

# An HI Survey of 2MASS Galaxies in the Zone of Avoidance

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&

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# Outline

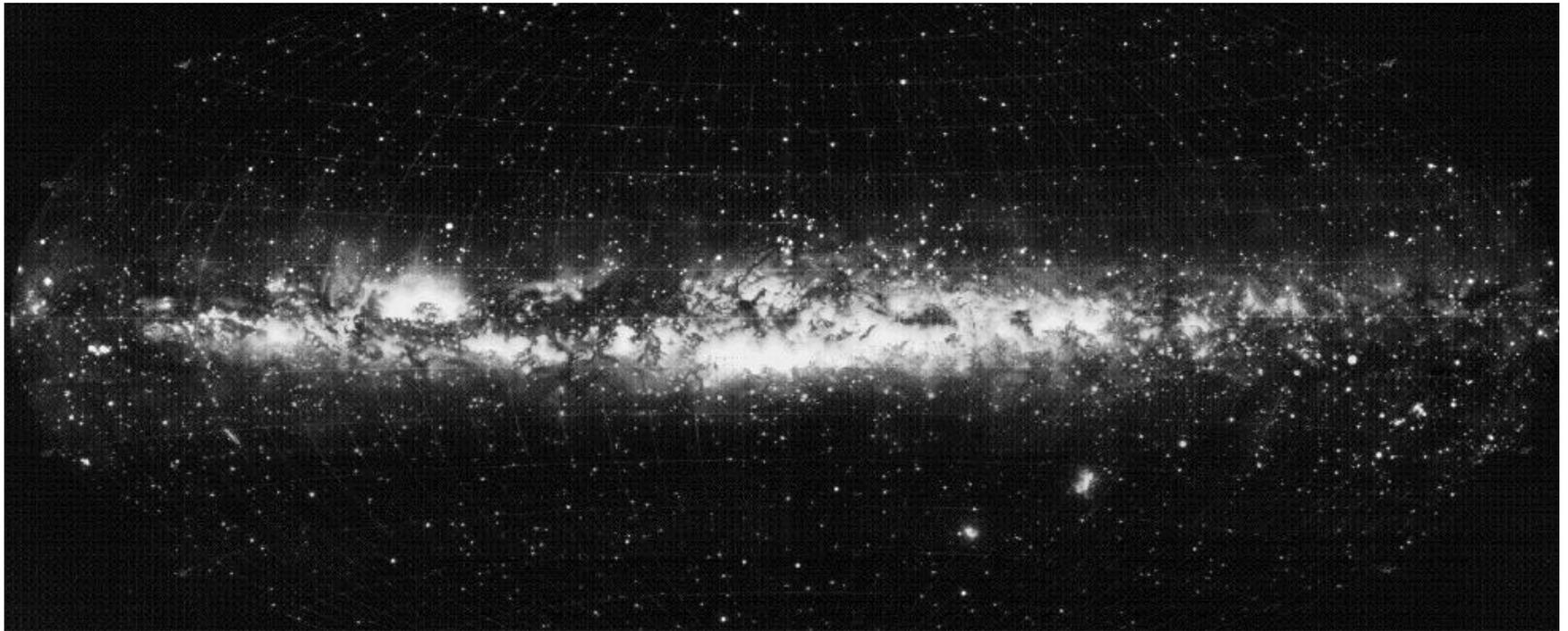
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- Introduction: the Zone of Avoidance
- A magnitude-limited 2MASS galaxy sample
- HI survey of the Northern ZoA
- A massive cluster in the Pisces-Perseus filament
- Outlook

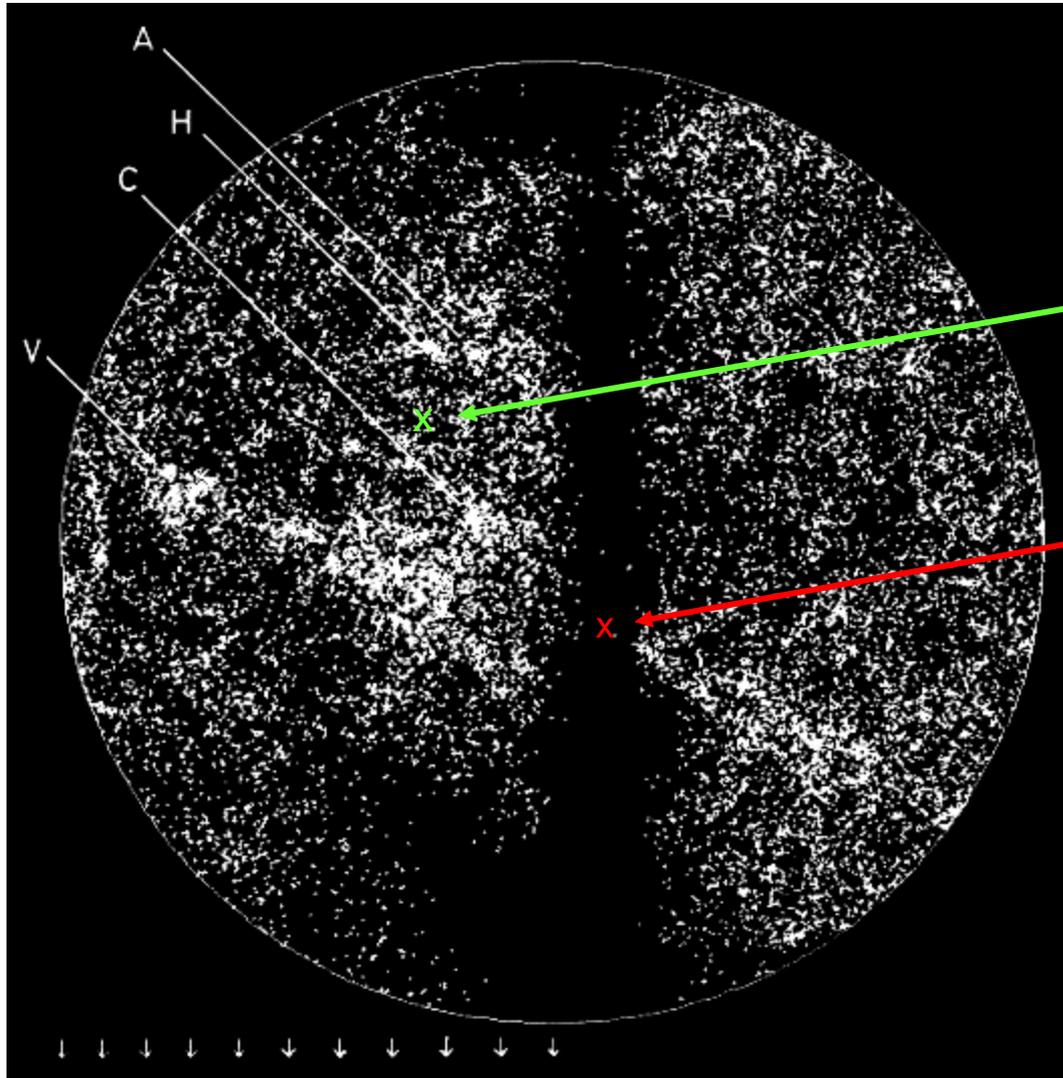
# The Milky Way

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25% of the optical sky is obscured by our *Galaxy*



