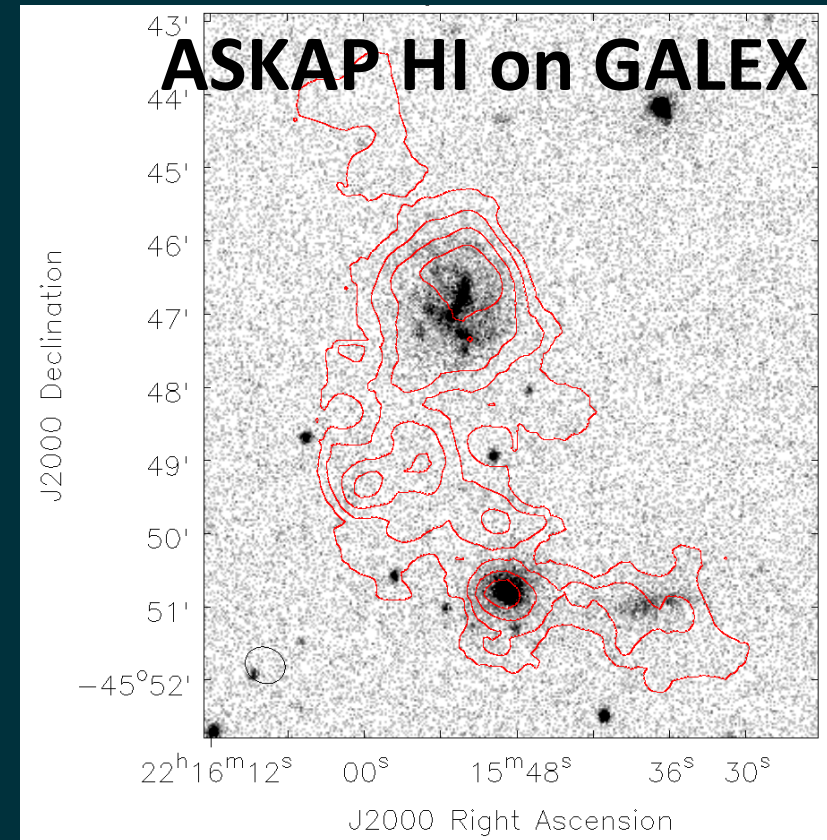
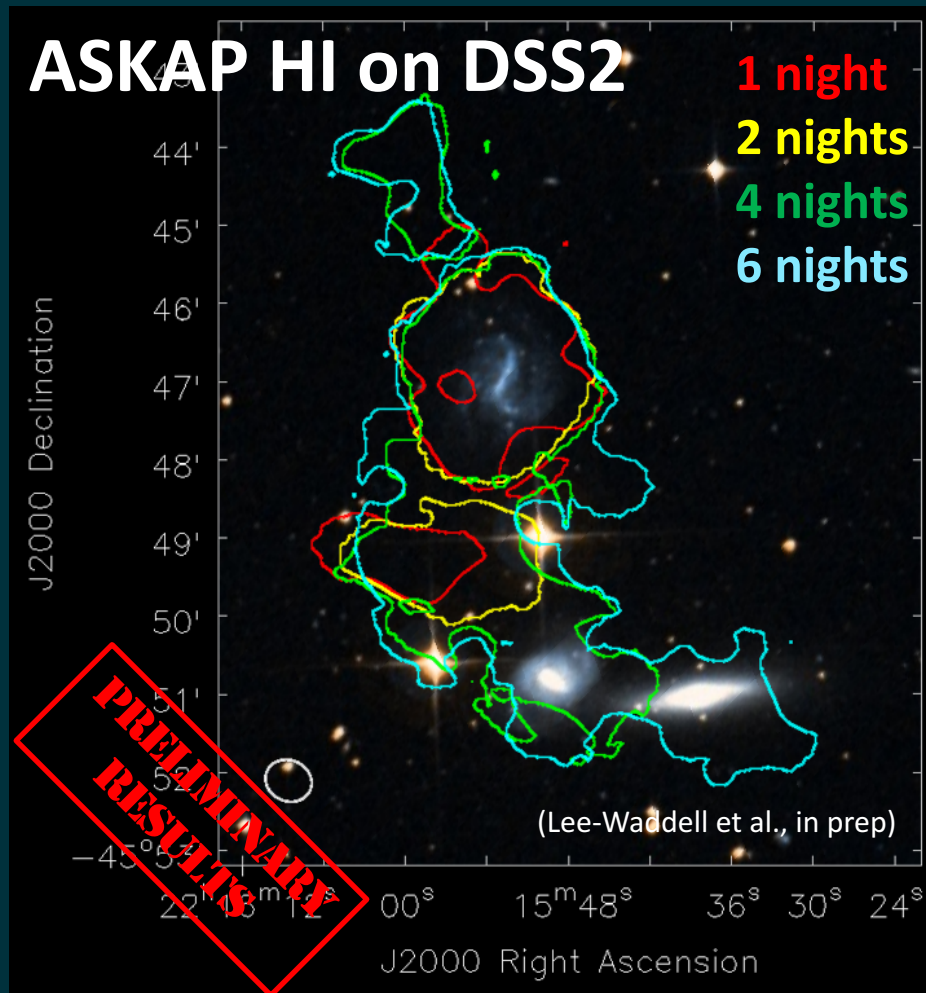
(Madrid, Lee-Waddell et al., in prep)

