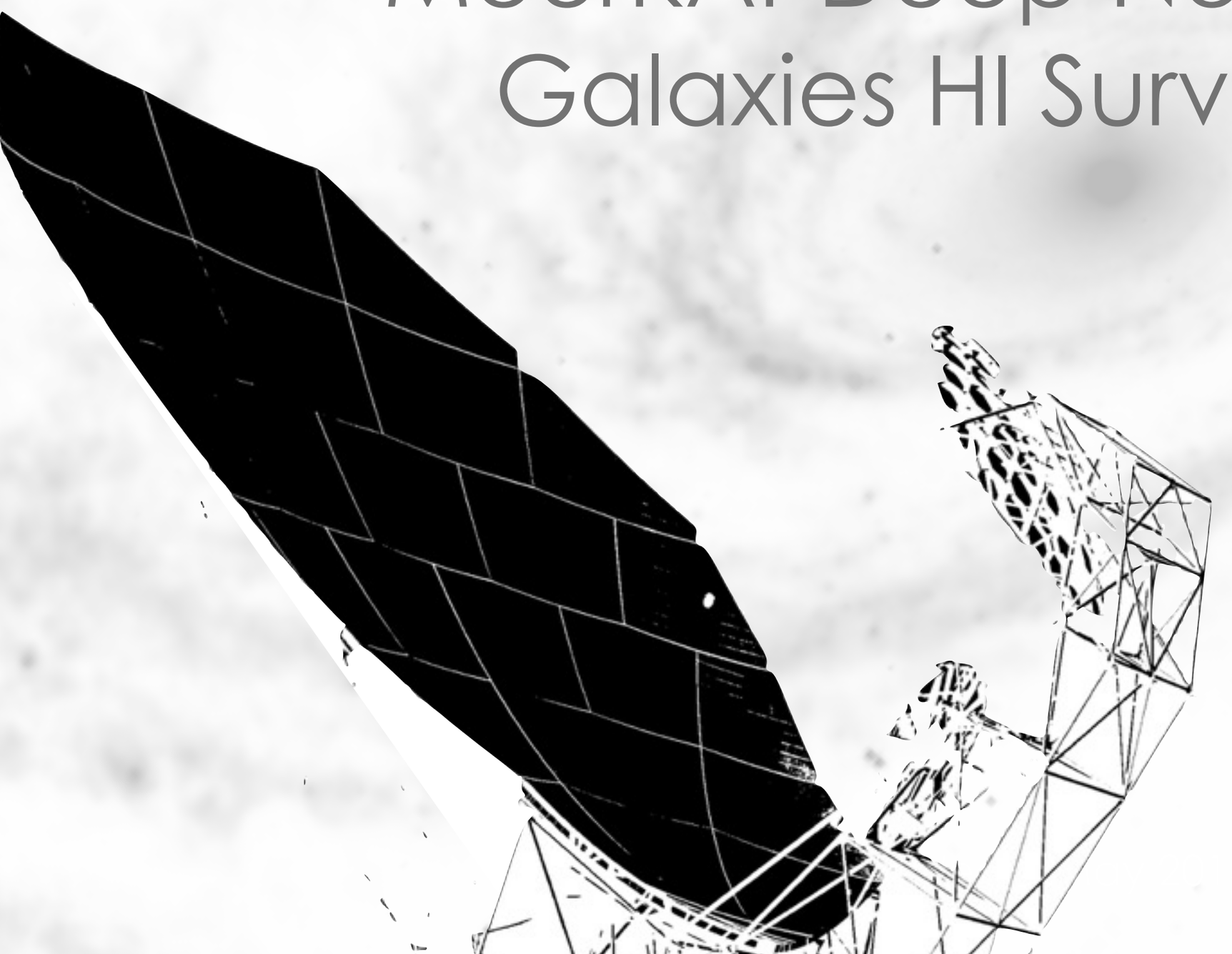
MHONGOOSE

MeerKAT HI Observations of Nearby Galactic Objects: Observing Southern Emitters

MeerKAT Deep Nearby Galaxies HI Survey



Erwin de Blok

ASTRON/UCT/Groningen

PHISCC 2016 Cape Town

Future HI science

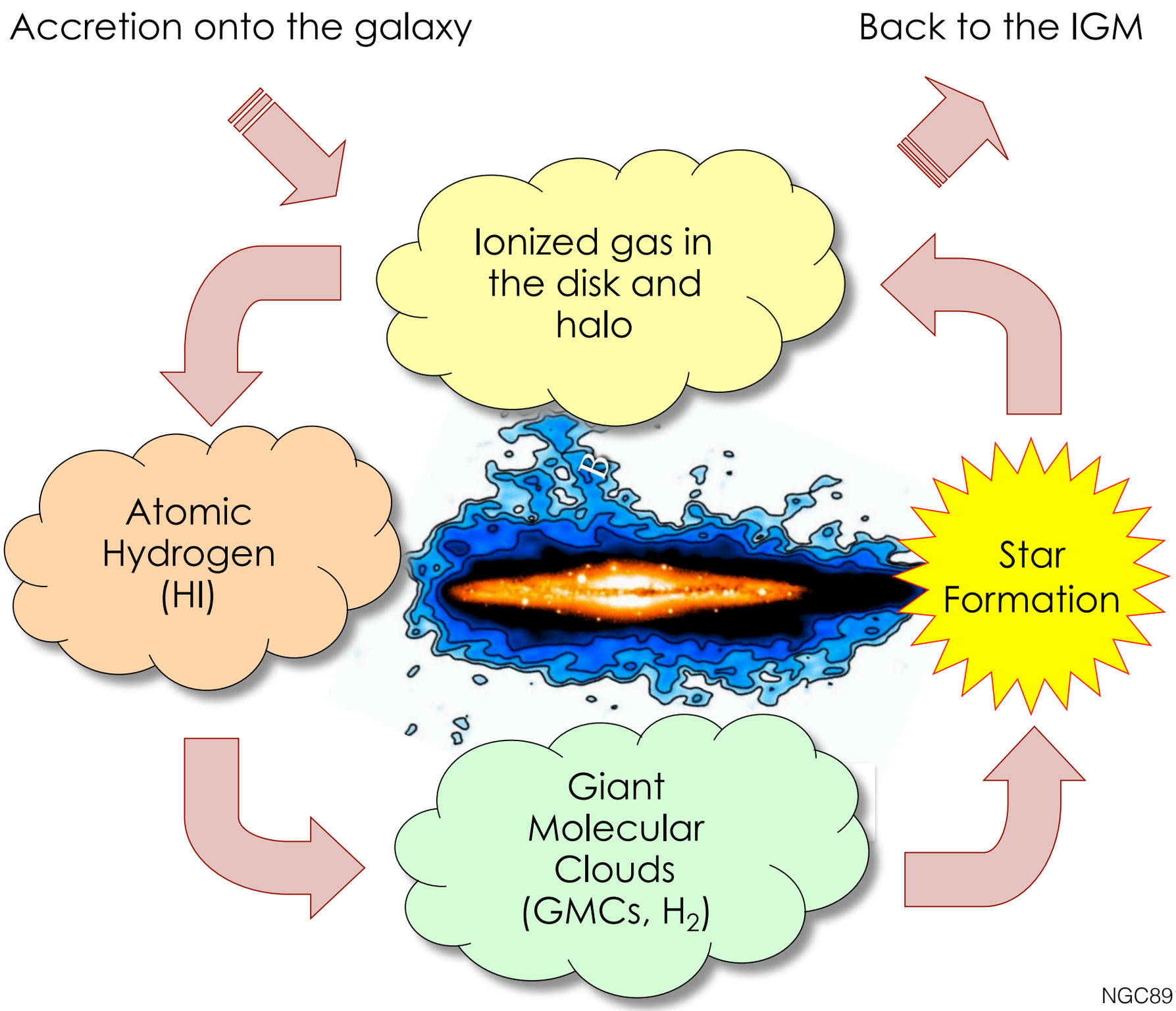
The connection, over time, between **star formation, HI, dynamics** and **accretion**, is one of the main issues to address in the coming years through *large, deep surveys* of the H I in the *local* and *distant* Universe

- How do galaxies assemble and evolve?

- How is star formation regulated?

- How are outer disks and cosmic web linked?

Galactic gas cycle



NGC891: Oosterloo et al (2007)

MHONGOOSE science

MHONGOOSE:

- Ultra-deep observations of 30 nearby galaxies
- 200 hours per galaxy; 6000 hours total
- 25 times longer than THINGS
- twice as deep as HALOGAS

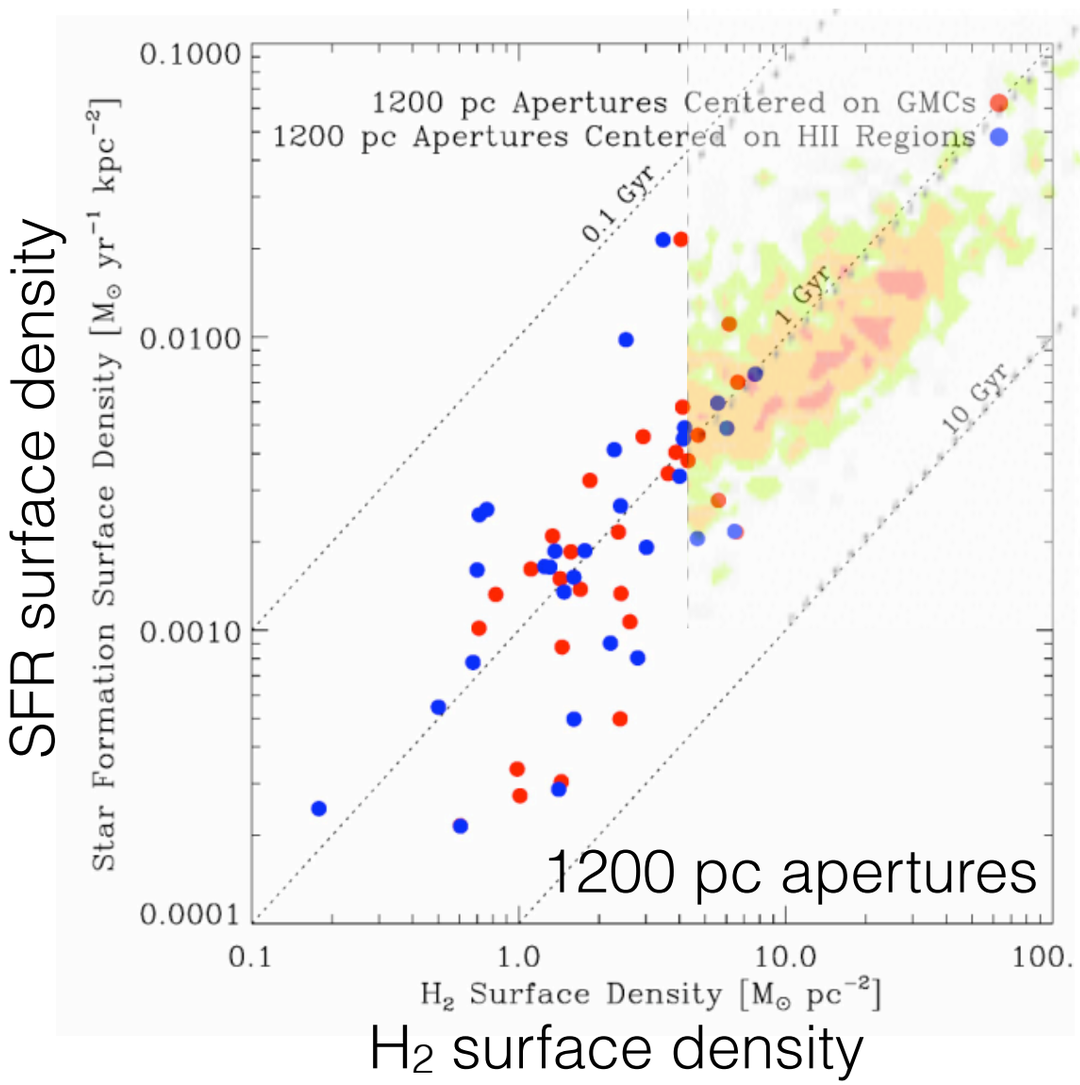
High resolution:

- star formation
- dynamics
- structure of the ISM

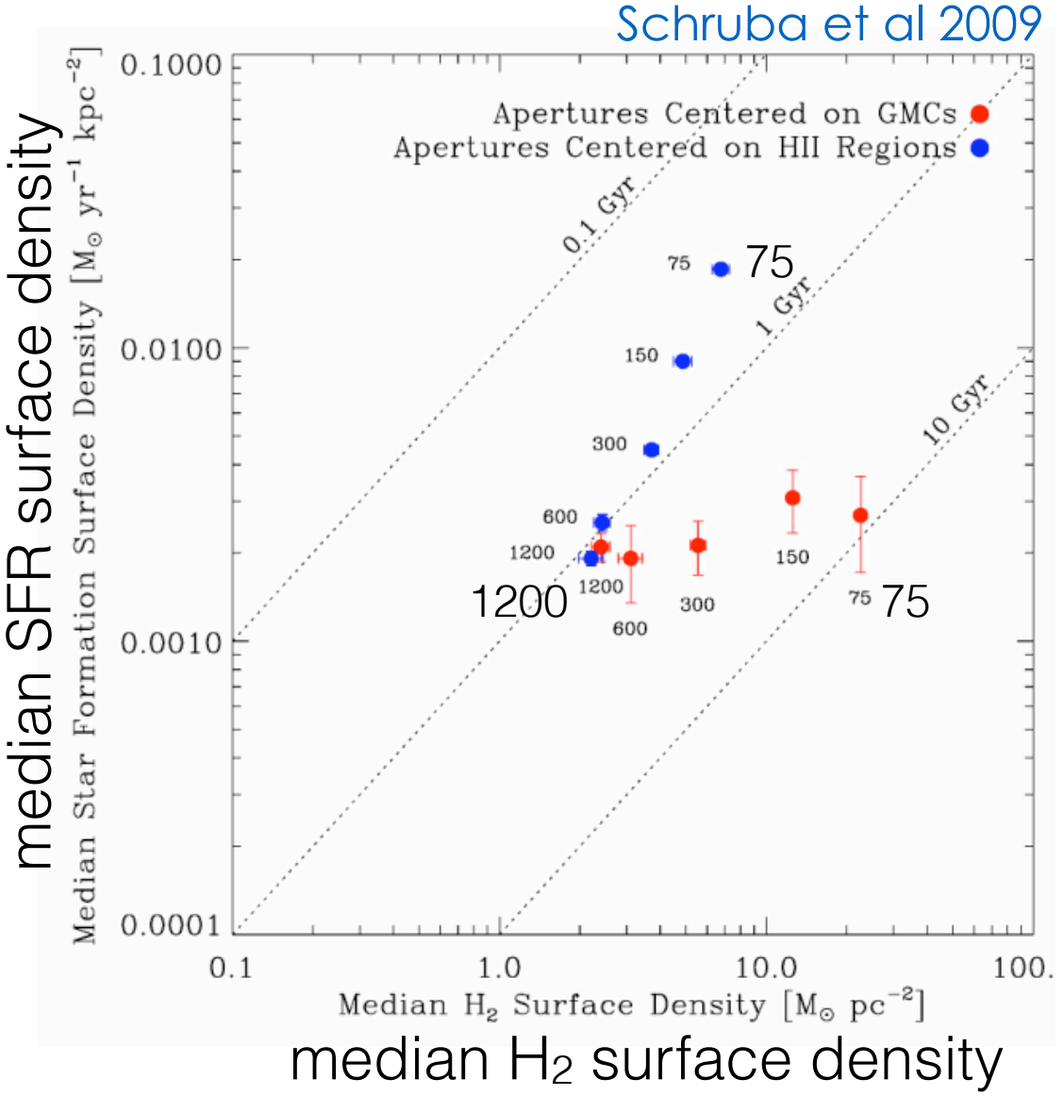
High sensitivity:

- cosmic web
- accretion

Scale-dependent SF



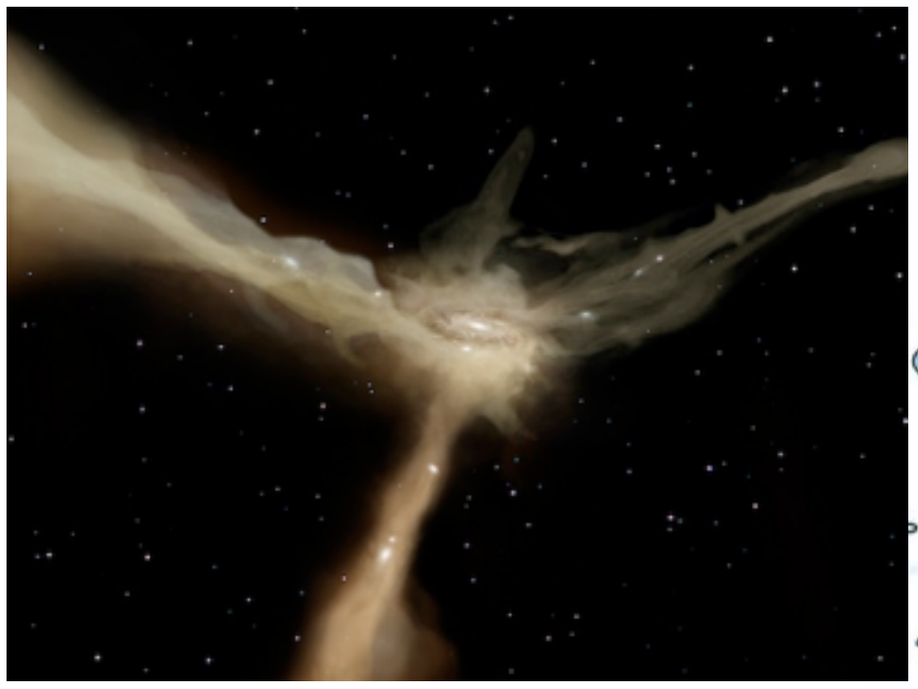
Schruba et al 2009



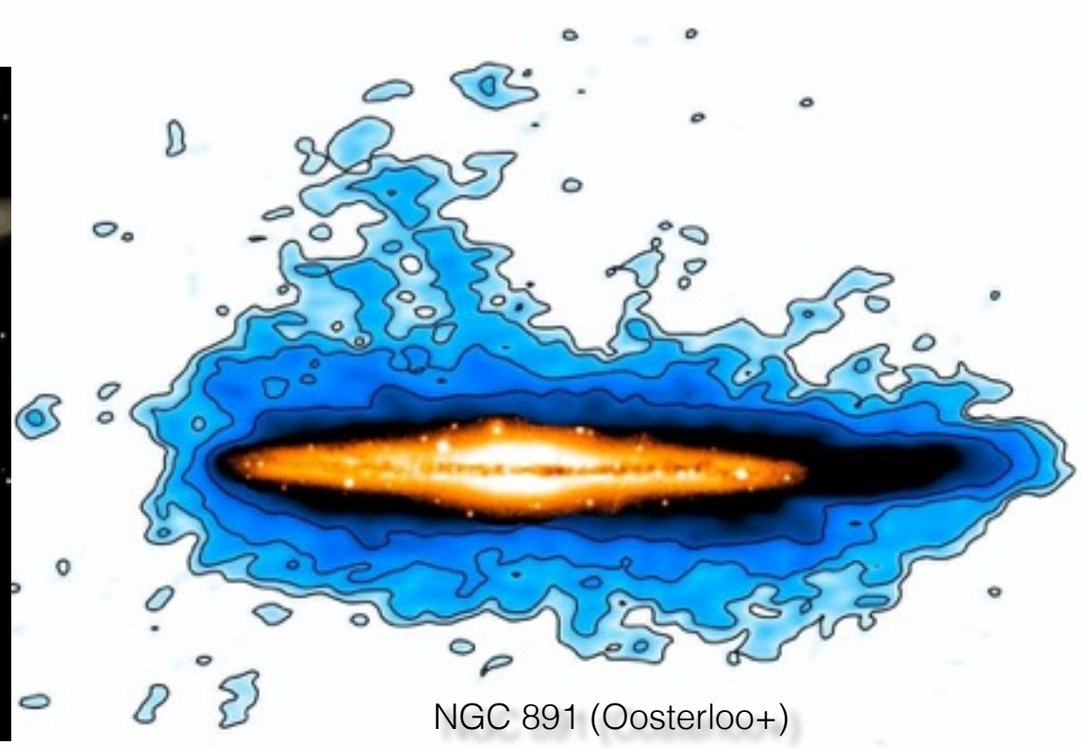
Kennicutt-Schmidt law breaks down (in M33) at scales of ~300 pc
Below that evolutionary state of SF regions becomes important

Accretion

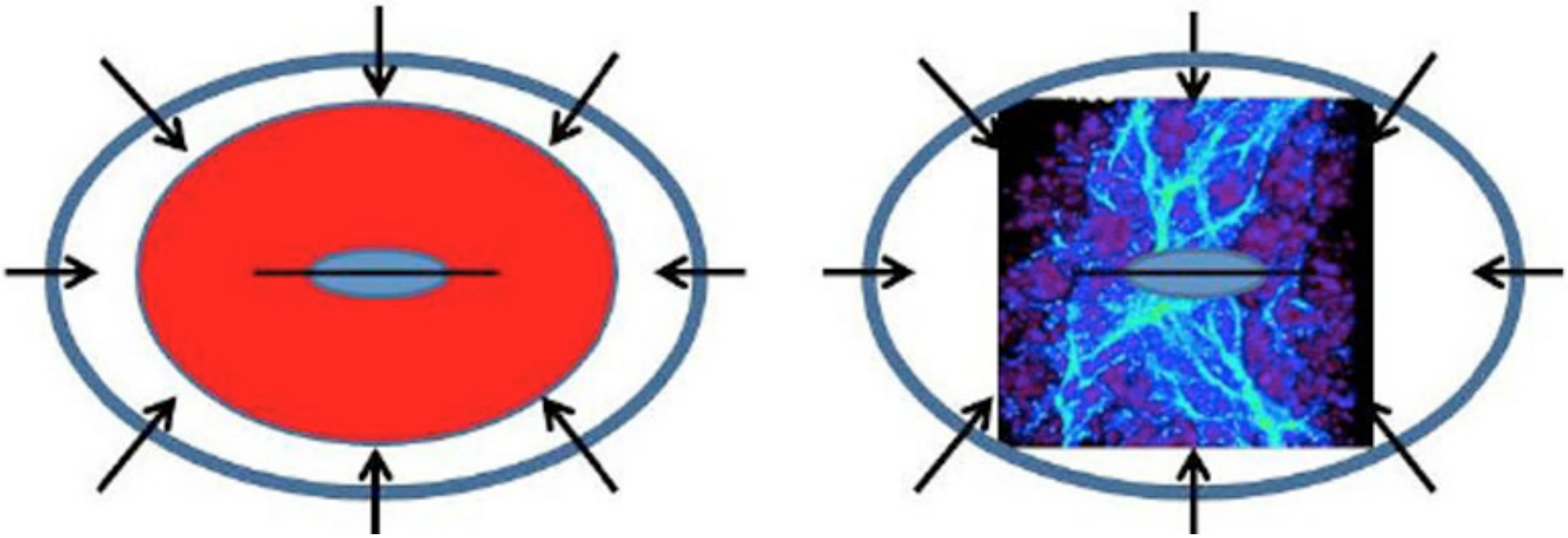
- What is the nature of extra-planar gas in galaxies
- What is the importance of (cold) accretion

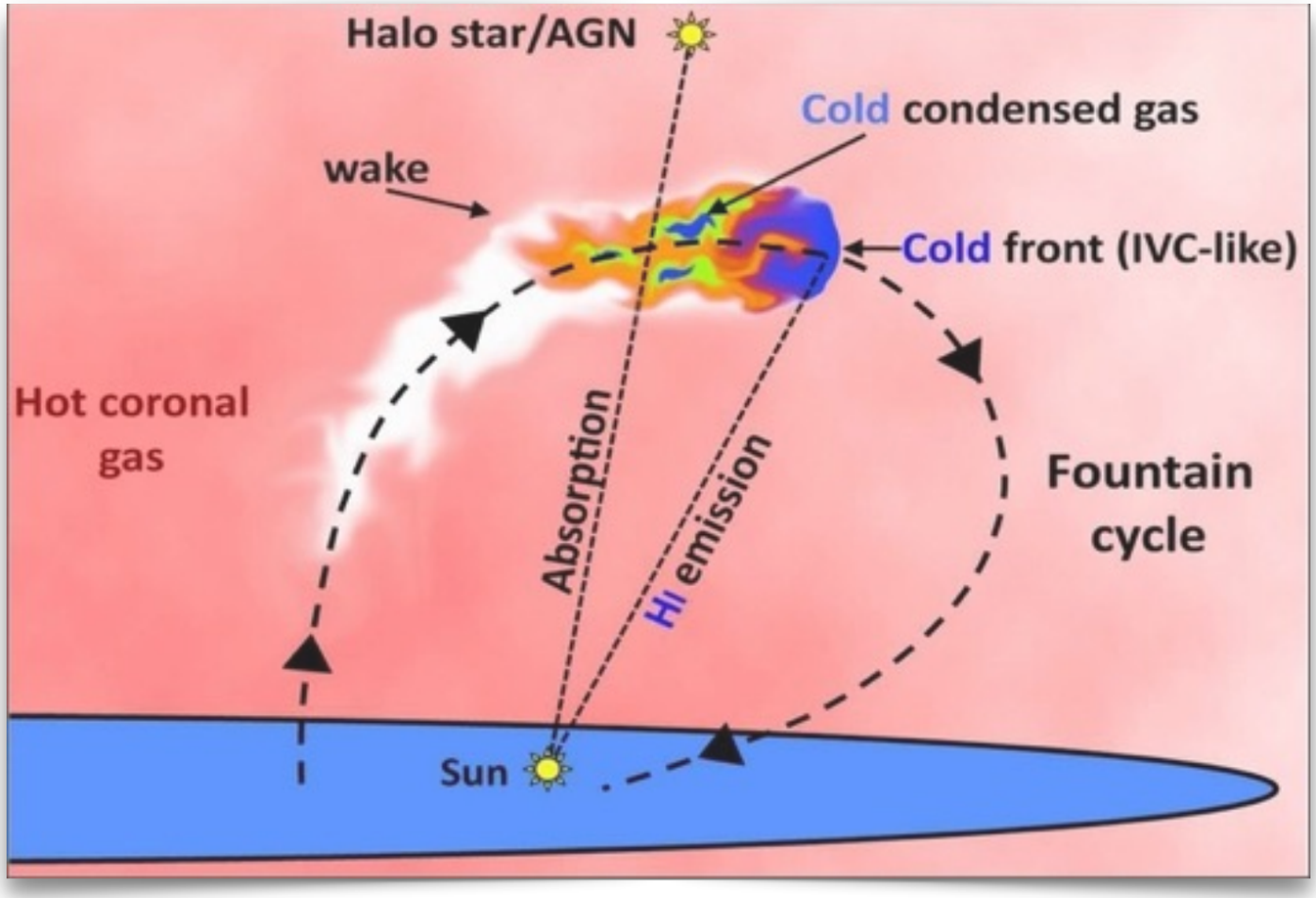


(ESA-AOES Medialab)