# The origin of the motion of the Local Group



CMB:

$$v_{LG} = \sim 600 \text{ km/s}$$

$$l=268^\circ, b=27^\circ$$

Great Attractor:

$$v_{LG} = \sim 4000 \text{ km/s}$$

$$l=320^\circ, b=0^\circ$$

(Kolatt et al. 95)

# Filling in the Gap

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Aim: a magnitude- or volume-limited **all**-sky survey with

a) redshifts

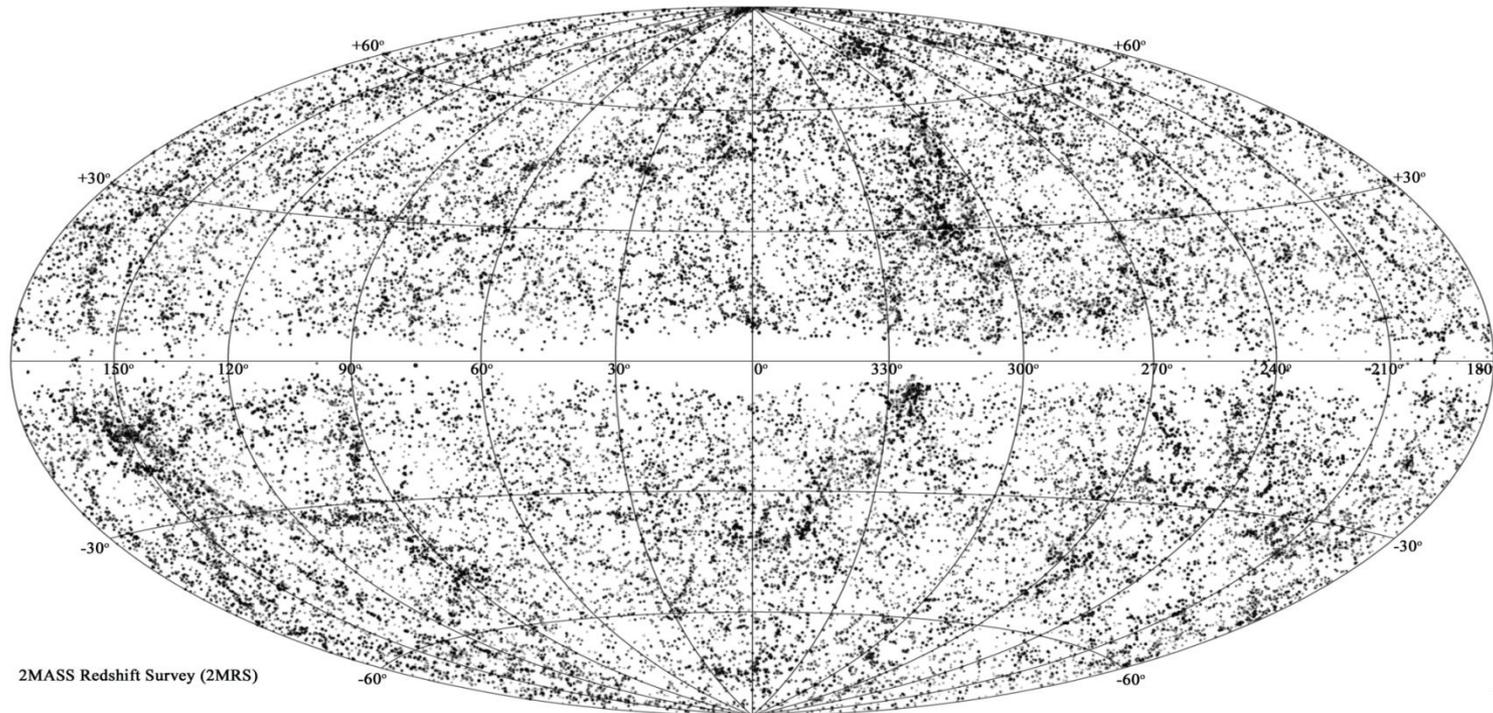
b) redshift-independent distances

Solution:

- complement an existing survey in NIR and/or HI  
=> **2MASS, blind HI surveys**
- fill in the ZoA with new observations
- apply the **TF relation** to derive peculiar velocities [see Khaled's talk]
- combine with existing survey

# 2MASS Redshift Survey (2MRS)

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## Huchra, Macri et al 2012:

- $K_s \leq 11.75$  mag and detected at H-band
- $E(B-V) < 1.0$  mag
- $|b| > 5.0$  deg for  $30 < l < 330$  ;  $|b| > 8.0$  deg otherwise

**=> 45,086 sources**

# 2MRS-ZoA sample

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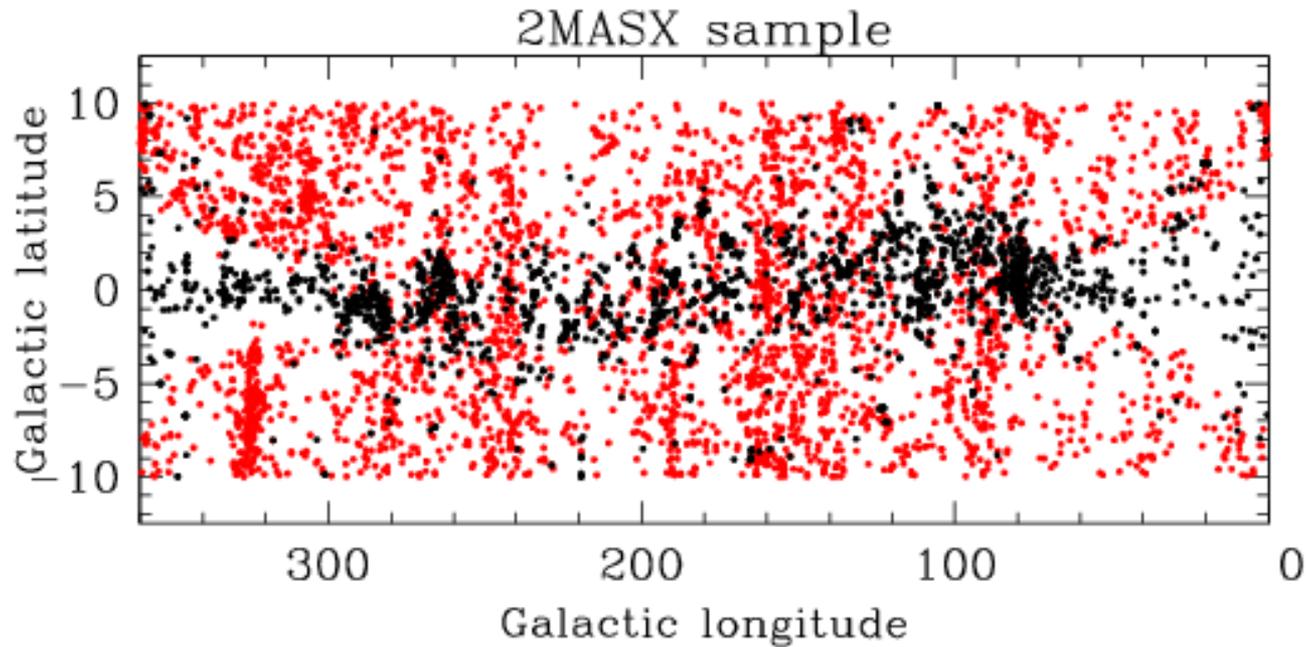
2MASS extended source catalogue:

- $|b| < 10^\circ$   $\Rightarrow$  145 294 sources
- $K^\circ \leq 11.25$  mag  $\Rightarrow$  6642 sources
- Galaxies  $\Rightarrow$  3675 galaxies

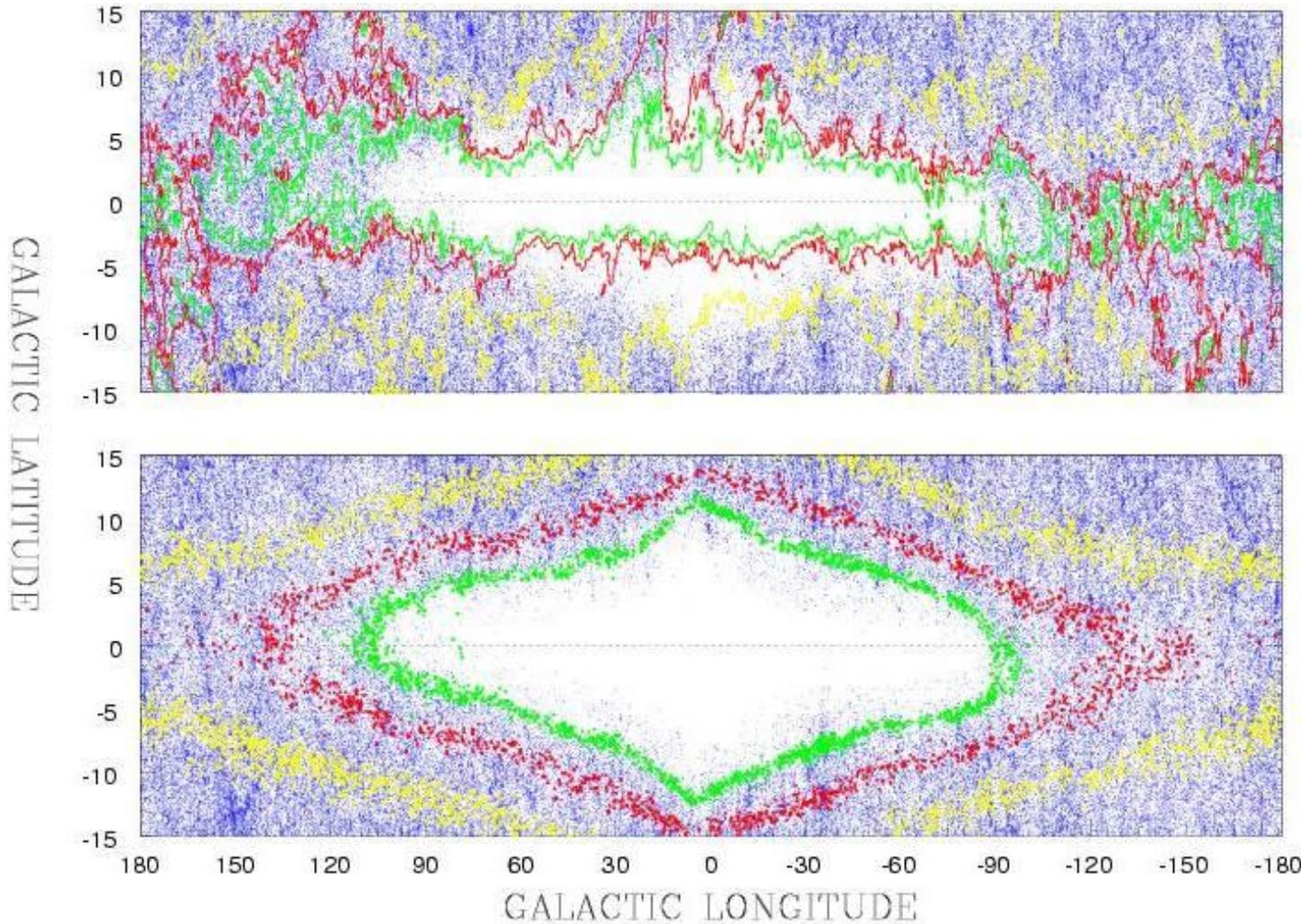
# 2MRS-ZoA sample

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- Galactic objects and blended stars
- **galaxies**



