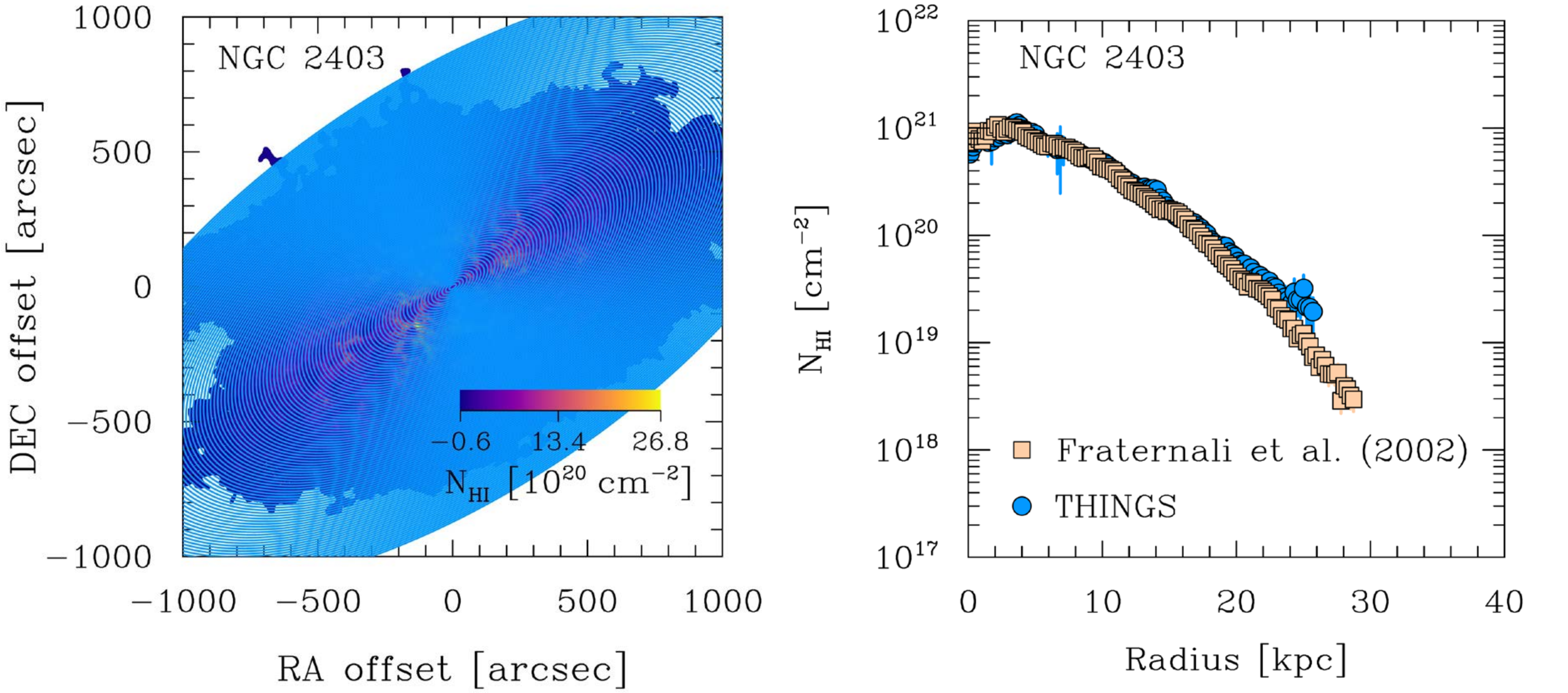
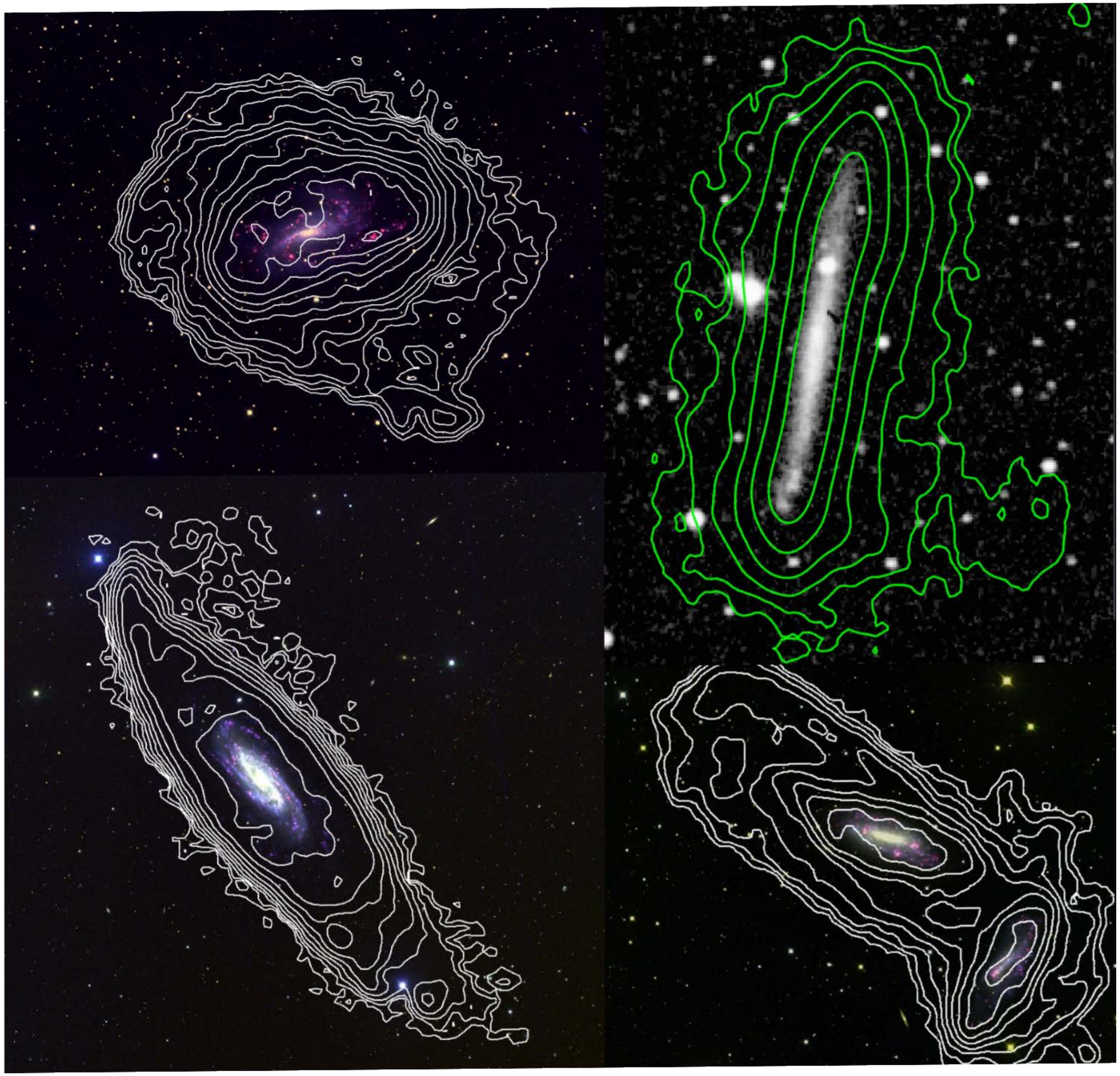
Smooth HI Low Column Density Outskirts in Nearby Galaxies

