

# *HIDEEP: a deep blind HI survey with the Parkes telescope*



R. Minchin  
M. Disney  
Q. Parker  
P. Boyce  
E. de Blok  
G. Banks

K. Freeman  
D. Garcia  
M. Grossi  
R. Haynes  
P. Knezek  
R. Lang

D. Malin  
R. Price  
M. Putman  
I. Stewart  
A. Wright

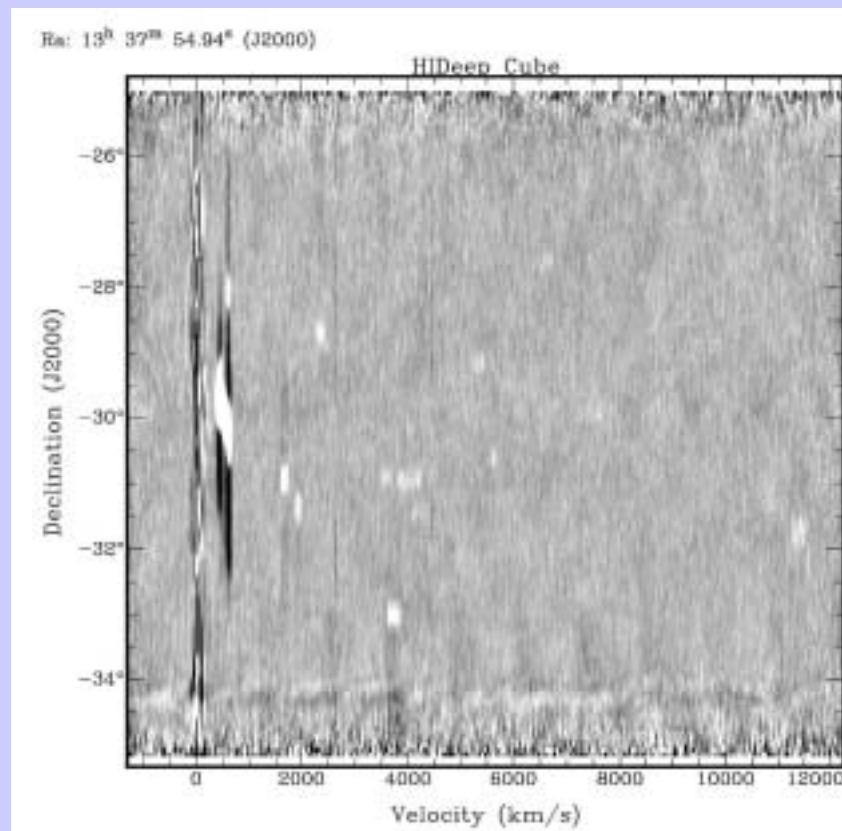
# Background

- ❖ HI surveys were until a few years ago limited by single beam and correlator velocity range
- ❖ New Multibeam instruments and correlators have now made large surveys possible
  - o HIPASS - all sky up to dec +22 (450s per beam)
  - o HIJASS - northern sky down to +22 (350s per beam)
- ❖ Parallel to HIPASS:
  - o **HIDEEP**: "The HI equivalent of the Hubble Deep Field" - (9000s per beam)