NGC 891 (Oosterloo+)





Fraternali (2013)

Selecting a Sample

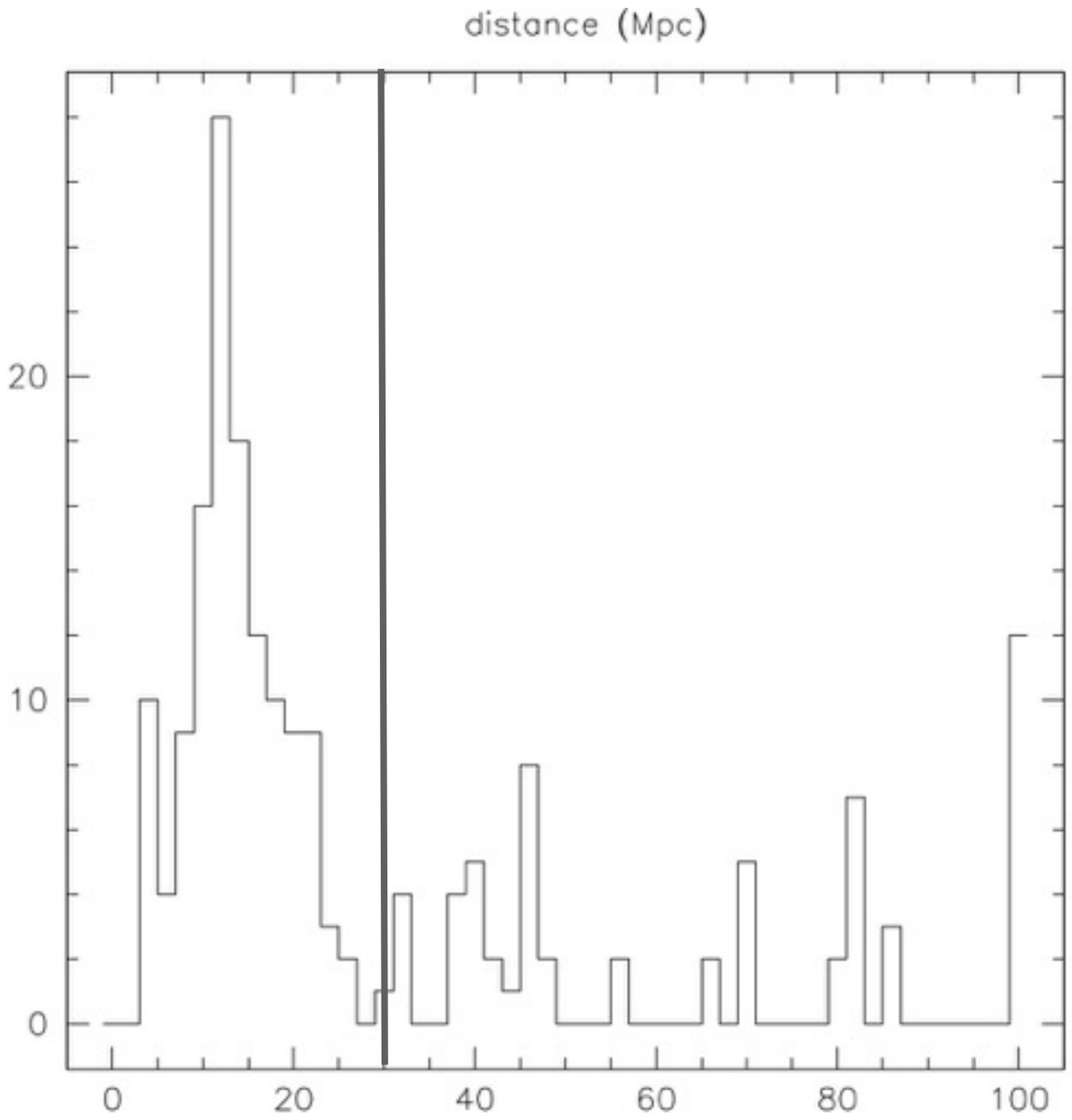
HI detected

- HIPASS-based sample
- Galactic latitude $|b| > 30^{\circ}$, Galactic standard of rest velocity > 200 km s^{-1}
- Projected distance from the LMC $> 10^{\circ}$

Detected in SINGG (Survey for Ionization in Neutral Gas Galaxies) and SUNGG (Survey for Ultraviolet emission in Neutral Gas Galaxies) (P.I. Meurer)

- Hα, photometry, WISE and GALEX are available
  → 151 galaxies.

Pre-cursor Sample



- cut at 30 Mpc (MeerKAT beam 1 kpc)
- Galaxies with dec < -10
- Exclude galaxies in Paolo Serra's Fornax survey region.
- → 88 galaxies

Pre-cursor Sample

- representative number of galaxies as uniformly as possible over log(M_{HI})

6	< log M_{HI} < 8	5
8	< log M_{HI} < 8.5	16
8.5	< log M_{HI} < 9	18
9	< log M_{HI} < 9.5	26
9.5	< log M_{HI} < 10	15
10	< log M_{HI} < 11	7

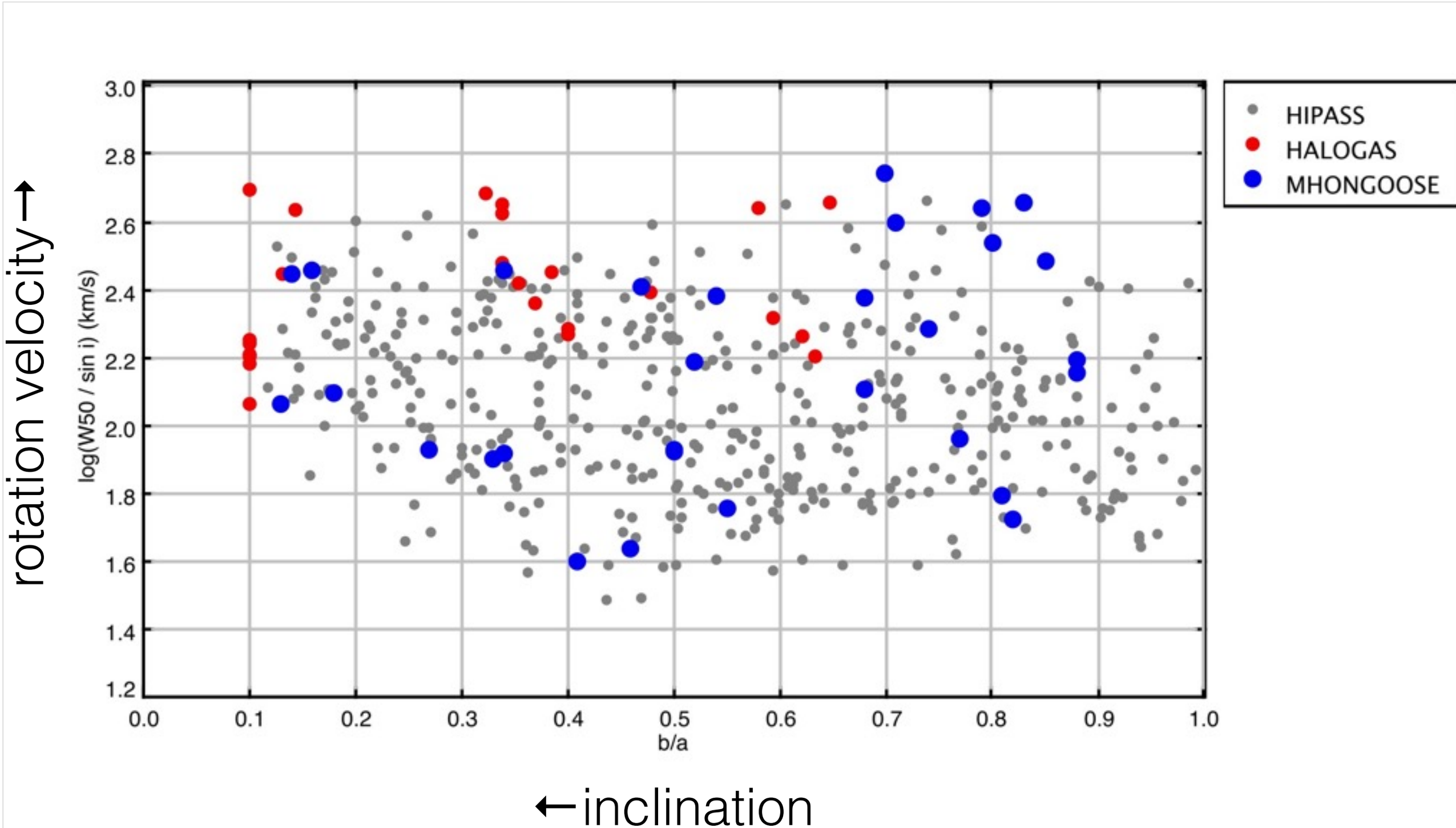
- 5 galaxies per bin → 30 galaxies

Selecting a sample

Criteria for the MHONGOOSE final sample

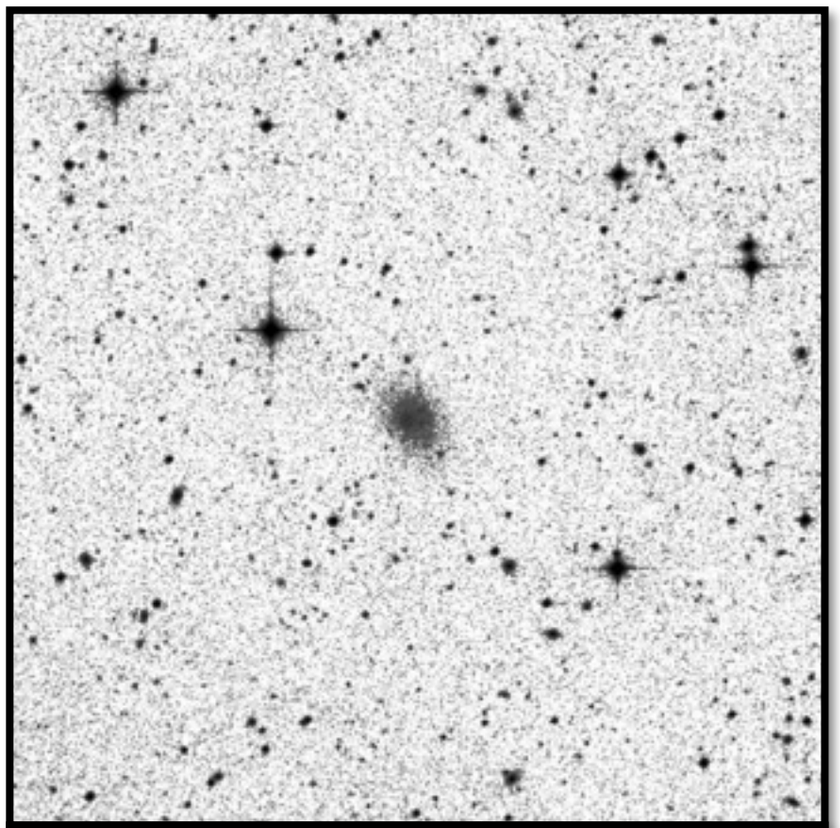
- Exclude galaxies with obvious quality issues
- Exclude interacting galaxies
- Best edge-on, face-on and ~60 deg inclination
- With these, range in surface brightness and SFR