ROGER IANJAMASIMANANA, FABIAN WALTER, ERWIN de BLOK, G. HEALD, ELIAS BRINKS

By Roger IANJAMASIMANANA
Groningen 2018



Introduction



HI 21 cm emission dominates the outskirts of galaxies . Slide by Maria Patterson (HALOGAS)

History: Sharp HI edge in M33 (See also KAT-7 M83 Observations)

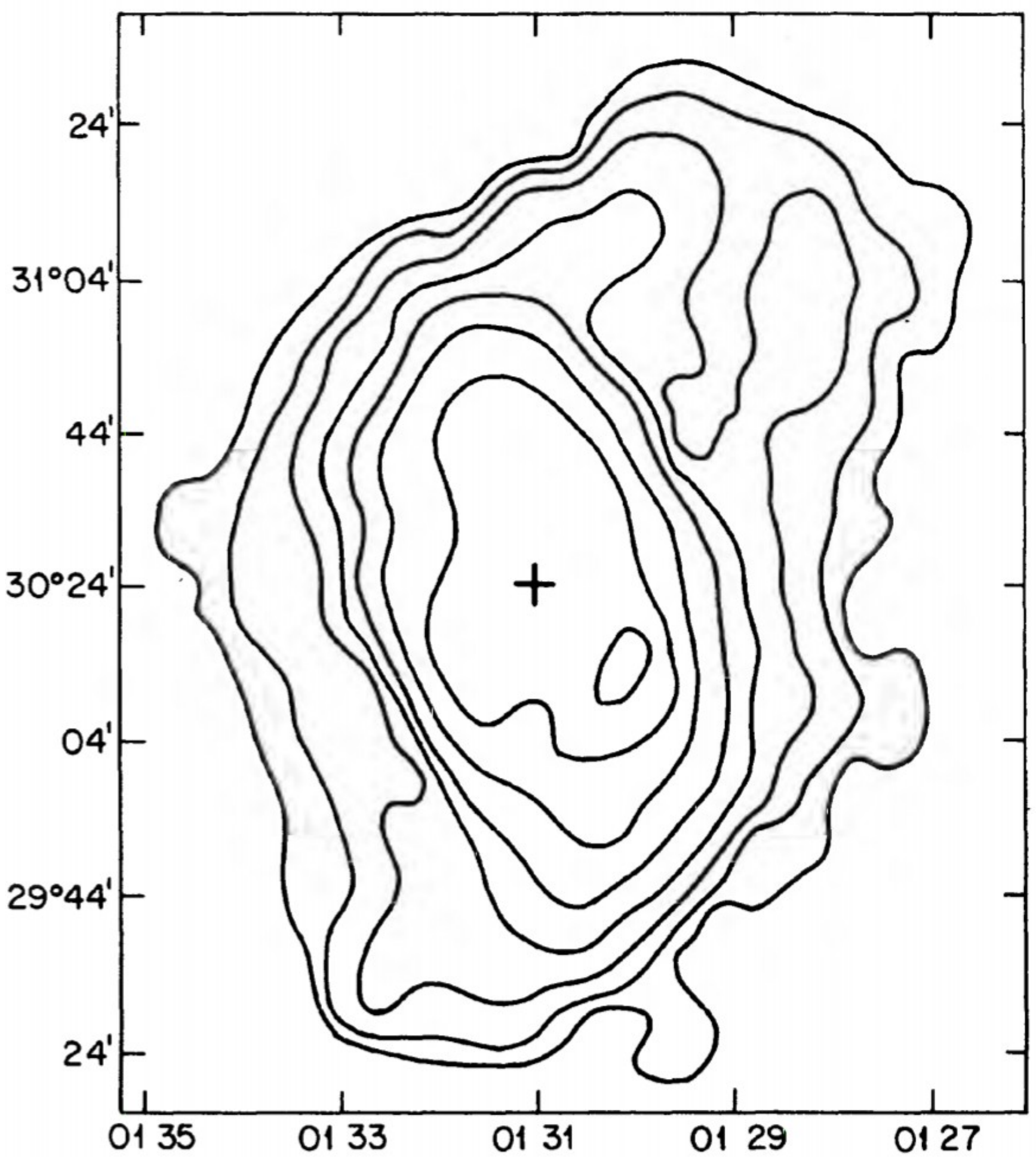


FIG. 2. Integrated H I emission in M33 using data taken from the spectra shown in Fig. 1. Column-density contours are shown at levels of 2.5, 5, 10, 20, 40, 80, 130, and 180 Jy km s^{-1} beam.

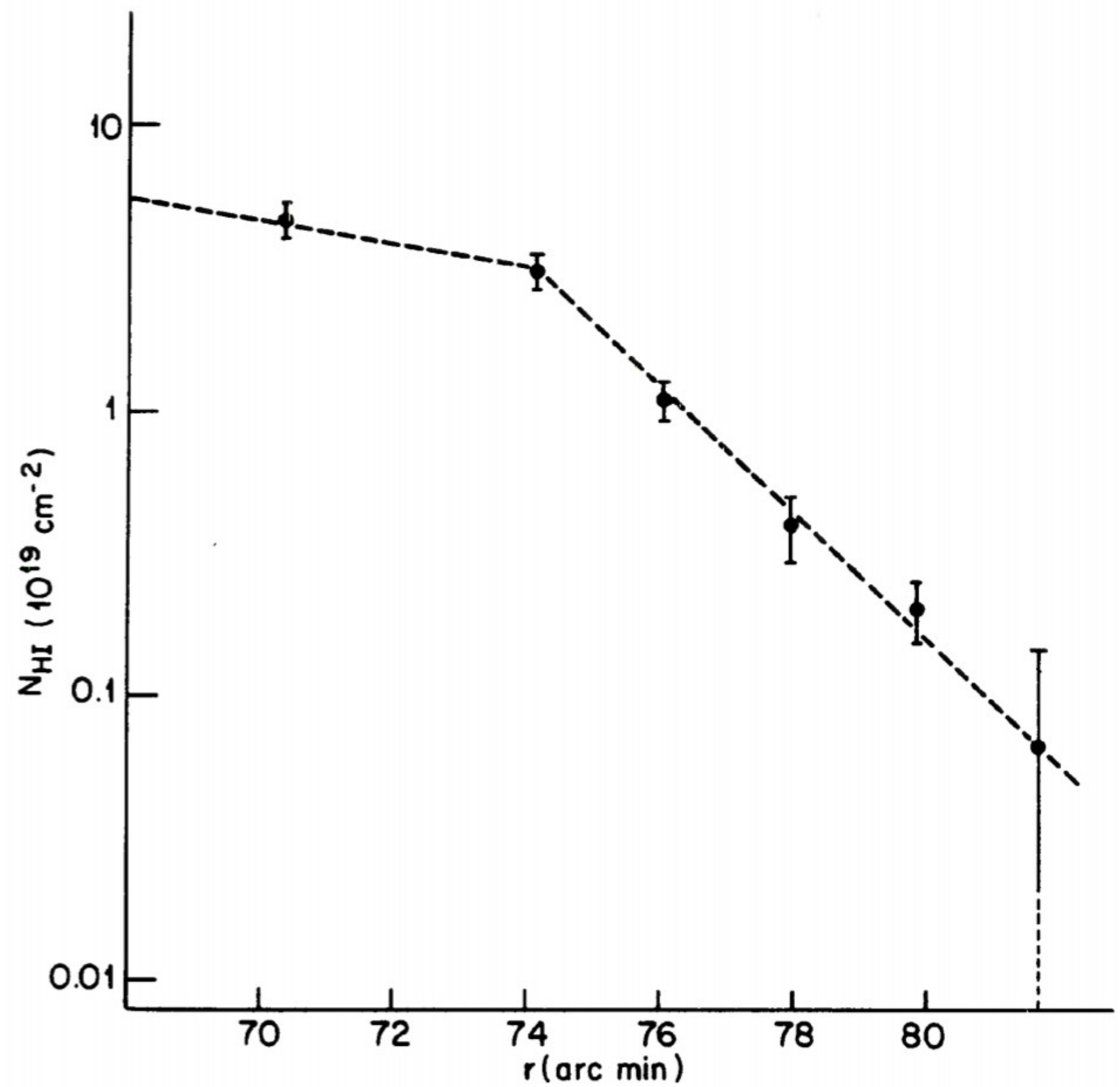
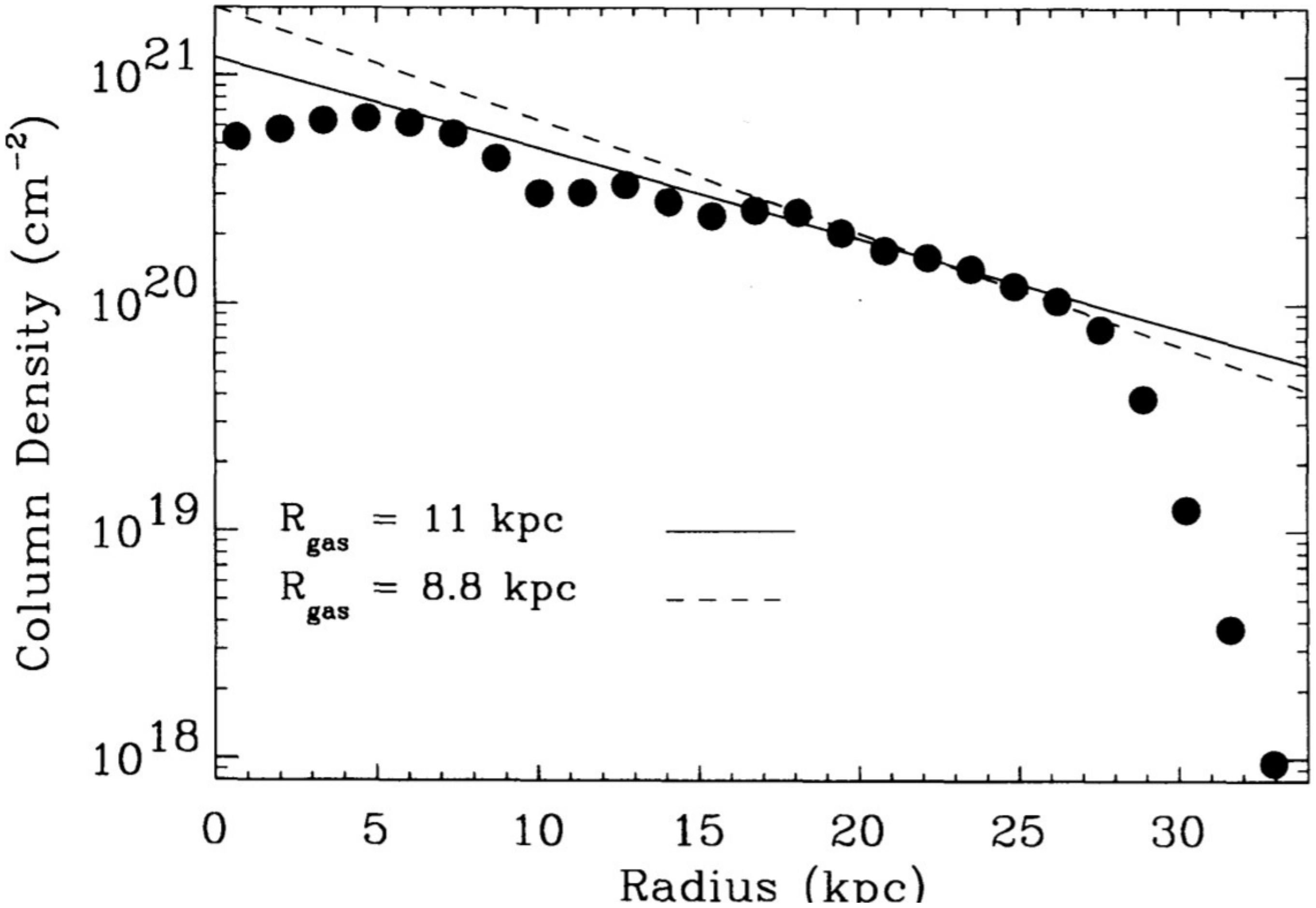