ASKAP early science

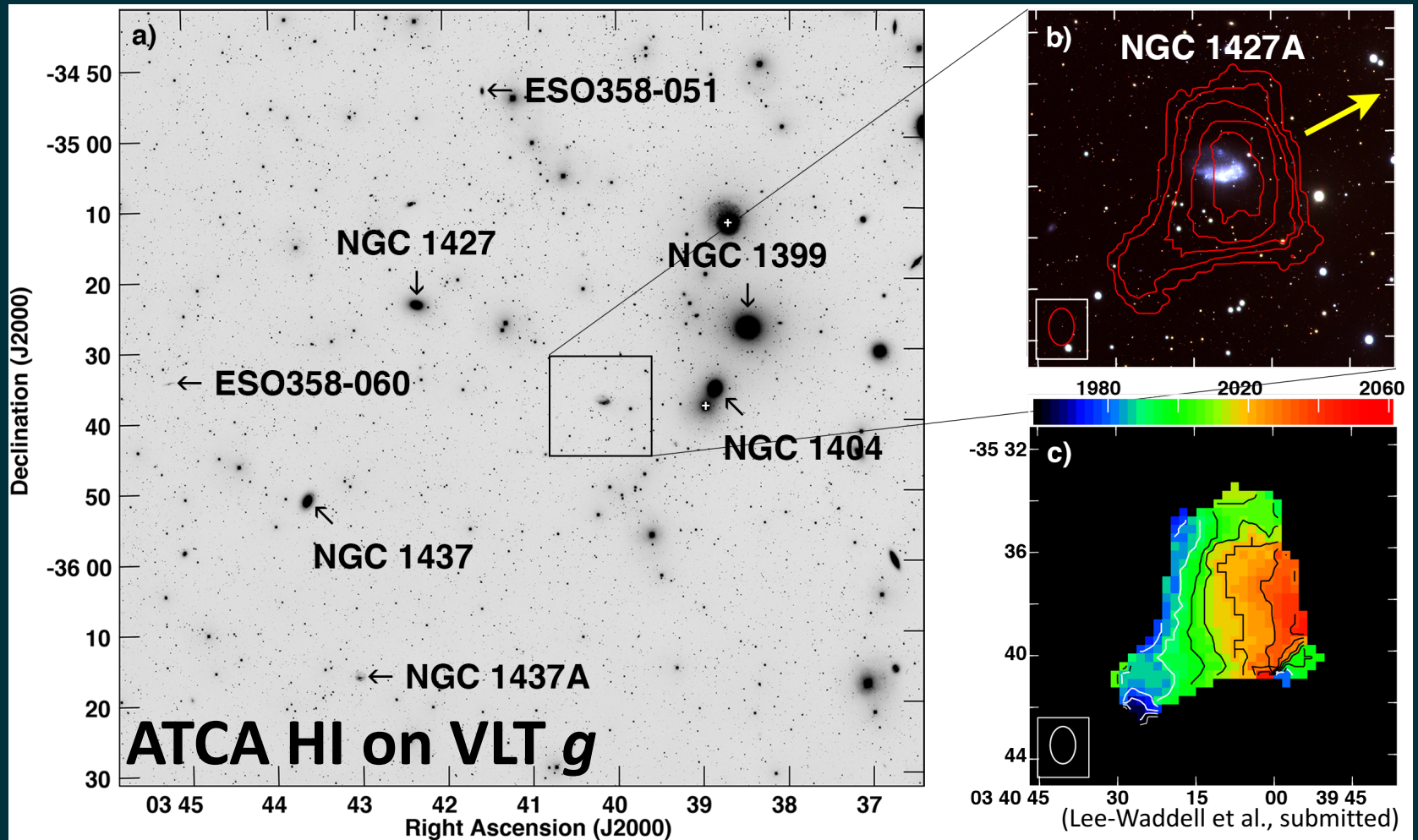
- started 7 October 2016
- HI observations for WALLABY
- 36 beams (5.5 x 5.5 deg FOV)
- 12 MkII PAF-fitted antennas
- 48 MHz bandwidth
- 4 km/s spectral resolution