# 2MRS-ZoA sample



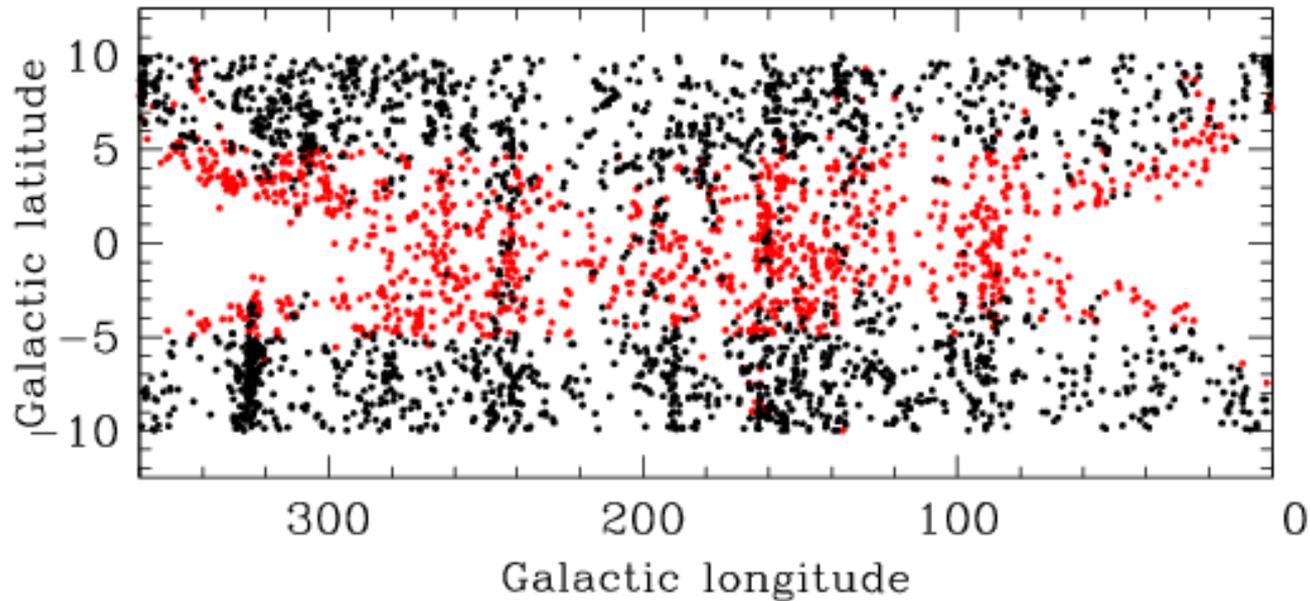
Galactic  
extinction

stellar  
density

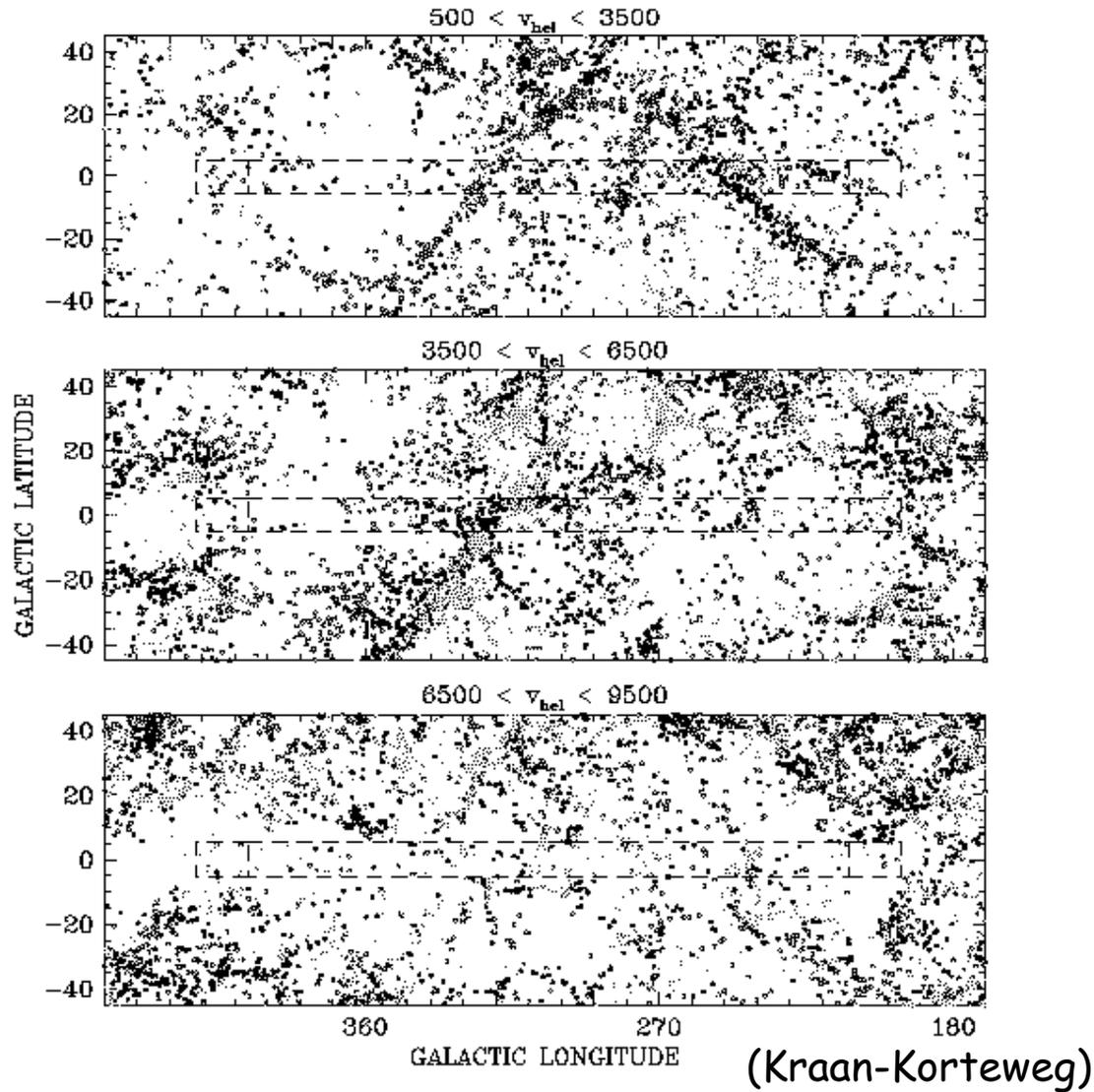
# 2MRS-ZoA sample

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- 2MRS galaxies: 1778 + 610 ('extra')
- 2MRS-ZoA galaxies: 1287



# Deep HIZOA survey (Parkes)



# Nançay survey

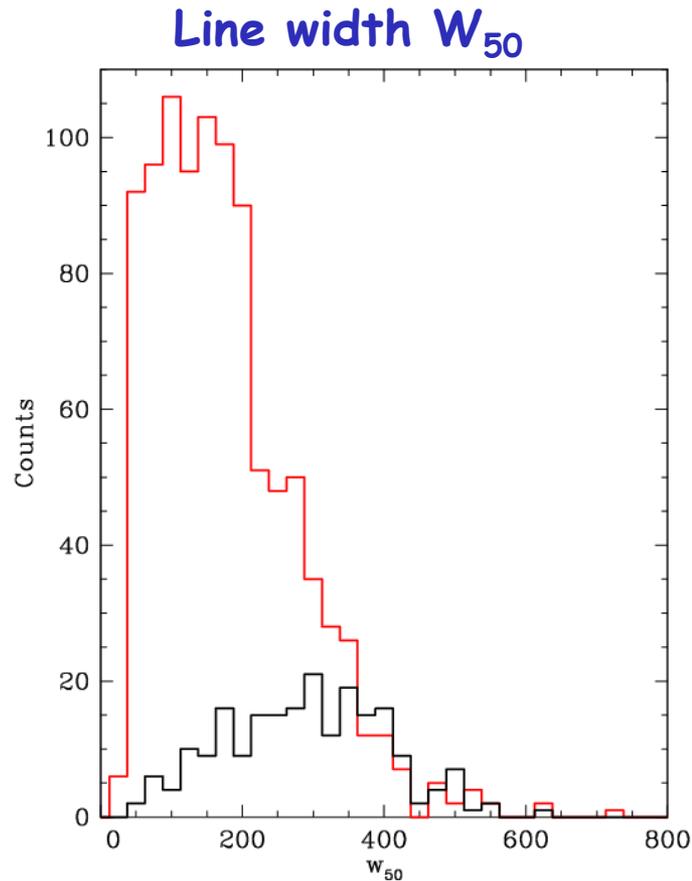
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Observations: 100m-class radio telescope  
-500 km/s < vel < 10500 km/s  
18 km/s velocity resolution  
3.3 mJy/beam rms noise