FIG. 10. Falloff of the H I in the outer disk of M33. The column density, derived from the H I integrated flux and corrected for sidelobe contamination (see Table III), is plotted against the radial distance from the center of M33 along the northern end of the kinematic major axis.

Corbelli et al. 1989

History: Sharp HI edge in NGC 3198

NE side of the major axis of NGC 3198



The galaxy has a very sharp edge in H I; the surface density drops by an order of magnitude from 2×10^{19} cm^{-2} to less than 4×10^{18} cm^{-2}, within one synthesized beam (2.7 kpc).

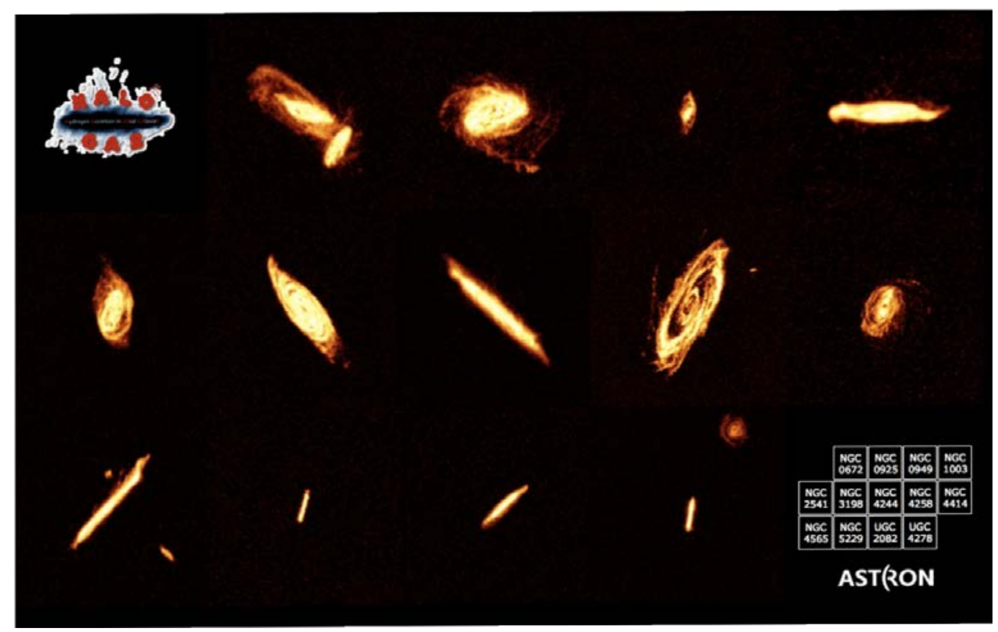
Van Gorkom (1993) ; Dove & Shull (1994)

Purposes of this study: Is the sharp HI edge common in nearby galaxies?