Selecting a sample

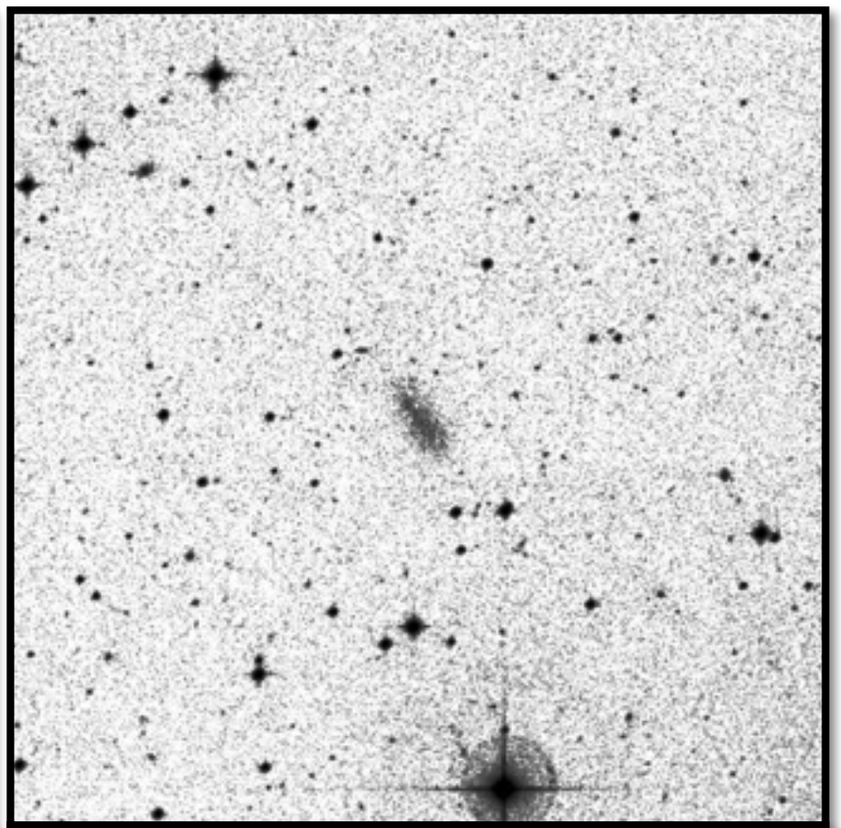


$6 < \log M_{HI} < 8$ group 1

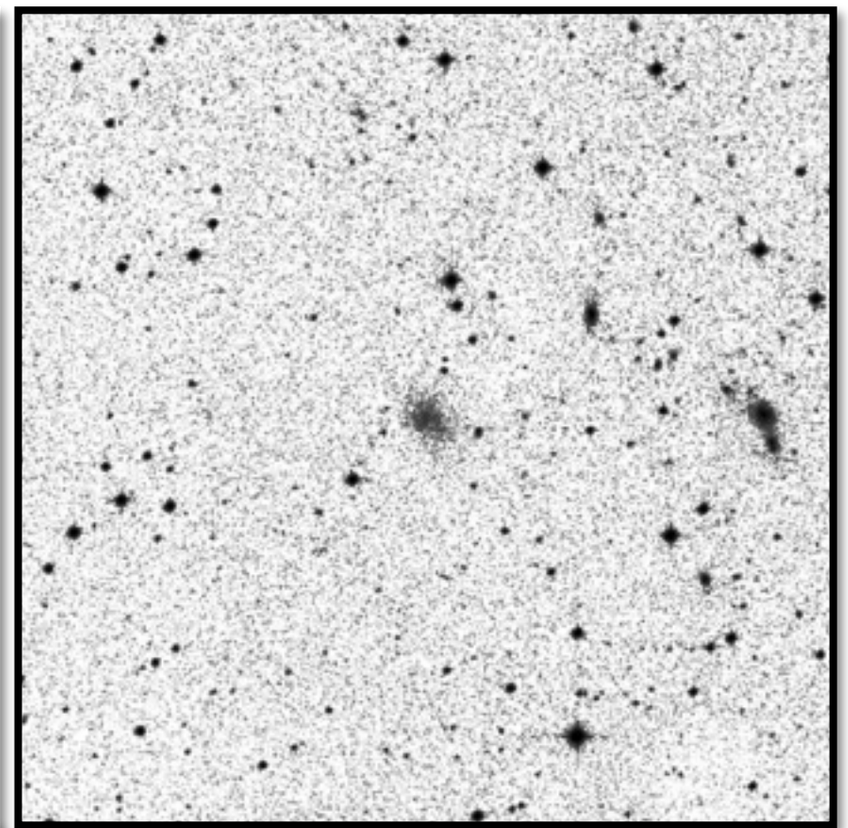
J0008-34

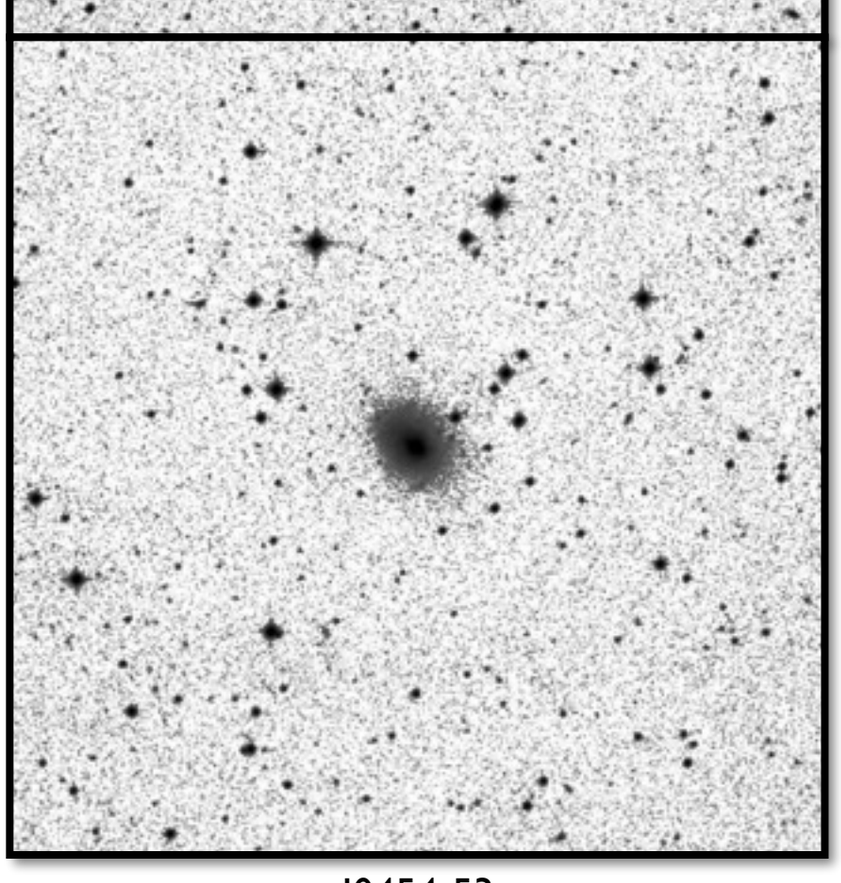


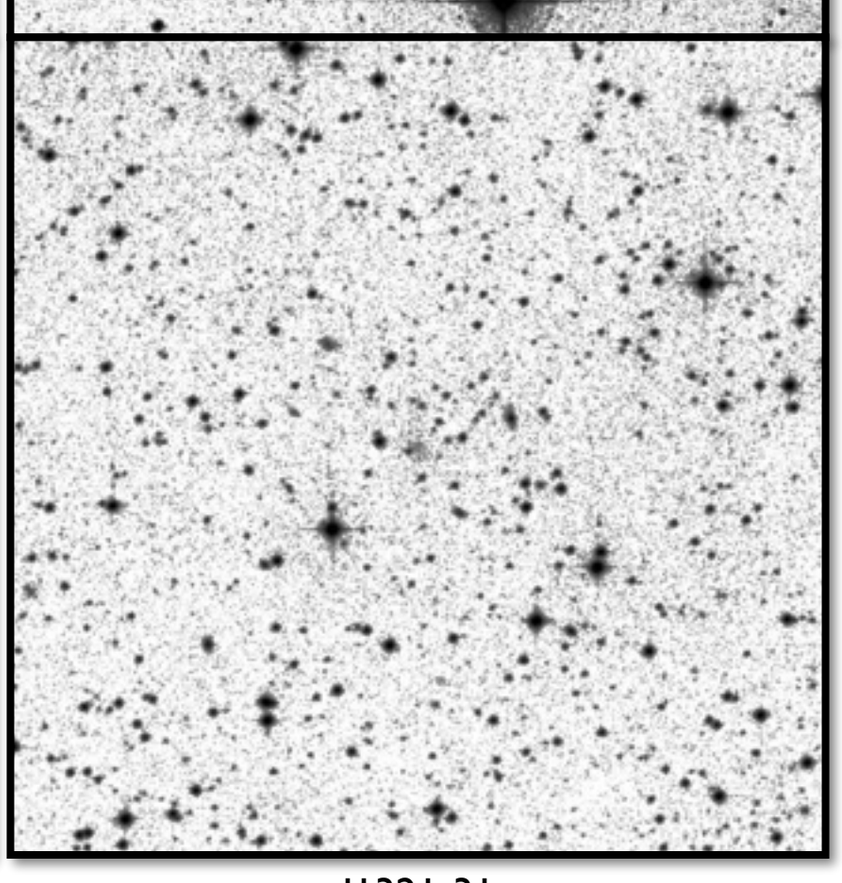
J0049-20



J0310-39