Results: 978 galaxies observed  
212 galaxies detected  
13 marginal detections => 23% total  
a few pointings have more than one detection

# Nançay survey: HI survey comparison

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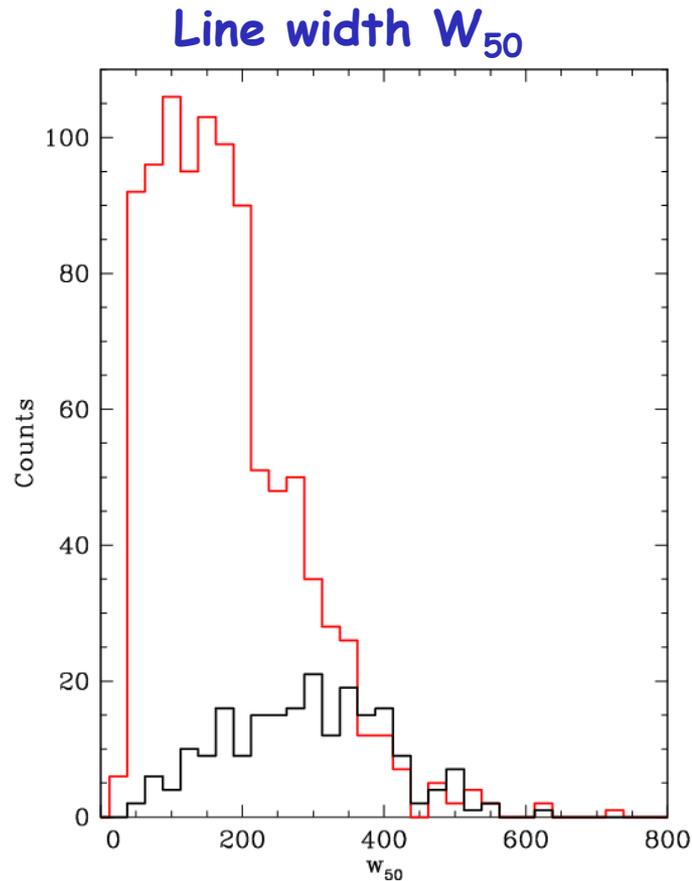


**NRT targeted survey**  
**n = 225**

**HIZOA blind survey**  
**n = 883**

# Nançay survey: HI survey comparison

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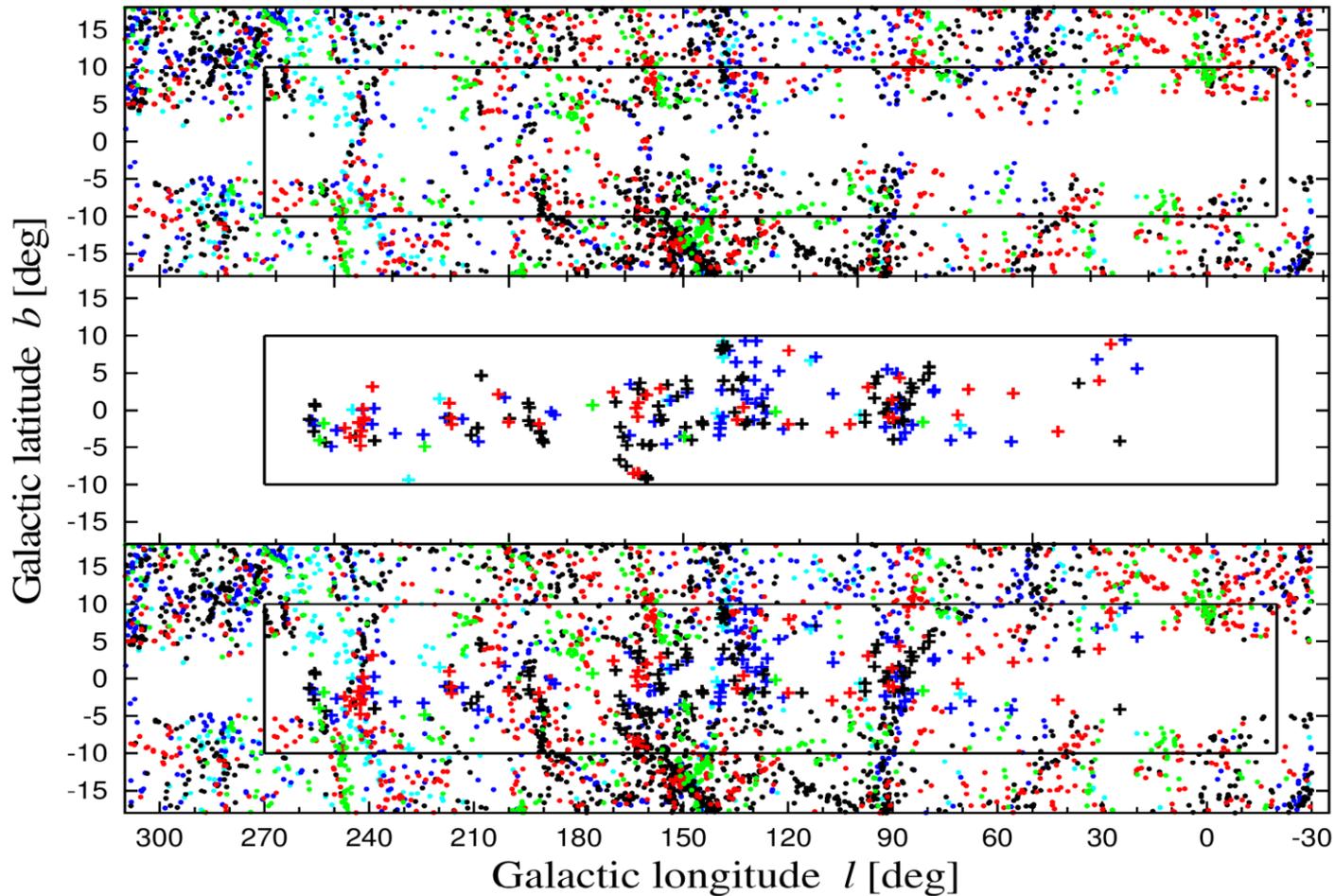