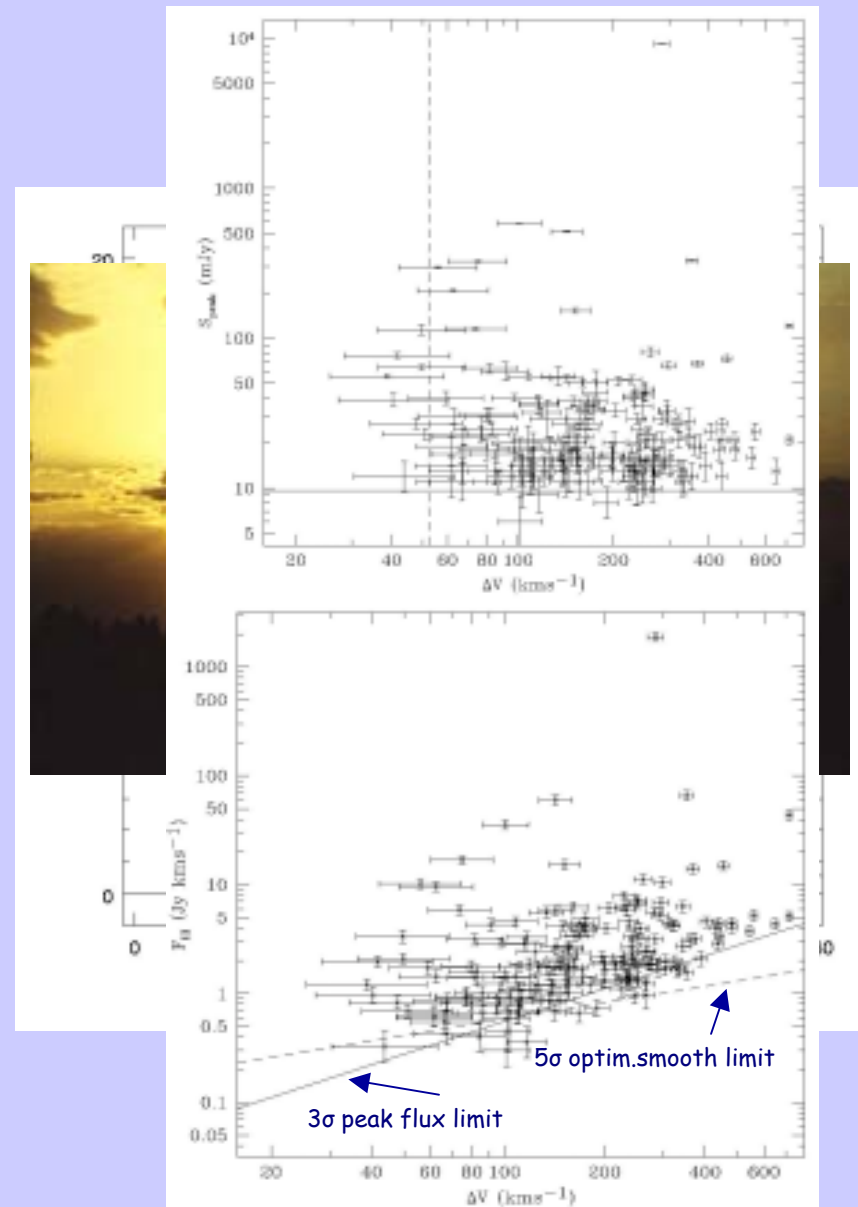
# HIDEEP: The Basics

- ❖ 4 by 8 degrees region in Centaurus
- ❖ centered on  $\alpha = 13^{\text{h}}40^{\text{m}}00^{\text{s}}$ ,  $\delta = -30^{\circ}00'00''$
- ❖ velocity range: -1280 to 12,7000 km/s, 1024 ch at 13.2 km/s spacing
- ❖ velocity resolution 18 km/s
- ❖ beam size  $\sim 14'$ , pixel size  $4'$
- ❖ includes Cen A group and outer parts Cen cluster
- ❖ not instrumentation noise limited: noise  $\sim 1/\sqrt{t}$
- ❖ noise =  $3.2 \pm 0.2$  mJy



# HIDEEP: The Detections

- ❖ Data cube searched 3 times:
  - o 2 humans and 1 computer
  - o only objects detected 2 out of 3 times retained
- ❖ 173 detections
- ❖ profiles and positions extracted and quantified
- ❖ selection limits:
  - o peak flux and velocity width limited
  - o limits are 9.6 mJy and 4 ch = 52.8 km/s
  - o completeness limit at ~18 mJy



# *HIDEEP: Optical Follow-Up*

- ❖ HIDEEP field imaged with UK Schmidt telescope at Siding Spring, Australia
- ❖ 8 1hr exposures in R-band on Tech-Pan plates
- ❖ Digitised using SUPERCOSMOS
- ❖ 6 by 4 degrees overlap with HI field
- ❖ limiting surface brightness is 26.5 R (27 to 28 B)
- ❖ 96 HI sources in field
  - o 59% known galaxies, z known
  - o 24% known galaxies, z unknown
  - o 17% uncatalogued galaxies
  - o no HI without optical....