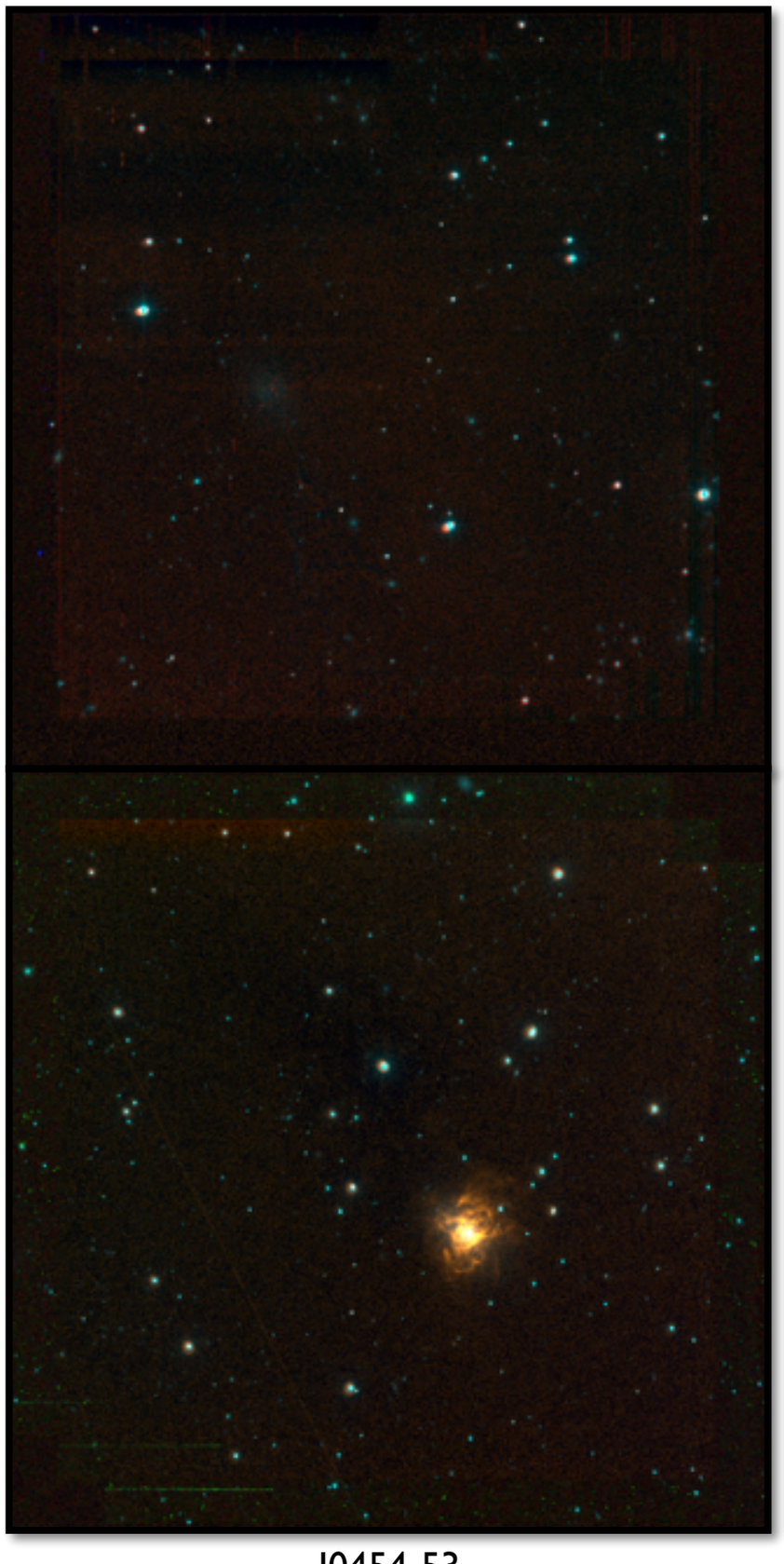
DSS

J0454-53

J1321-31

$6 < \log M_{HI} < 8$ group 1

J0008-34



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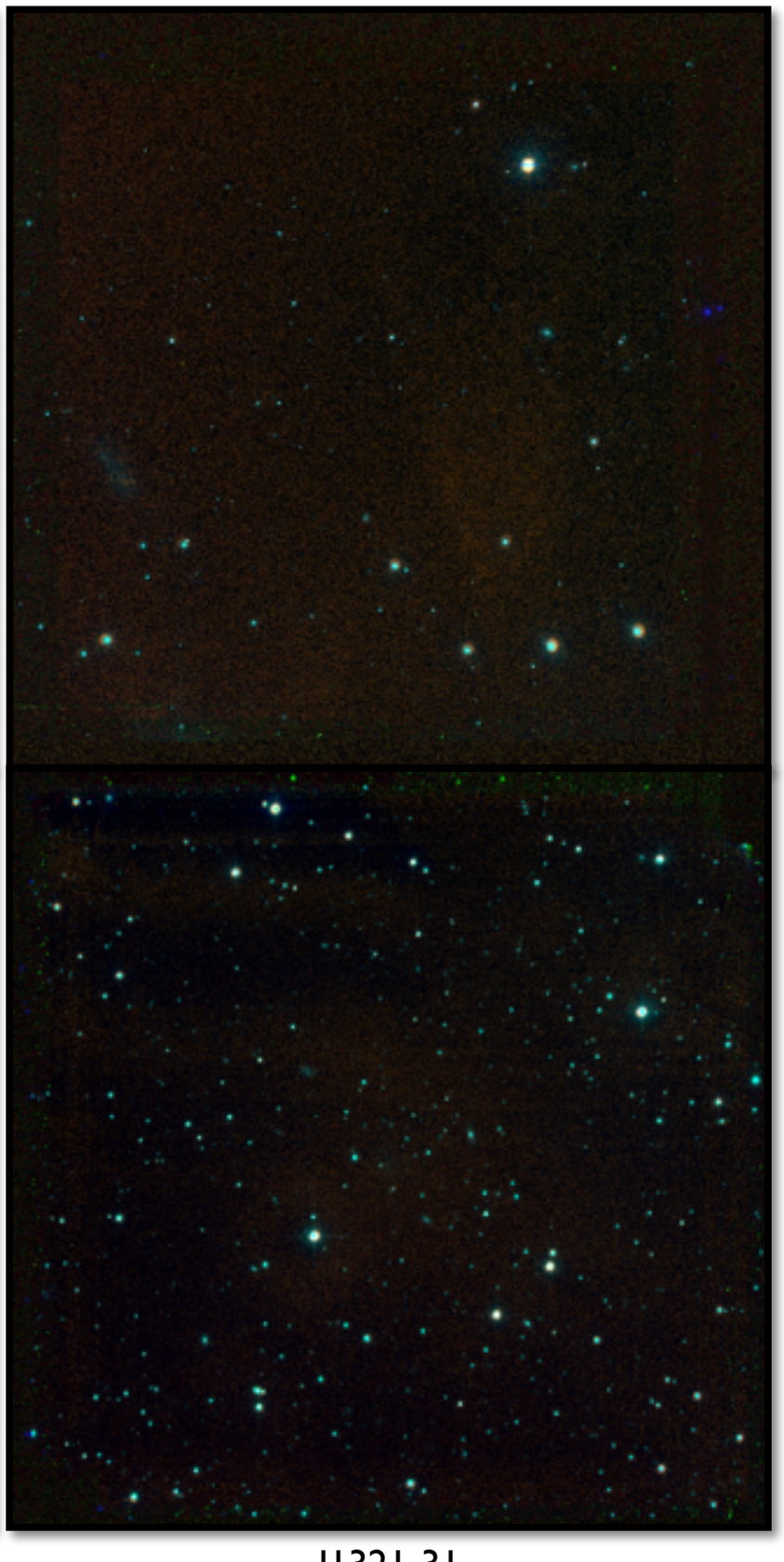
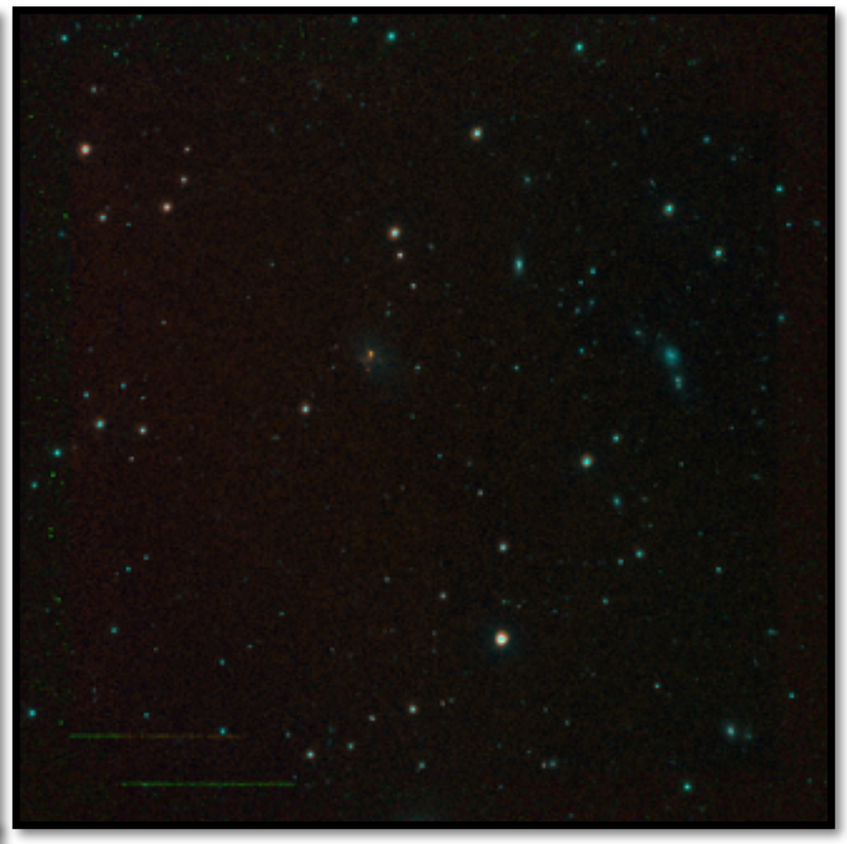