~~NRT targeted survey  
n = 225~~

~~HIZOA blind survey  
n = 883~~

NIR-selected survey  
versus  
HI-selected survey

# Nançay survey: New detections



before

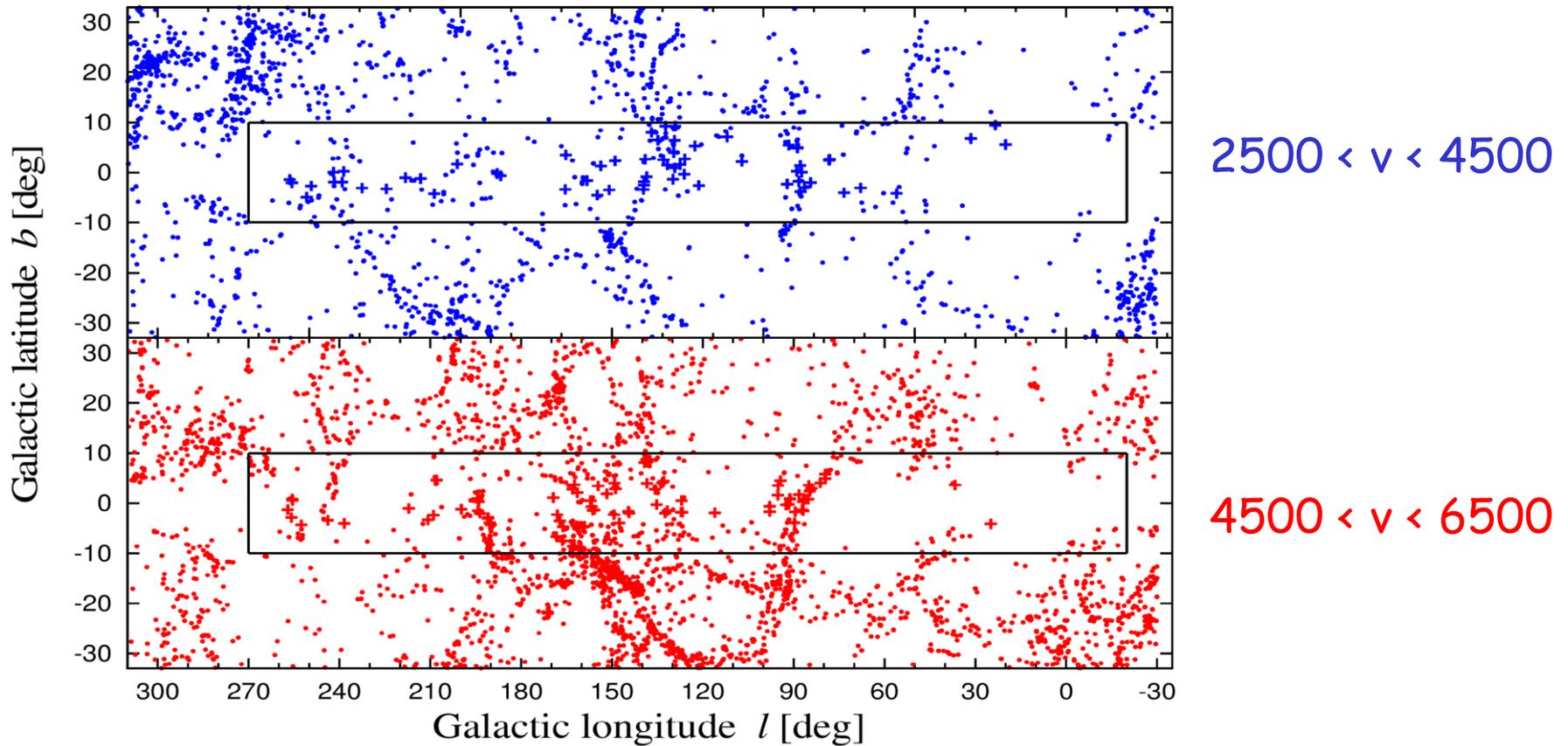
NRT  
detections

after

Vel: 0 - 2500 - 4500 - 6500 - 8500 - 10500

# Nançay survey: New detections

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# WSRT survey: Pisces Perseus filament

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PhD project Mpati Ramatsoku [MNRAS 460, 923]

Westerbork Synthesis Radio Telescope

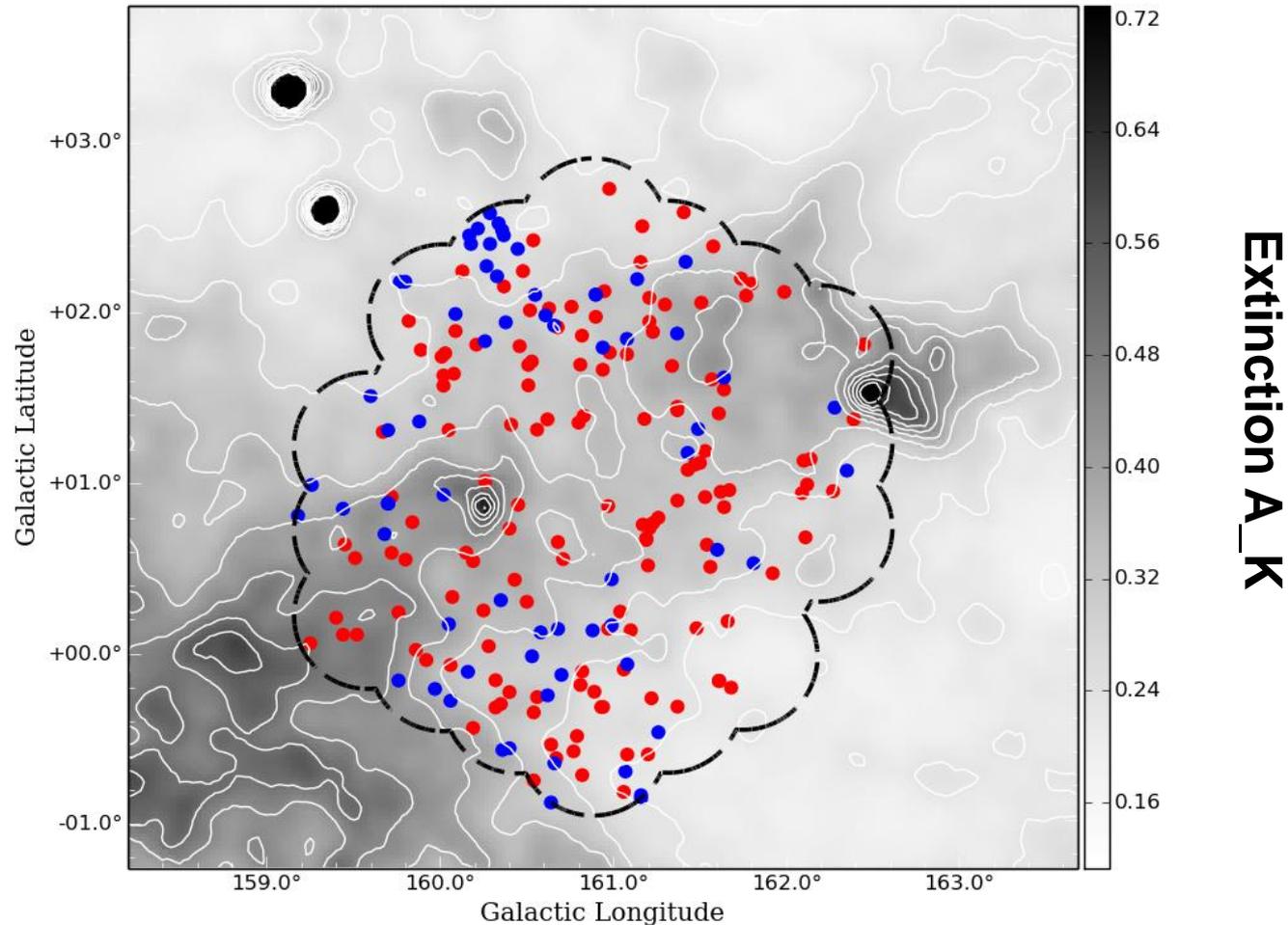
- mosaic: 35 x 12 hr pointings
- area: 9.6 sq.deg
- velocity range: 2000 - 17000 km/s
- velocity resolution: 16.5 km/s
- spatial resolution: 23" x 16"