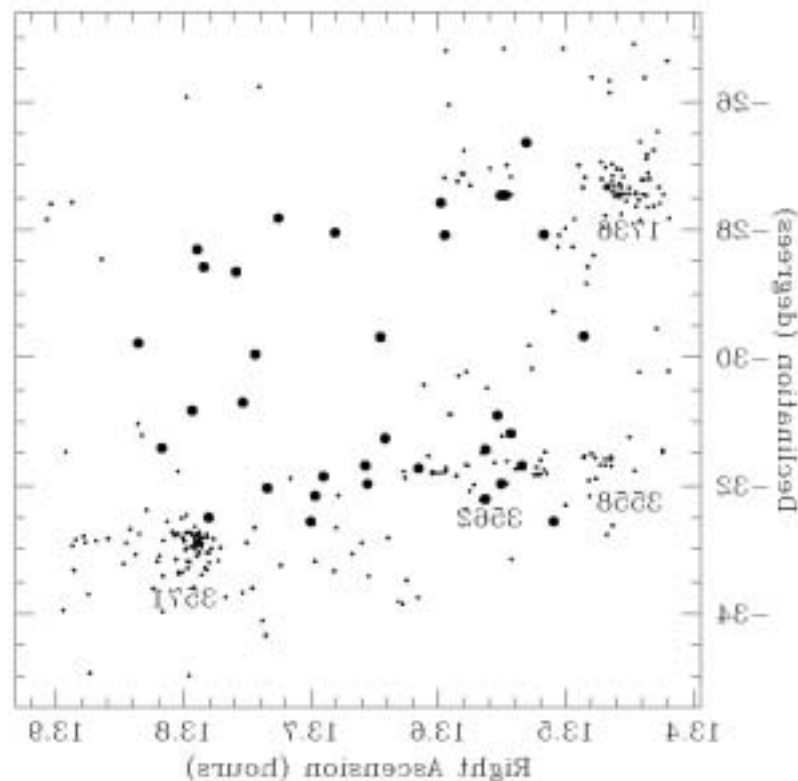


# *HIDEEP: Galaxy Properties*

*(a personal and biased selection)*

## *Large Scale Structure:*

- ❖ HIDEEP lies in the super galactic plane
- ❖ For  $z < 10,000$  km/s good correlation between optical LSS and HI LSS
- ❖ Beyond 10,000 km/s HI sources appear to populate void
  - real or HI/optical selection effects?