J0310-39



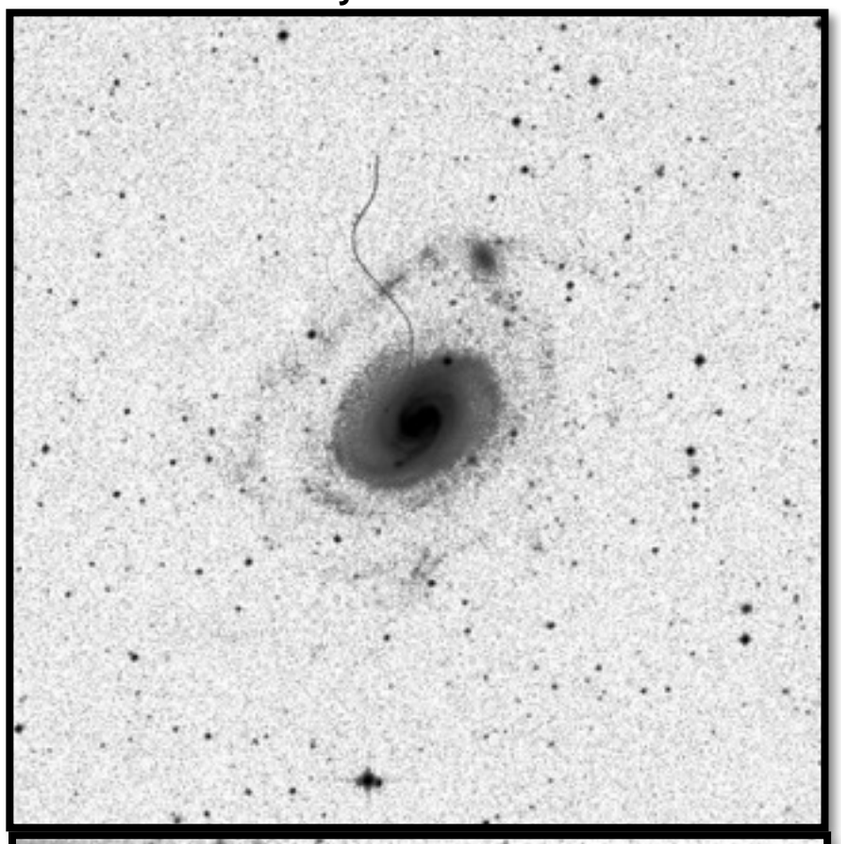
J0454-53

J1321-31

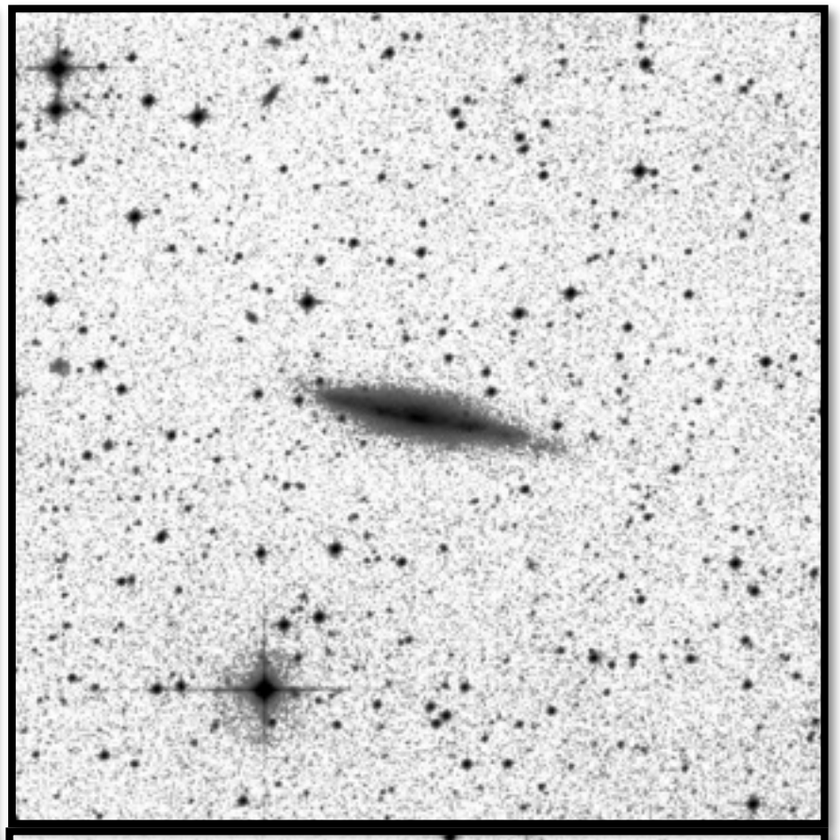
SINGG

10 < logM_{HI} < 10.5 group 6

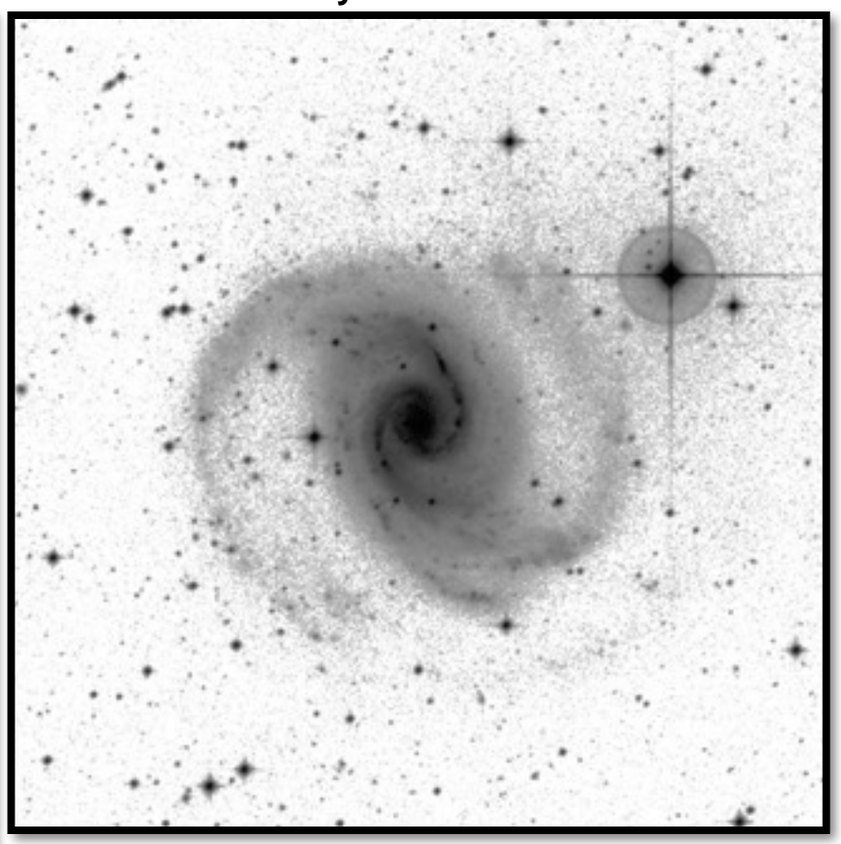
J0052-31

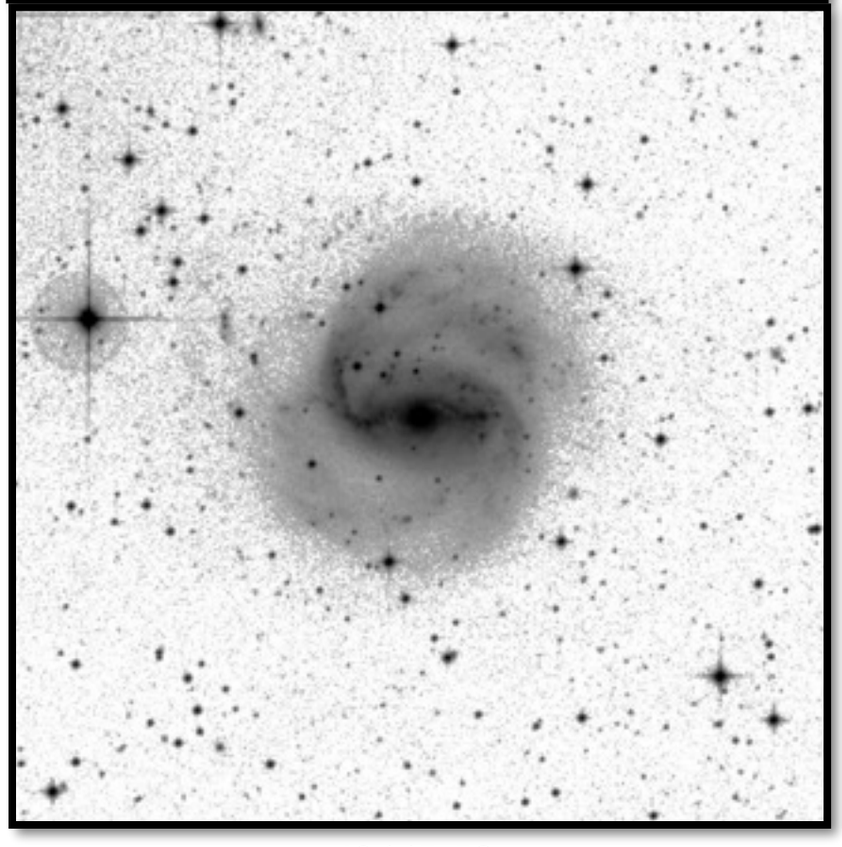


J1153-28

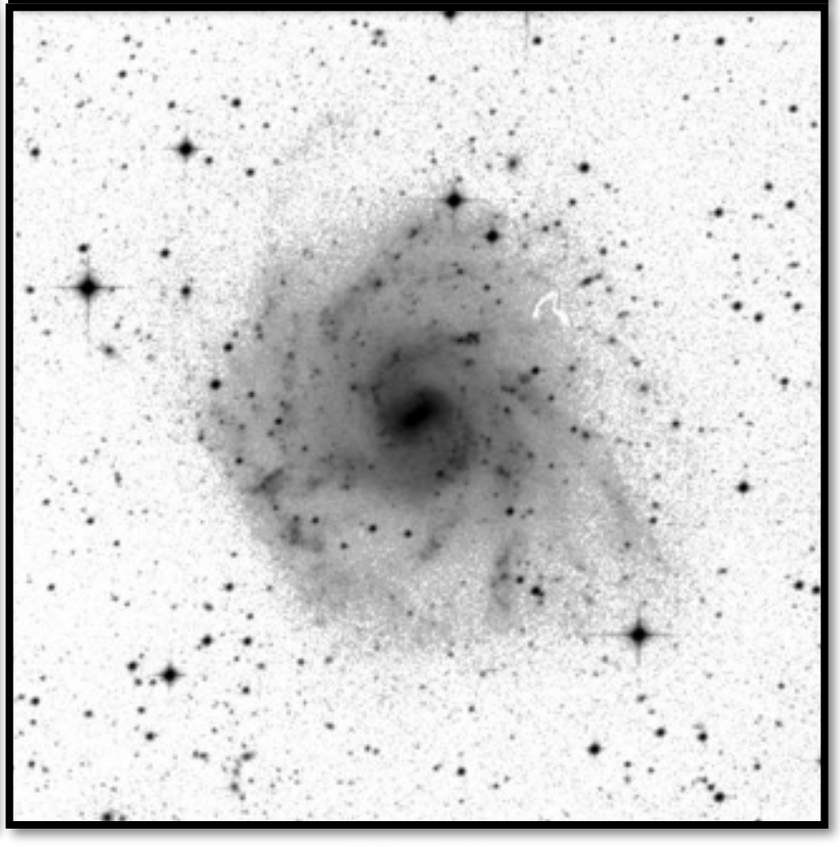


J0419-54





J0445-59

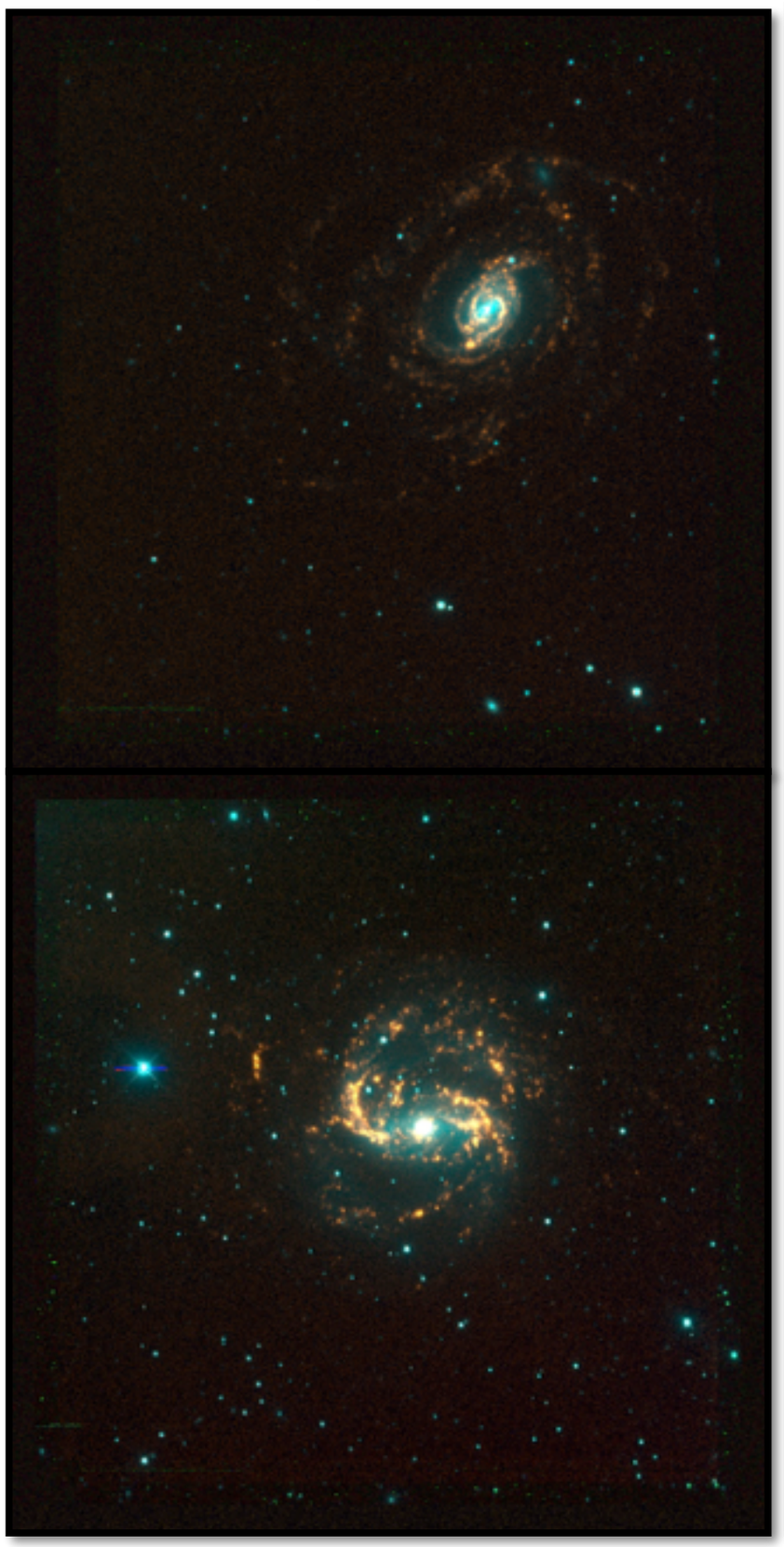


J2257-41

DSS

$10 < \log M_{HI} < 10.5$ group 6

J0052-31



J1153-28

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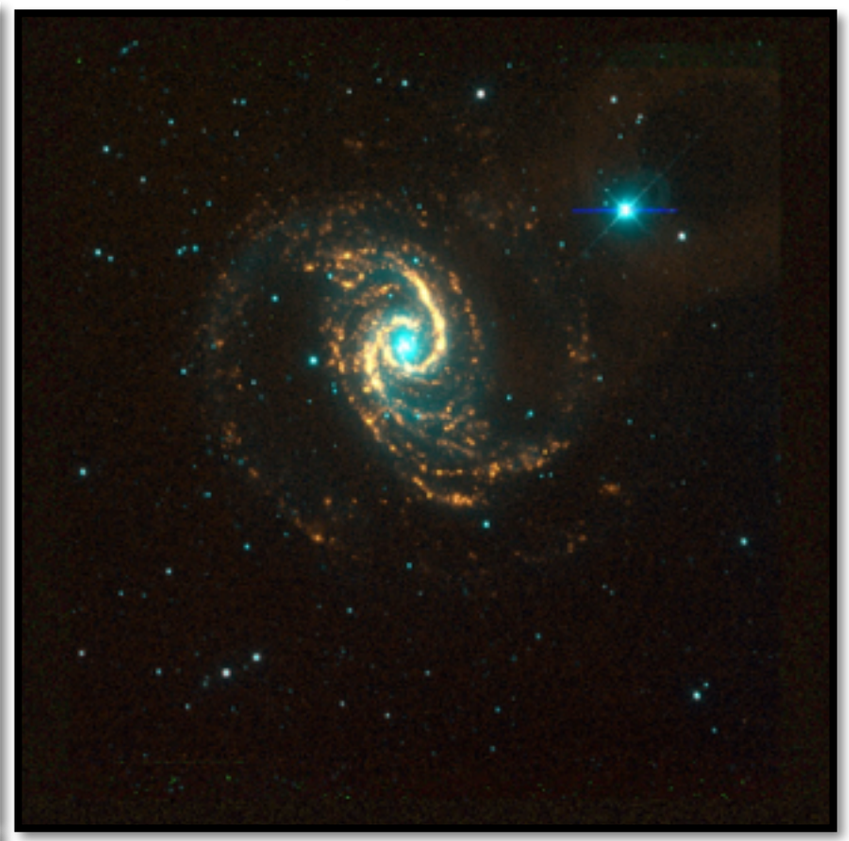