Study the shapes of the radial HI column density profiles for a large sample of nearby galaxies

Investigate if the presence of an “HI edge” is common in nearby galaxies

Sample



THINGS:

34 nearby galaxies (Dwarfs & Spirals)

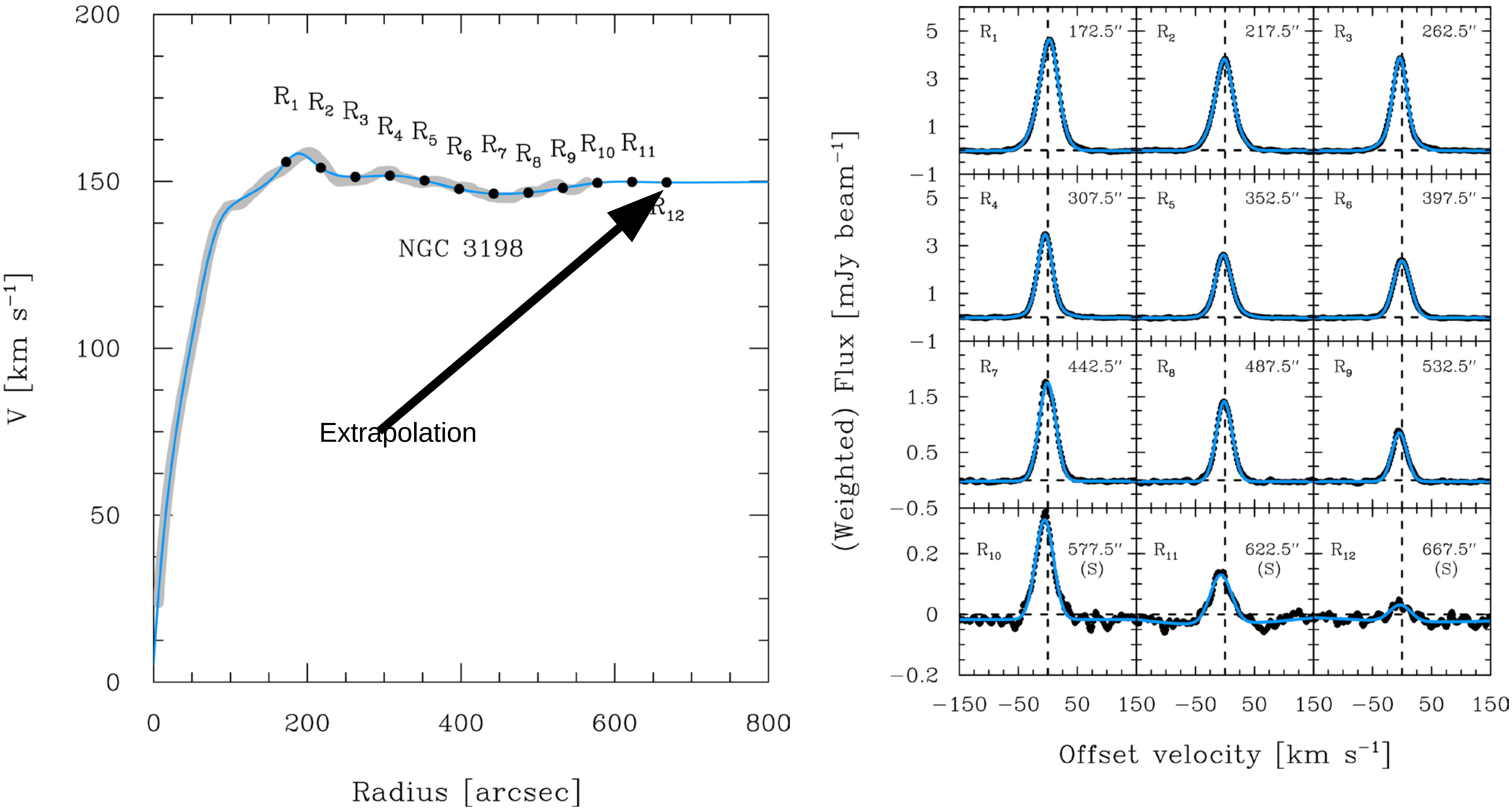
$M_{\rm HI}$ $(0.01 \text{ to } 14 \times 10^9 M_\odot)$,

SFR $(\sim 10^{-3} \text{ to } 6\, M_\odot\, \text{yr}^{-1})$.

HALOGAS:

24 nearby galaxies

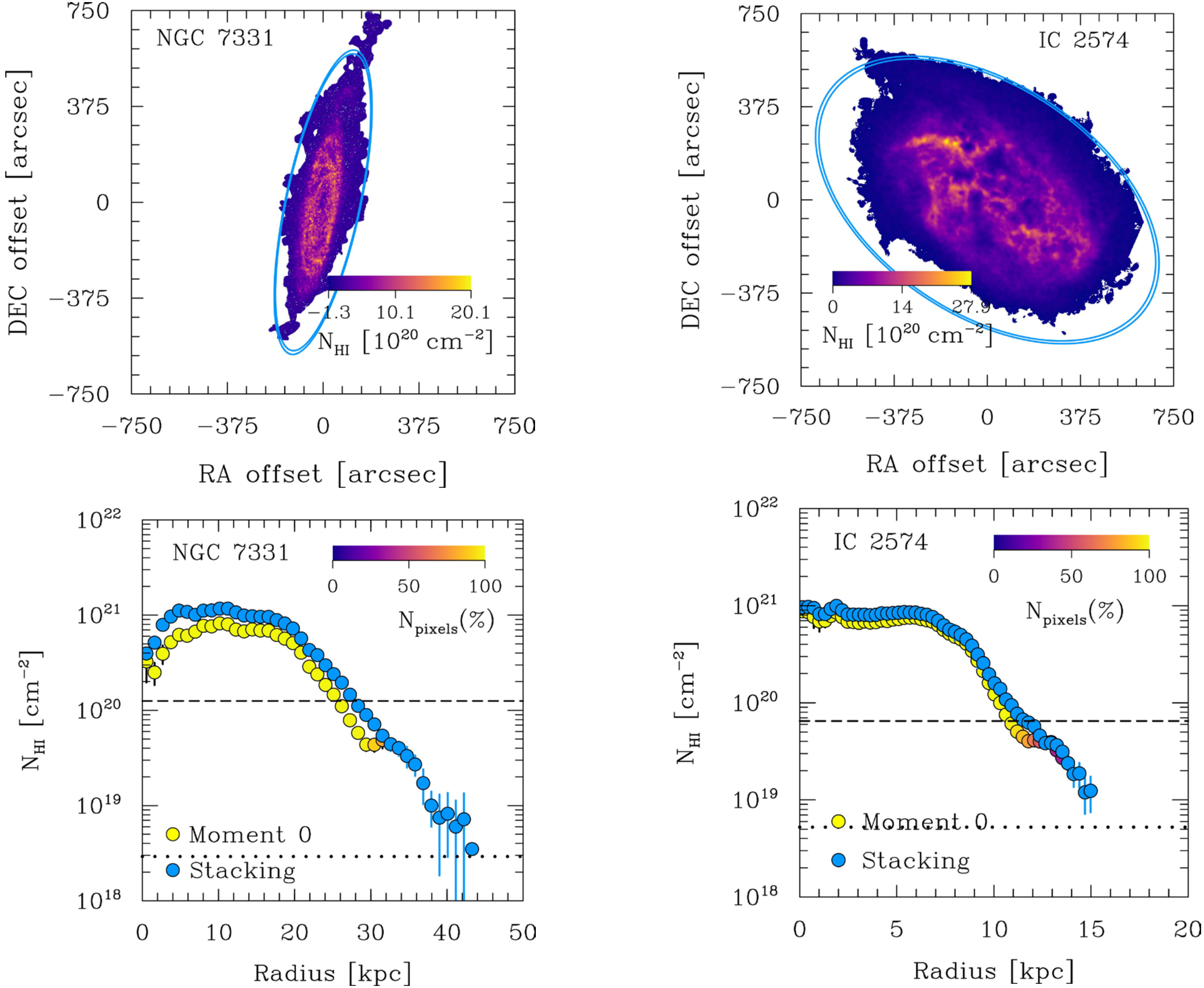
$(5\sigma \text{ per } 4.1 \text{ km s}^{-1} \text{ channel})$
$\sim 5 \times 10^{18} \text{ cm}^{-2}$ at $30''$ resolution



Left: The observed rotation curve of NGC 7331 (thick grey line)
and our interpolation and extrapolation of the rotation curve (blue solid line).
Right: Azimuthally averaged stacked profiles of NGC 7331.
The solid lines are the fit to the data (black circle symbols).

Ianjamasimanana et al. (submitted)

Results



NGC 7331
DEC offset [arcsec]
RA offset [arcsec]
N_{HI} [10^{20} cm^{-2}]
−1.3
10.1
20.1
IC 2574
0
14
27.9
Radius [kpc]
N_{HI} [cm^{-2}]
N_{pixels}(%)
Moment 0
Stacking