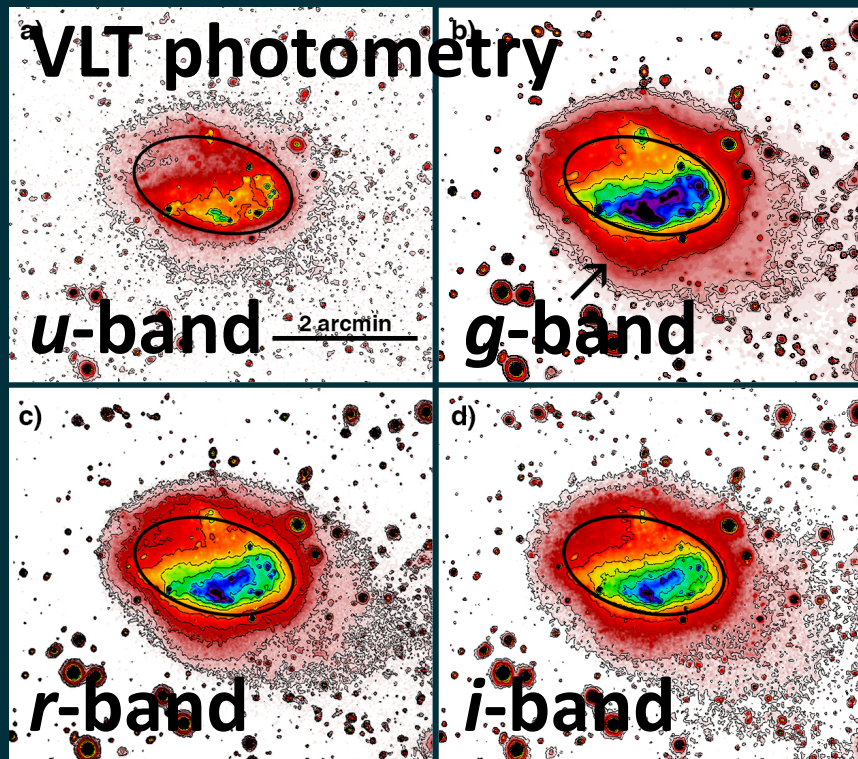
ASKAP-12 observations: NGC 7232 triplet



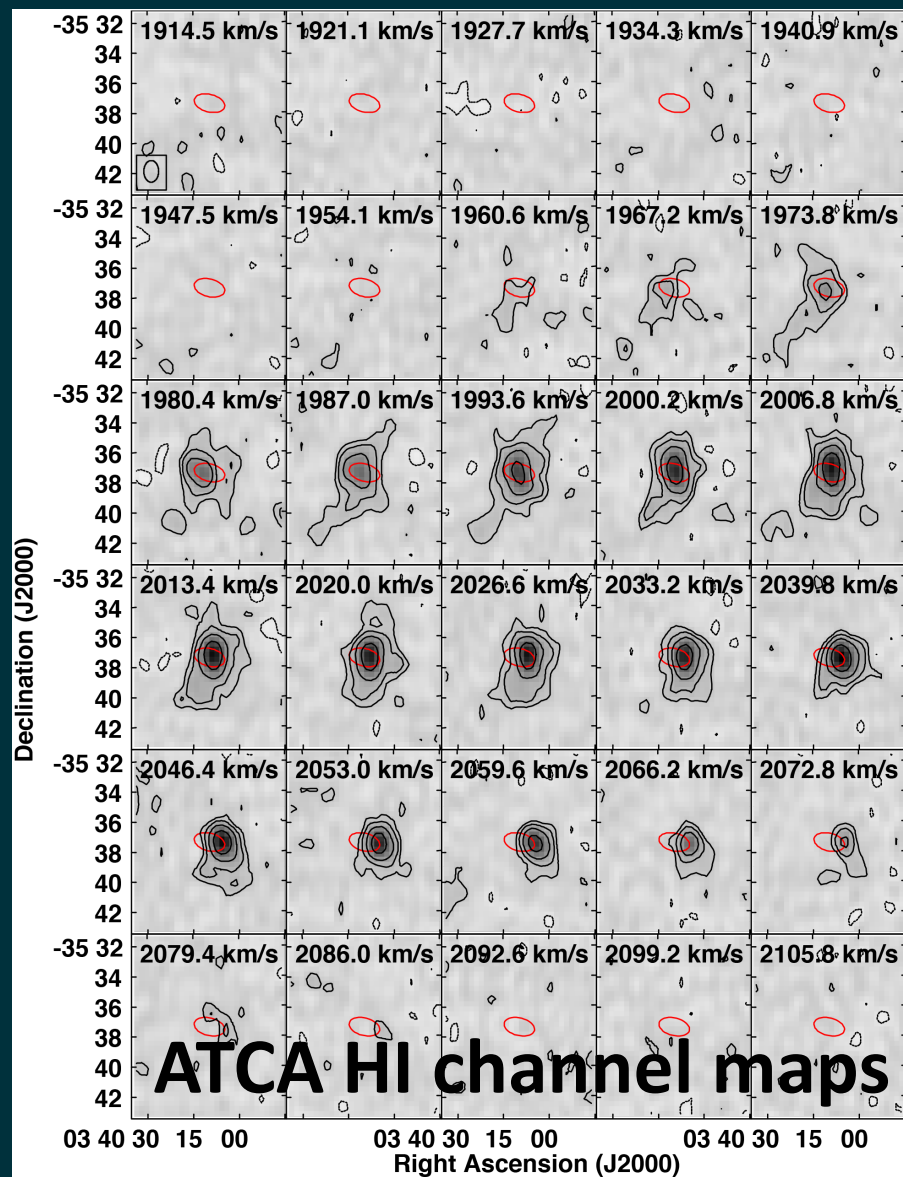
Fornax cluster: HI tail of NGC 1427A



NGC 1427A



(Lee-Waddell et al., submitted)



Summary

- survey of HI-rich groups
 - AGC 208457 → likely TDG ($M_{\text{HI}} = 10^8 M_{\odot}$)
 - AGC 749170 → optically dim tidal feature ($M_{\text{HI}} = 10^9 M_{\odot}$)
 - NGC 4747 → tail with tidal knots ($M_{\text{HI}} = 10^8 M_{\odot}$)
- ASKAP observations
 - IC 5270 → two optically dark tidal features ($M_{\text{HI}} = 10^9 M_{\odot}$)
 - NGC 7232/3 → newly resolved tidal features
- Fornax cluster
 - NGC 1427A → has extended tidal tail ($M_{\text{HI}} = 10^8 M_{\odot}$)



Thank you!