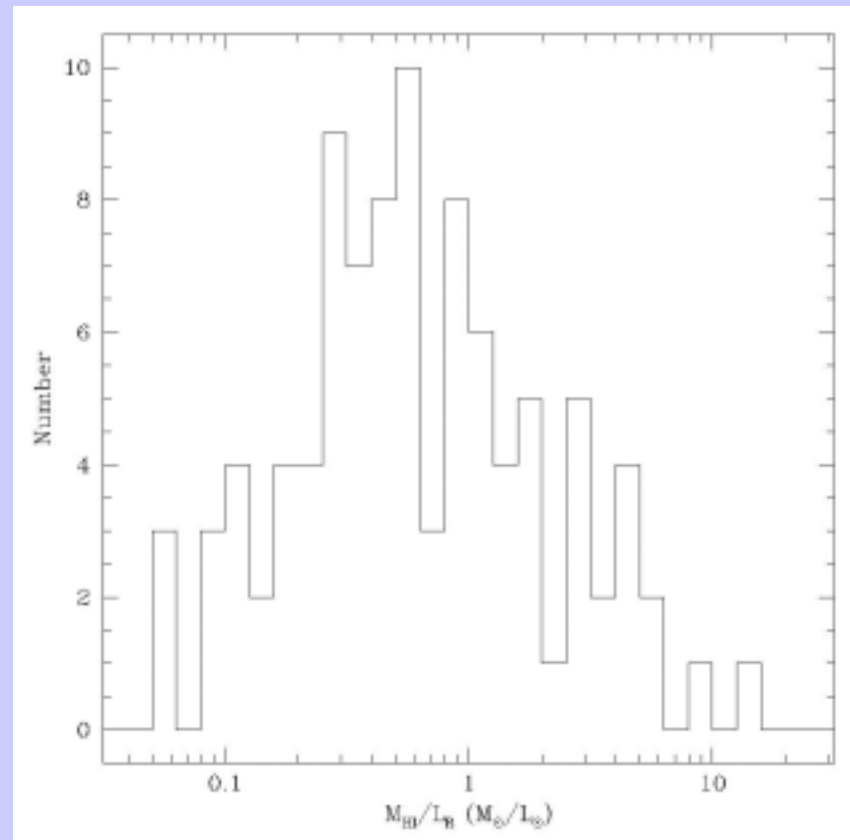
x NED ● HIDEEP

# *HIDEEP: Galaxy Properties*

*(a personal and biased selection)*

## *Surface Brightnesses:*

- ❖ Large fraction of sample has LSB
- ❖ KS test: late-type ESO-LV and HIDEEP surface brightness parent distribution differ at 99%
- ❖ Galaxies in HIDEEP are more gas-rich



— observed  
..... corrected

# HIDEEP: Column Densities - Theory

- ❖ Column density sensitivity of radio-telescope
- ❖ HIDEEP:  $T_{\text{sys}} = 26\text{K}$ ,  
 $t_{\text{obs}} = 9000\text{s}$ ,  $\Delta V = 13.2\text{ km/s}$
- ❖  $N_{\text{HI}} > 2.1 \cdot 10^{16} \Delta V \text{ cm}^{-2}$
- ❖ For  $\Delta V = 200\text{ km/s}$ ,  
 $N_{\text{HI}} \sim 4 \cdot 10^{18} \text{ cm}^{-2}$

$$T_B = \frac{\lambda^2}{2k} \frac{S_\nu}{\Delta\Omega}$$

$$T_A \geq \frac{T_{\text{sys}}}{\sqrt{t_{\text{obs}} \Delta V}}$$

$$N_{\text{HI}} = 1.8 \cdot 10^{18} T_B \Delta V \text{ cm}^{-2}$$

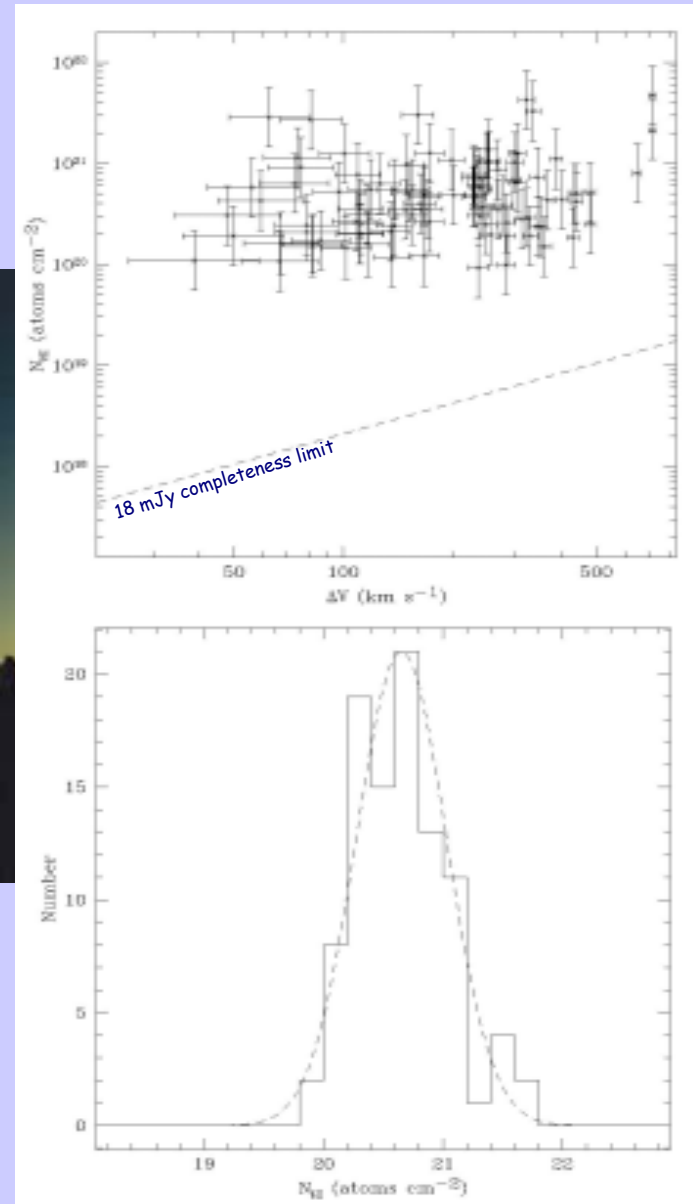
$$N_{\text{HI}} \geq 2.75 \cdot 10^{17} \frac{\sigma T_{\text{sys}}}{\sqrt{t_{\text{obs}} \Delta V_{\text{ch}}}} \Delta V$$