Two strong radio sources 3C 129 (4Jy) and 3C 129.1 (0.9Jy)

=> Pilot project for APERTIF HI surveys

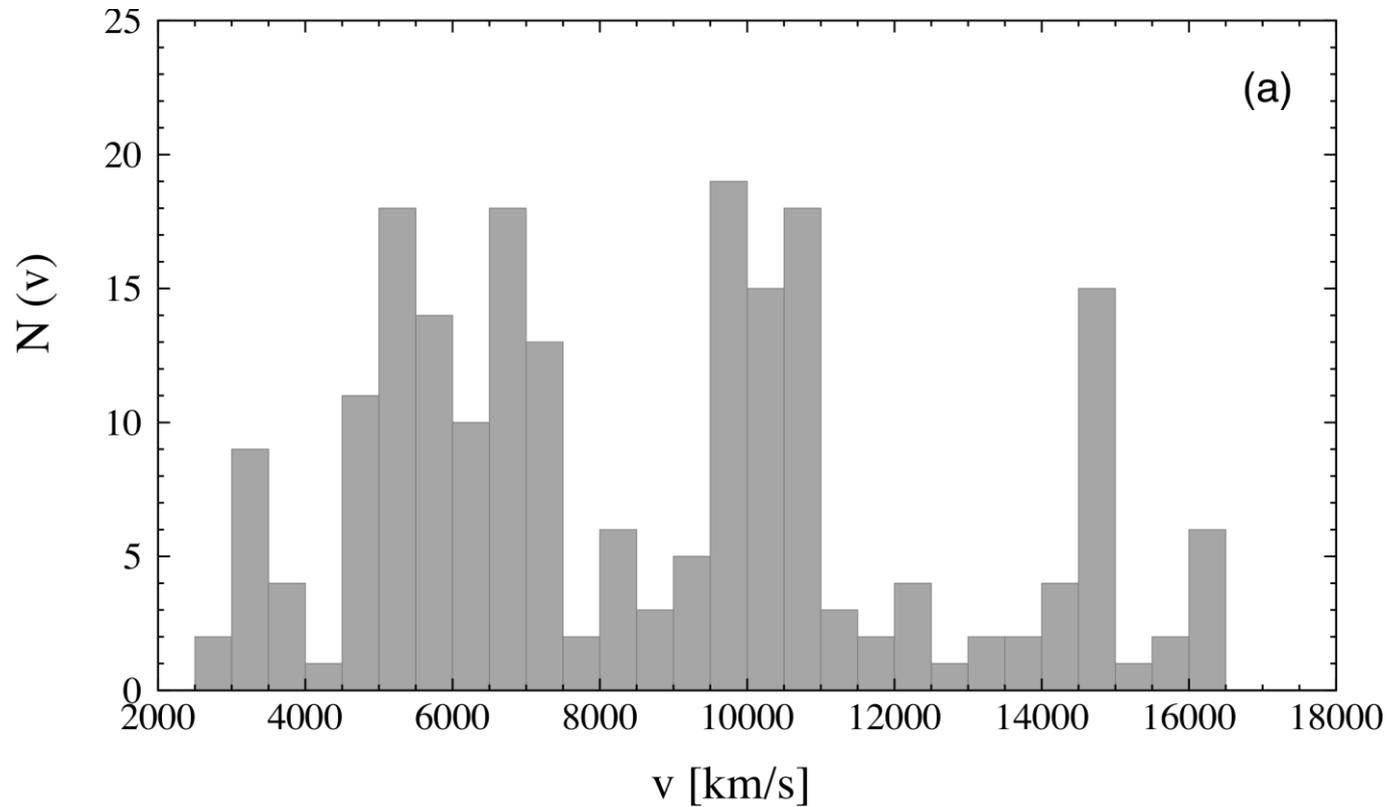
# WSRT survey: Pisces Perseus filament

214 galaxies; => 65% with NIR counterpart



# WSRT survey: Pisces Perseus filament

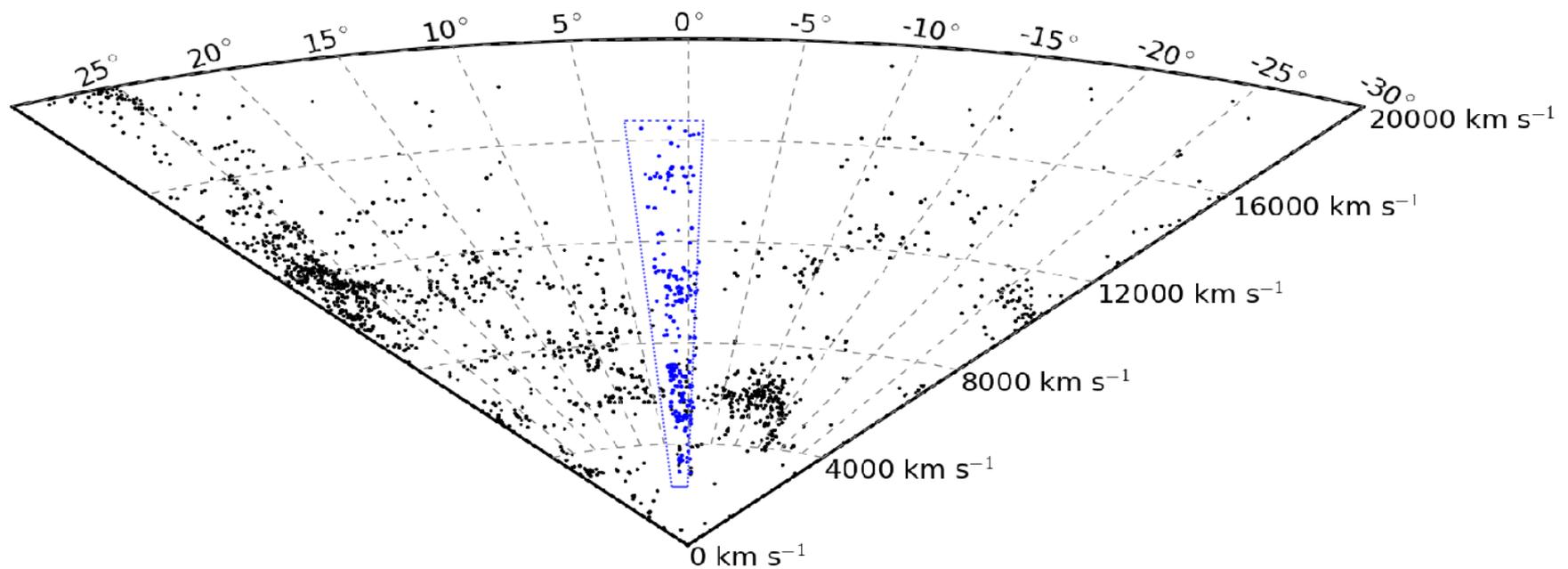
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# WSRT survey: Pisces Perseus filament