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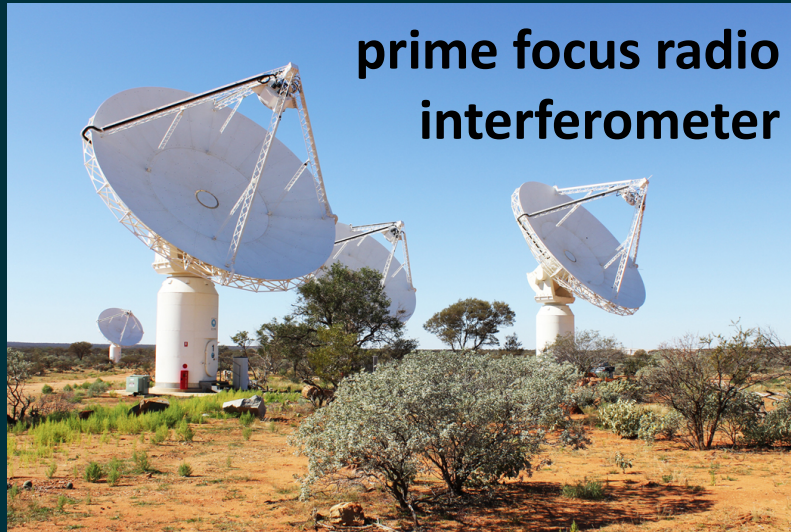
 [@KarenLeeWaddell](https://twitter.com/KarenLeeWaddell)

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Extra Slides (details about ASKAP)

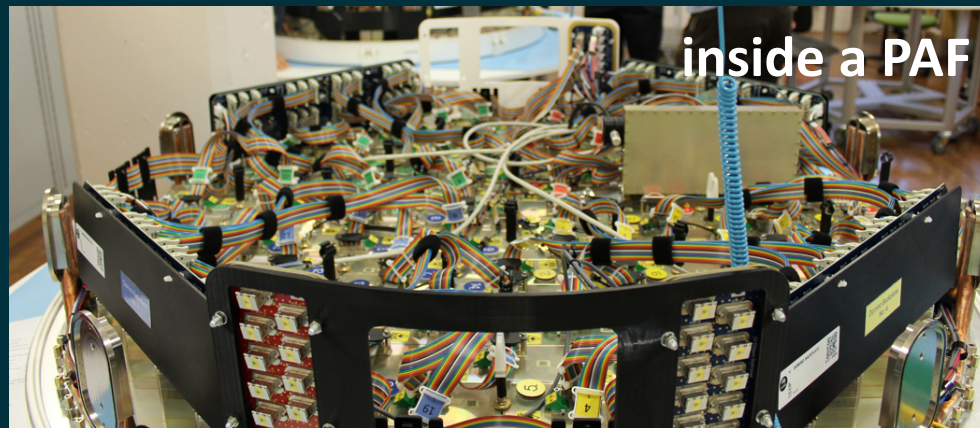
ASKAP: innovative design



**prime focus radio
interferometer**



**revolutionary
phased array
feed (PAF)**



inside a PAF

ASKAP: survey science projects

- galaxy formation and gas evolution in the nearby Universe → GASKAP, WALLABY
- evolution, formation, and population of galaxies across cosmic time → DINGO, EMU, FLASH
- characterization of radio transients and variable sources → COAST, CRAFT, VAST, VLBI
- evolution of magnetic fields in galaxies over cosmic time → POSSUM

ASKAP: neutral hydrogen survey

Widefield ASKAP L-band Legacy All-sky Blind survey

PIs: B. Koribalski & L. Staveley-Smith

- high resolution neutral hydrogen (HI) maps
- covering **75%** of the entire sky
- detecting **500,000+** gas-rich galaxies
- study the properties and environments of galaxies