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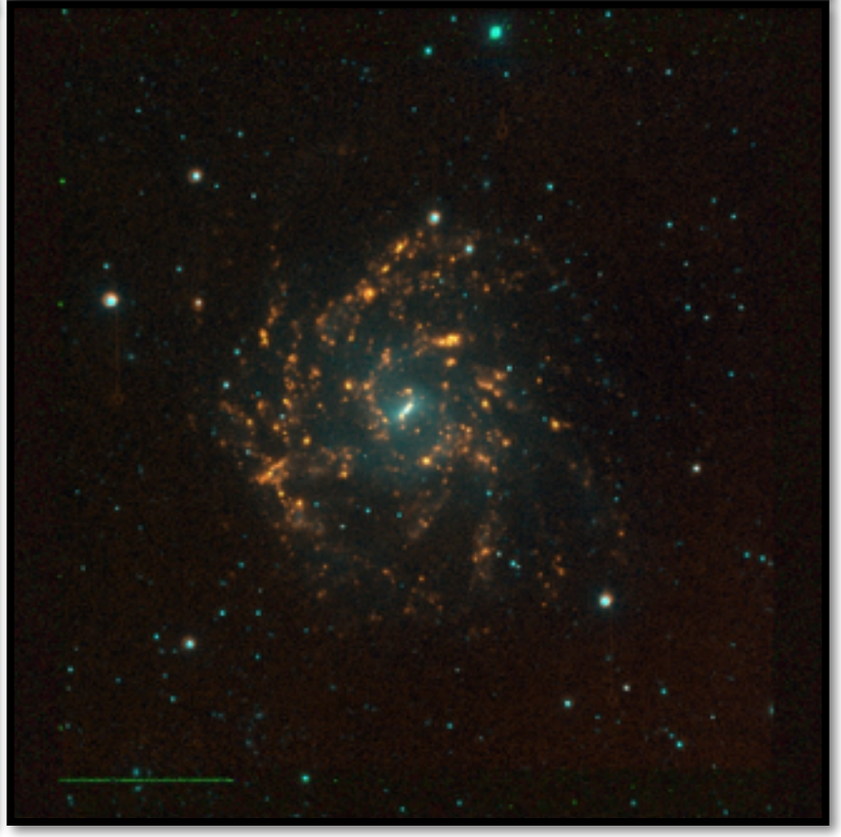
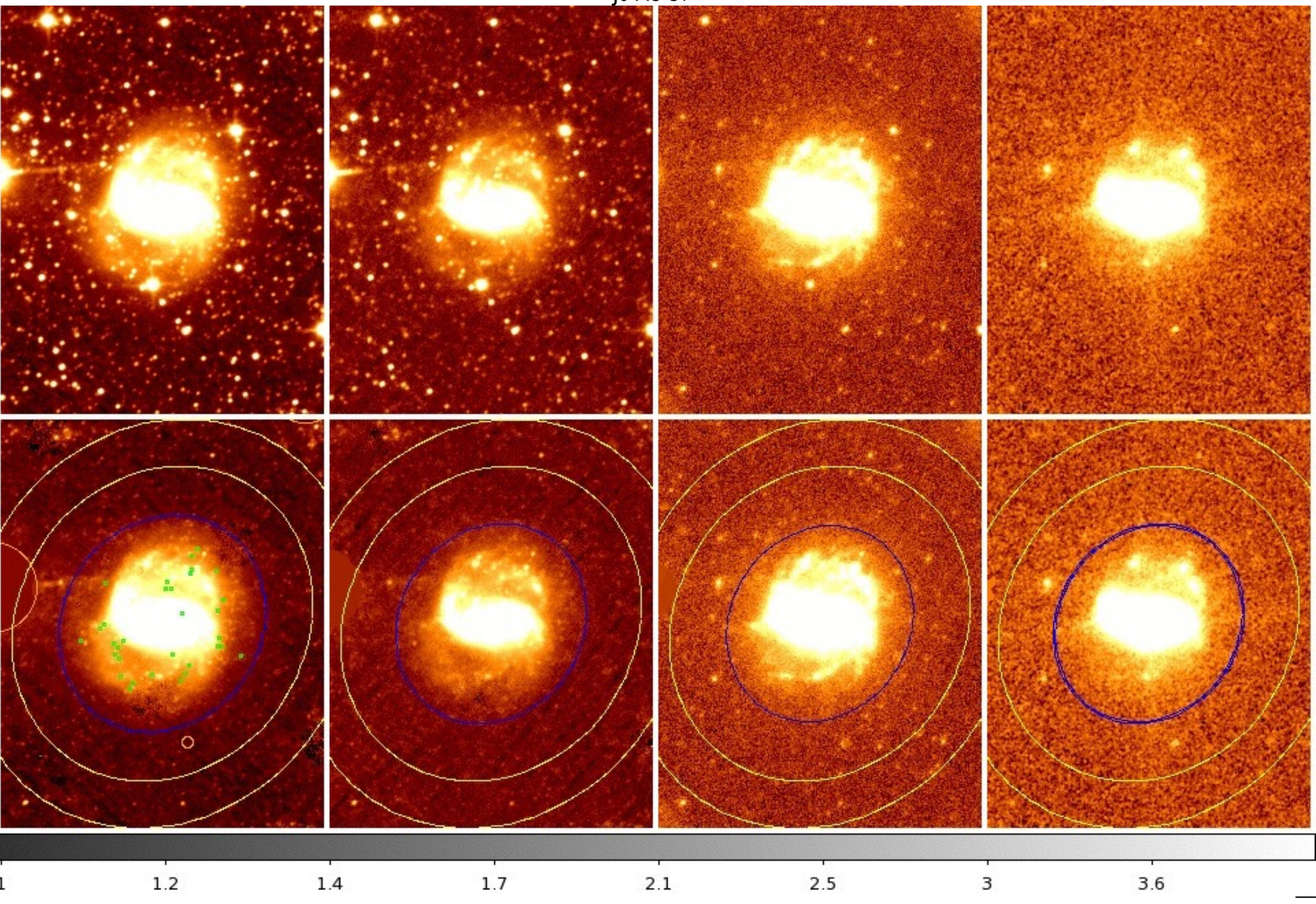


J2257-41

SINGG

see mhongoose.astron.nl
for further groups

J0445-59

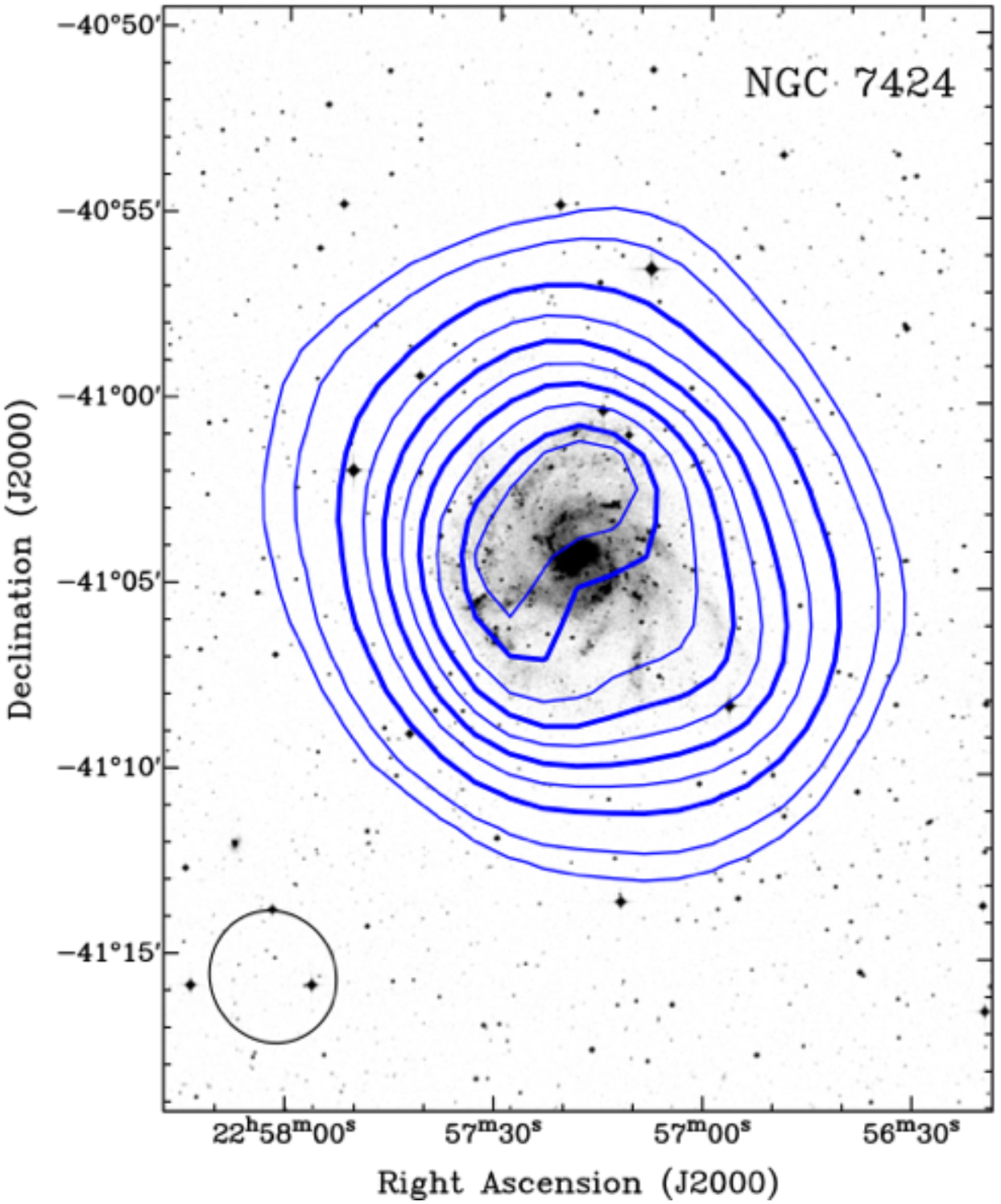


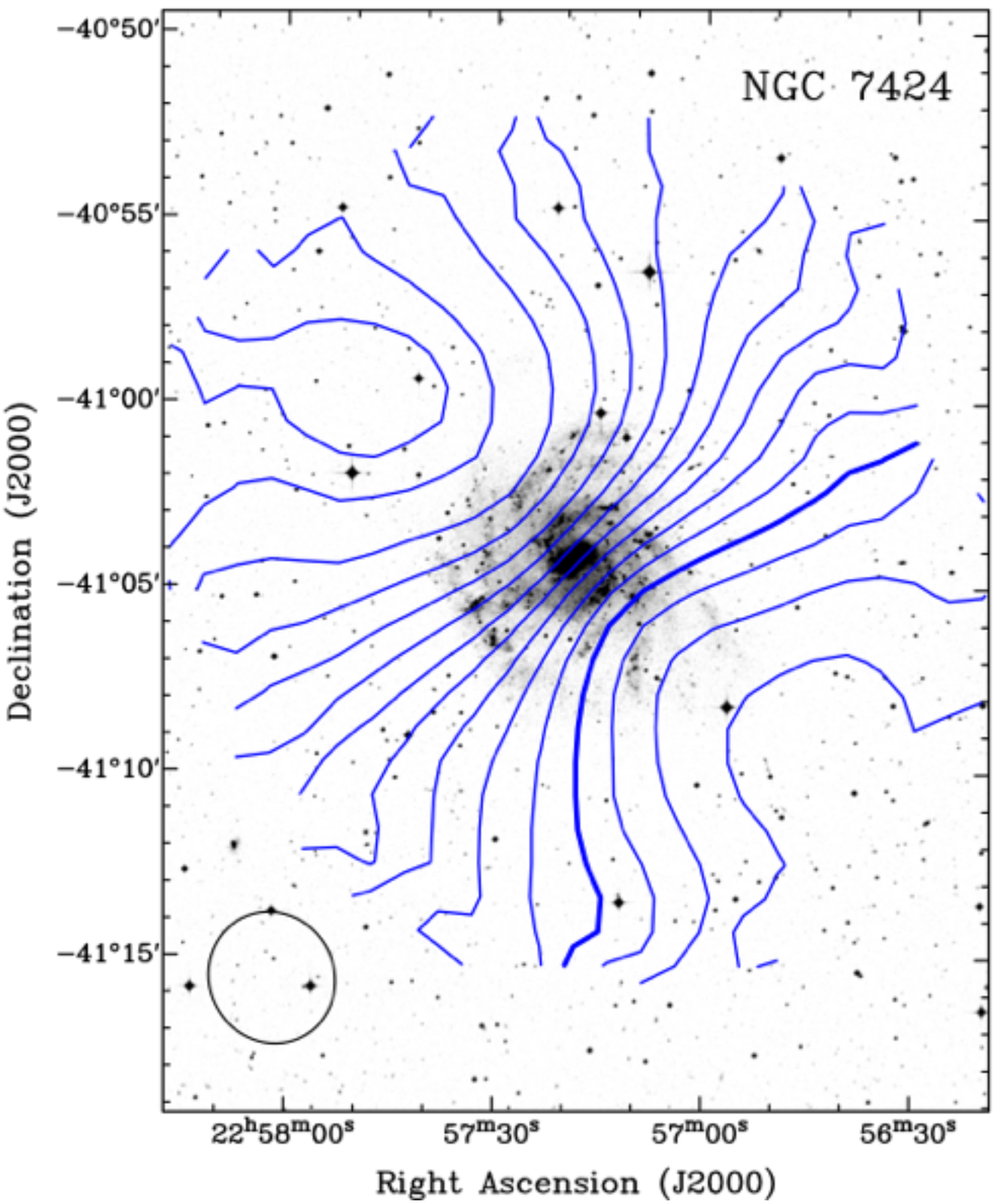
WISE, courtesy Tom Jarrett

Sample work

- Work is underway to characterise the properties of the sample further
  - ATCA: 1/3 has been observed with one or more arrays
  - KAT-7 observations (Sorgho)
  - GBT (Pisano)
  - high-res IFU for internal dynamics (Mogotsi)