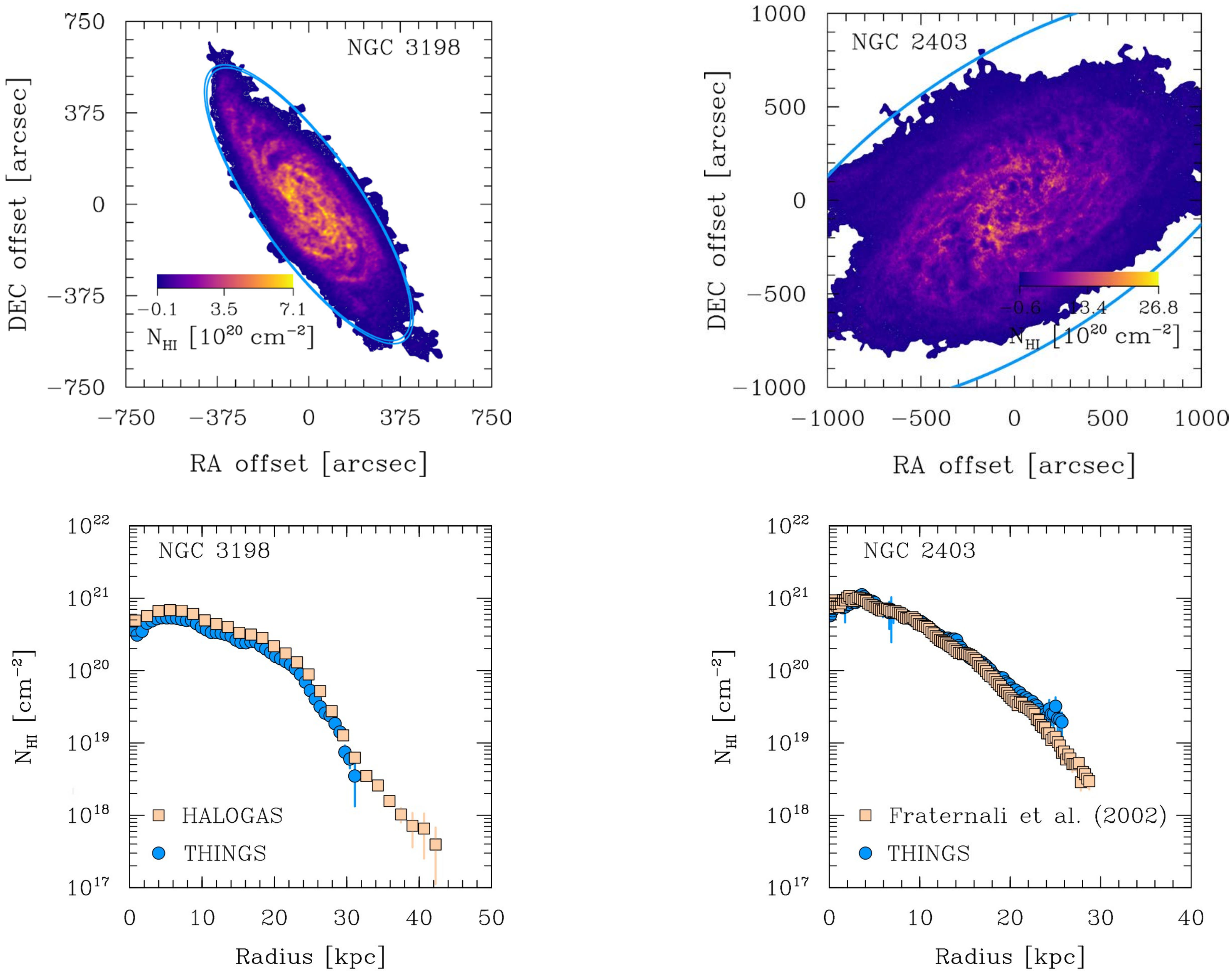
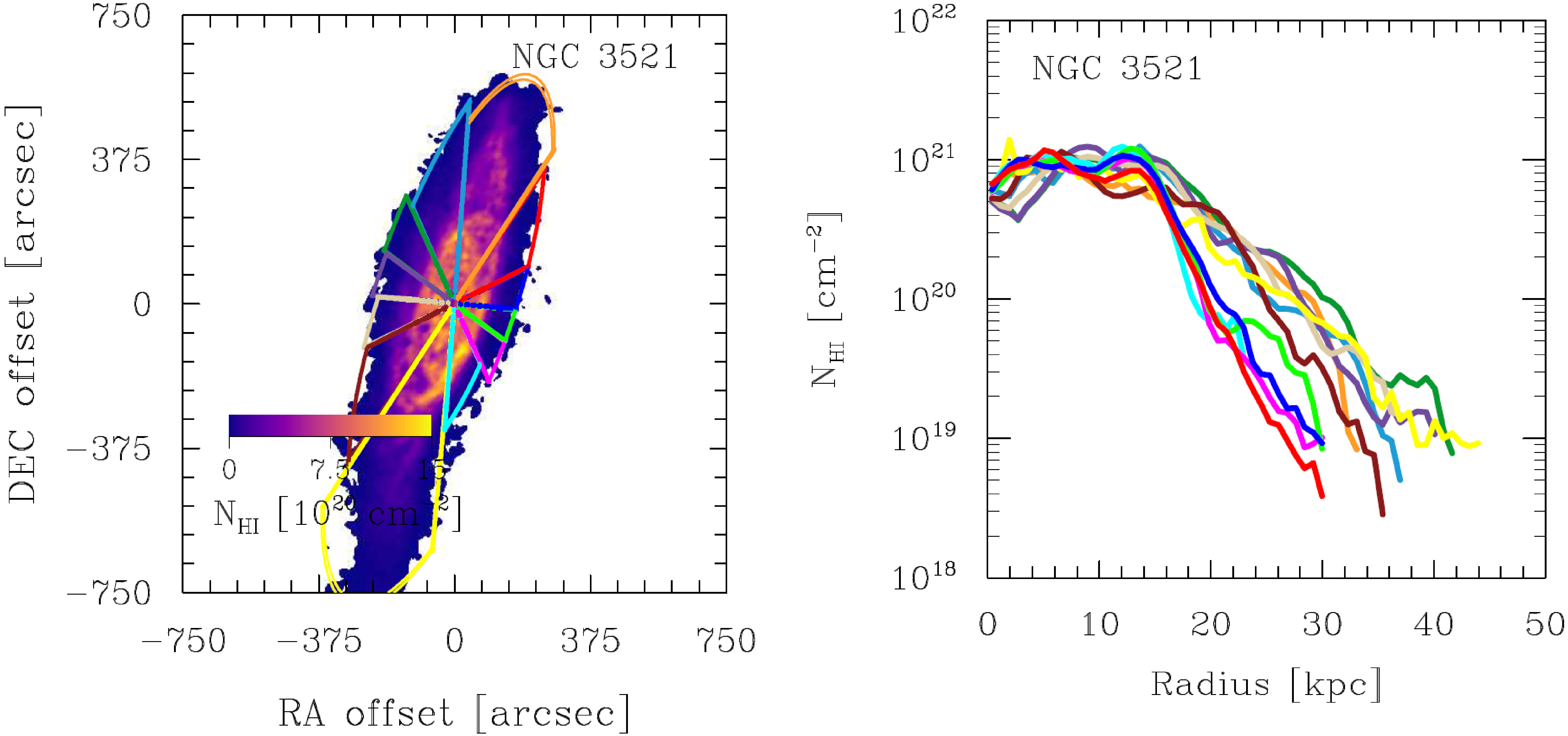


Figure 4. Radial H I column density profiles of NGC 3198 and NGC 2403, showing both the results based on the THINGS and HALOGAS data. We find good agreement between the two independent methods to analyze the data.