WALLABY



ASKAP: early science HI observations

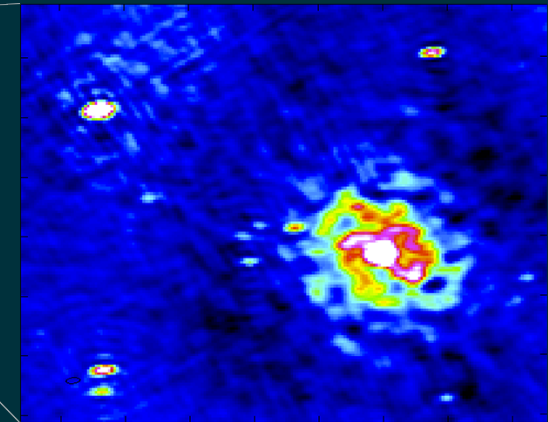
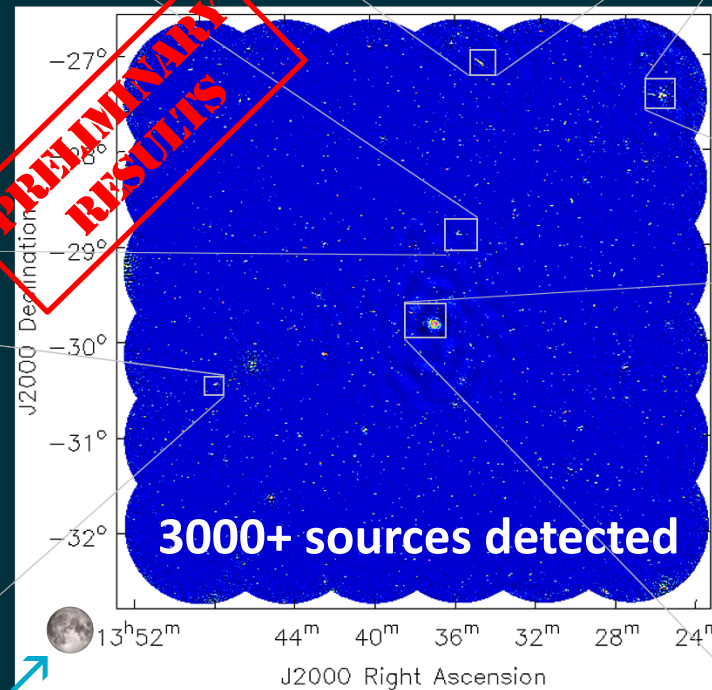
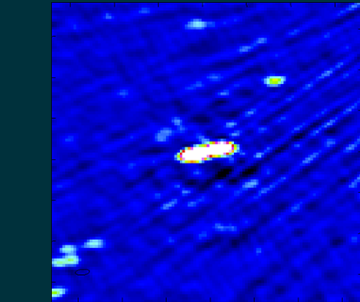
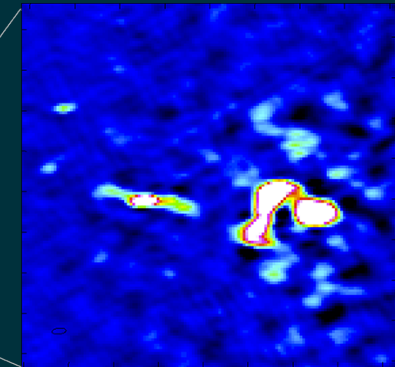
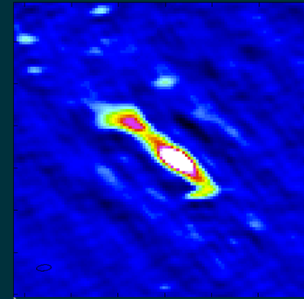
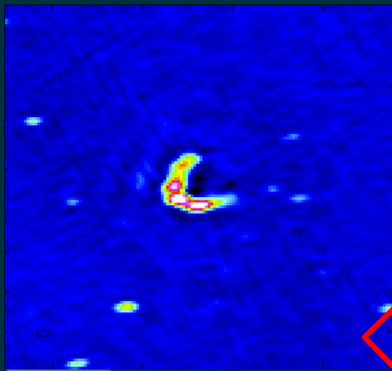
Field identifier	Observation Dates	Bandwidth (MHz)	Time on source (hours)
NGC 7232 group	Oct 2016	48	140+
Fornax cluster	Dec 2016	192	160+
Dorado group	Dec 2016 – Jan 2017	192	70
M83 group	Dec 2016 – Jan 2017	192	80

“+” indicates that there is additional commissioning time on the field

M83 group: continuum images

10 antennas, 10 hours on source, 192 MHz bandwidth, 1344.5 MHz central frequency

Daytime observations taken on 31 Dec 2016



size of full moon