5 $\sigma$



# HIDEEP: Column Densities

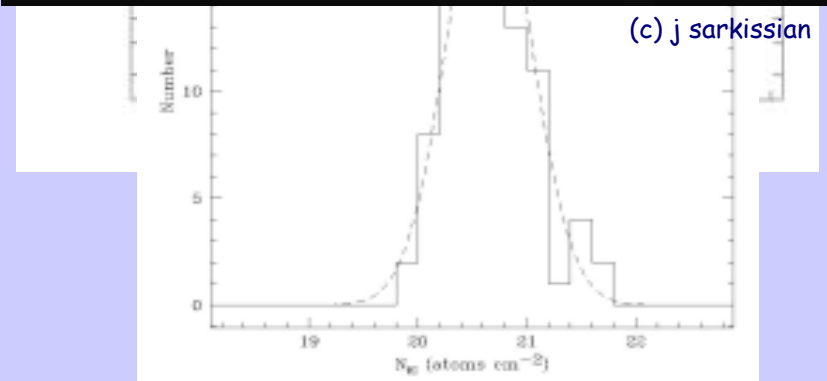
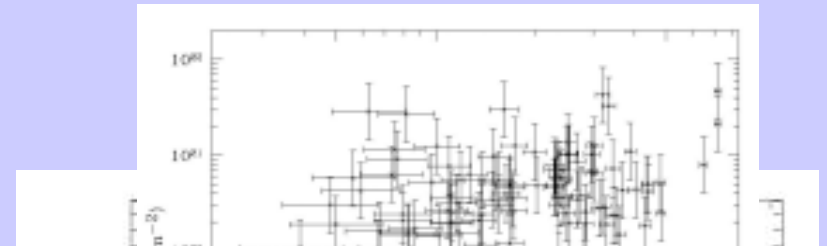
- ❖ What is distribution of HI column densities?
- ❖ No resolved imaging yet, so use mean column densities
- ❖ Have HI mass, need HI size
- ❖ Cut-off in distribution of column densities
- ❖ Need systematic underestimate of  $r_{\text{HI}}$  of factor 3



$r_{\text{HI}}$

# HIDEEP: Column Density Cut-off?

- ❖ There don't appear to be any low-column density galaxies in HIDEEP
- ❖ Distribution is consistent with constant column density  $\log \sigma = 20.65 \pm 0.38$
- ❖ But previous surveys indicate  $\sigma \sim \mu$  ....
- ❖ Open questions:
  - o selection effects?
  - o why would HIDEEP field be different?
  - o KS test of resampled ISIB96 inconclusive
- ❖ But low column density galaxies still absent from both data sets



# *HIDEEP: Conclusions and Questions*

- ❖ HIDEEP shows that deep HI surveys are feasible and not limited by instrumental problems
- ❖ All HI sources are associated with optical counterpart - no "dark galaxies" ...?
- ❖ There is a lack of low-column density galaxies in HIDEEP
- ❖ If real, what causes this lack? Why different from some other surveys?
  - o ionisation?
  - o "frozen disks" ( $T_{\text{spin}} \sim T_{\text{CMB}}$ )?
  - o environment?