Ianjamasimanana et al. (submitted)



HI distribution in different sectors: 30 degree wide.

Summary, Conclusion and Future work

- We studied the radial HI column density profiles of the THINGS galaxies using stacking.
- We pushed the sensitivity limit of the THINGS data to lower column density
- Azimuthally averaged radial HI column density profiles show no clear break down to our sensitivity limit.
- The absence of a break may indicates that ionization by extragalactic photons is not the limiting factor of the extent of the HI disk.
- The outskirts of the HI disk may instead correspond to the transition to a low column density gas accreted from the cosmic web at later evolutionary stages of disk formation.
- We need to wait for the next generation of radio telescopes (MeerKAT, SKA) to map the morphology and kinematics of the low column density outskirts.
- Repeat the analysis for the HALOGAS or/and for other deep HI survey.
- Use a more sophisticated stacking technique

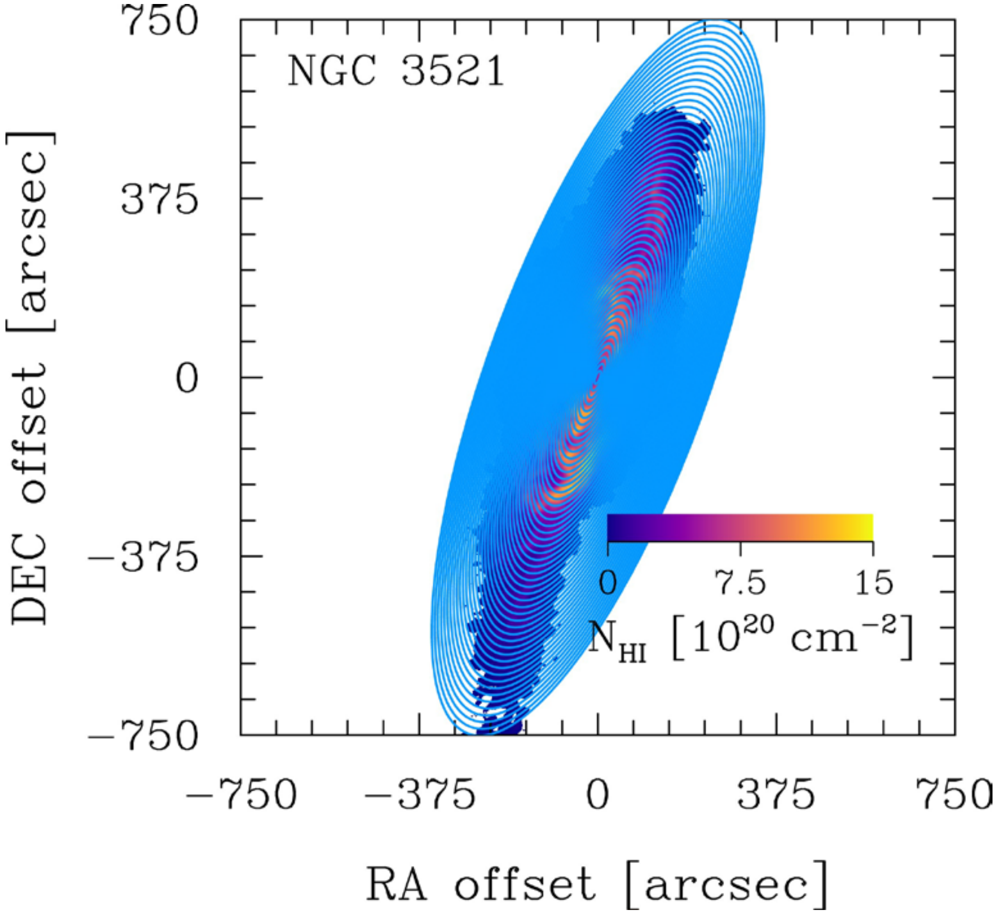
Why do we care about HI in the outer-disks?

HI is the ultimate fuel for star formation. Bigiet et al. 2010 have shown that HI traces star formation in the outer disks.

At large radii, with sufficient sensitivity, HI is the interface between the inner (star forming) disk and the intergalactic medium.

At large radii, HI is a good tracer of the signs of tidal interactions, effects by extragalactic radiation field.

At large radii, HI can be used to search for gas infall from the intergalactic medium (accretion).



We define our stacked profiles as

$$S = \frac{\sum_{i=1}^{N} w_i S_i}{\sum_{i=1}^{N} w_i}, \quad (1)$$

where $w_i = \frac{p_i^2}{\sigma_i^2}$ is the weight assigned to spectrum S_i, with p_i being the associated primary beam correction factor (we adopt a Gaussian shape, with $p_i = 1$ at the center and 0.5 at 15.4′ and 17.0′ from the pointing center of the VLA and WSRT, respectively) and σ_i is the rms noise before the correction. Since σ_i is assumed to be equal to σ for all profiles in a data cube, Equation 1 becomes

$$S = \frac{\sum_{i=1}^{N} p_i^2 S_i}{\sum_{i=1}^{N} p_i^2}. \quad (2)$$

Ianjamasimanana et al. (submitted)