$155^\circ < l < 165^\circ ; -30^\circ < b < 30^\circ$

WSRT:  $159^\circ < l < 163^\circ$



# What's next?

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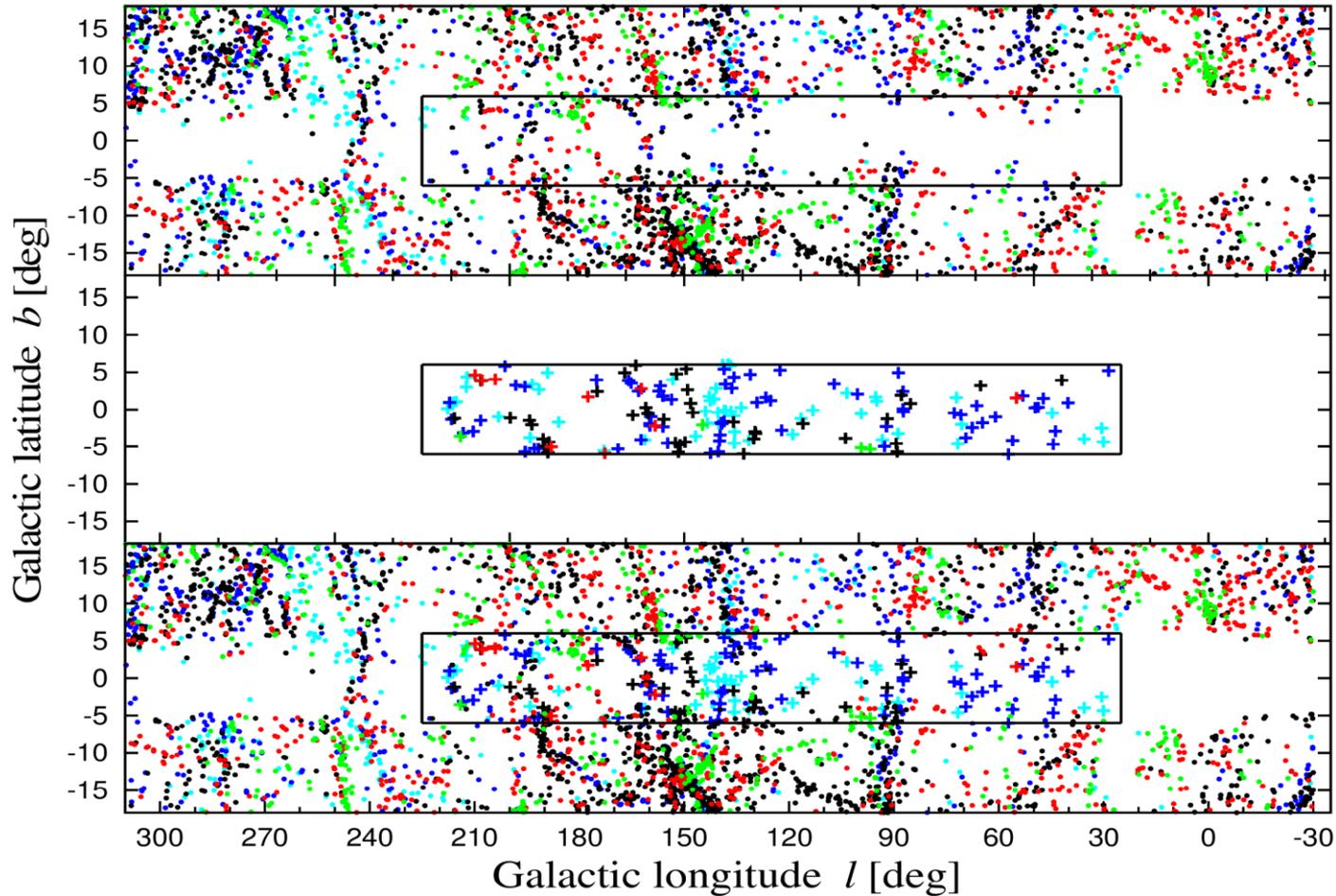
## Northern ZoA:

- Nançay TF survey (to complement 2MTF)
- EBHIS: Effelsberg Bonn HI survey
  - shallow survey exists: 172 ZoA detections;
  - deep survey will be complementary to HIPASS

## All-sky ZoA and flow field analysis:

- Parkes observations of 2MRS-ZoA galaxies in the south
- NIR observations of HI detections [see talk by Khaled Said]
- TF analysis [see talk by Khaled Said]

# EBHIS-ZoA survey: New detections



before

EBHIS  
detections

after

Vel: -500 - 2500 - 4500 - 6500 - 8500 - 10500

# What's next?

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# Future surveys

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## HI Surveys:

- **WALLABY: ASKAP HI all-sky survey**  
(PI Staveley-Smith & Koribalski)
- **WNSHS: Westerbork Northern Sky HI Survey**  
(PI Josza)

## NIR Surveys:

- **UKIDSS Galactic Plane Survey (GPS)**
- **VISTA Variables in the Via Lactea (VVV) and VISTA Hemisphere Survey (VHS)**

# Summary

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- **ZoA**: finding galaxies, determining redshifts and peculiar velocities -> **cosmic flow fields**
- **NIR and HI** surveys complement each other
- New large-scale structures in the **northern ZoA**
- A survey of a rich cluster in the **Pisces Perseus filament**
- **Future** all-sky HI surveys together with the UKIDSS and VISTA surveys will close that gap of the ZoA