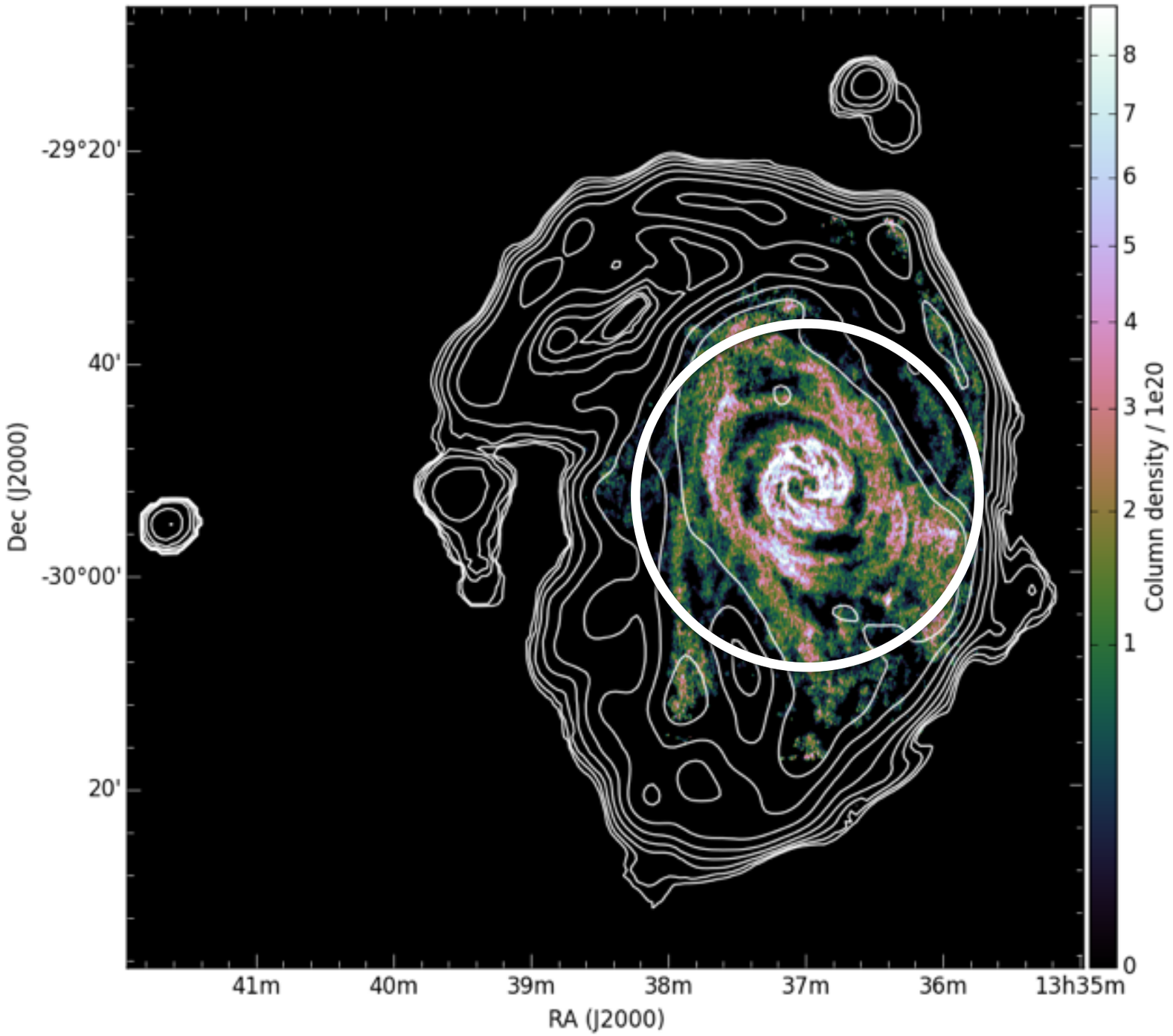
KAT-7 results





Courtesy Amidou Sorgho

KAT-7 results: M83



Contours: KAT-7
background: THINGS

Courtesy George Heald

Contours start at 5.6 × 10^{18} cm^{-2} (~3σ);
increase by powers of 1.778.

WISE image courtesy Tom Jarrett

Heald et al (in prep)

High-resolution dynamics

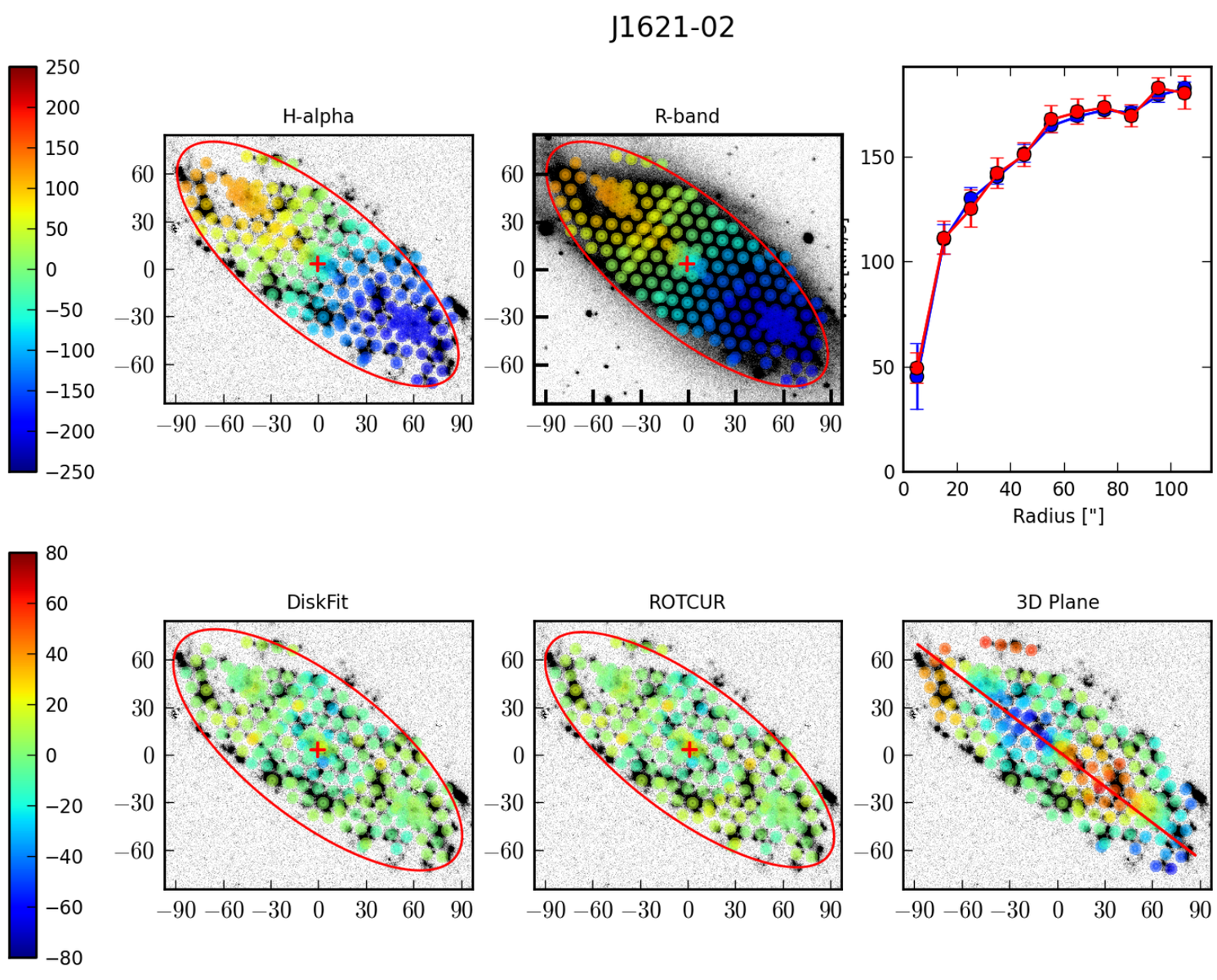


FIG. 1.— Velocity field and rotation curves of J0230-02S1. The velocity field overlayed over Hα (top left) and R-band (top center) SINGG images. The rotation curves derived using DISKFIT (red) and ROTCUR (blue) are shown on the top right. The corresponding DISKFIT (bottom left), ROTCUR (bottom center) and 3D Plane (bottom right) residual velocity plots are overlayed over Hα images. Crosses are used to indicate the central position of galaxy. Red ellipses are used to indicate the photometric (in the Hα and R-band plots) and kinematic (in the DISKFIT and ROTCUR residual plots) i and ϕ. The red line in the 3D residual plot is used to indicate the ϕ_{3D}.

Courtesy Moses Mogotsi

MeerKAT data

- MeerKAT output:
  - 5 narrowband sub-bands: 11.5 MHz/4k ch
    this is 2400 km/s at 0.6 km/s at z=0
  - 1 wideband: 856 MHz/32k ch
- MHONGOOSE core science: 1 subband plus a downsampled (1MHz ch) wideband [MeerQUITTENS]
- bonus 4 subbands: 200 h corresponds to ~M_{HI}* at z=0.15

Data models

- minimum data model
  - retain one sub-band, 8s dump time: 420 TB or 14 TB per galaxy
- maximum data model
  - all bands, all channels, 2s dump time: 45 PB
- minimum data model doable; maximum data model not trivial
- more info on correlator post-processing, archive specifications etc

Early Science

- MeerKAT16
- Sensitivity: 0.8 old WSRT or 0.4 JVLA
- Channel purity ("ringing") - 10^{20} vs 10^{18} cm^{-2} in adjacent channels
- Local MW emission can be very strong
- Column densities 10^{21} to 10^{17}: $>10^4$
- Continuum to line ratio
- 200h per galaxy: many tracks: stable bandpass
- Combine in uv or image planes

Early Science

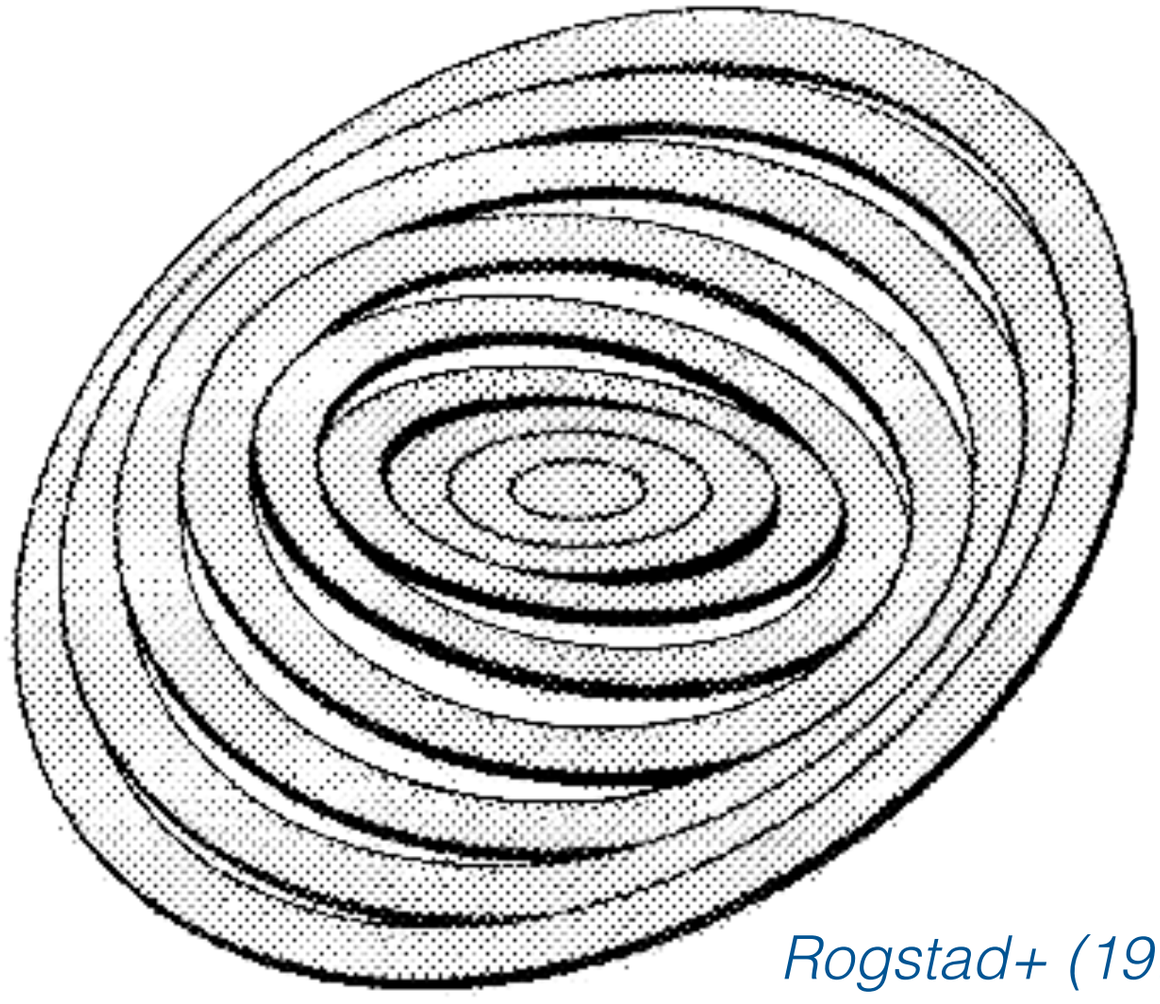
Tilted Ring Fitting Code

TiRiFiC

Used to model in 3D: warps, flares, thick disks, spiral arms, ...
Extraordinary ability to assess the effect of various features

Also:

3D-BBAROLO (Di Teodoro), as well as packages developed by Kamphuis and Oh



Rogstad+ (1974)

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