2MASS Tully-Fisher Survey

Mapping the Mass in the Universe

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On behalf of the 2MTF Team

2MTF Team

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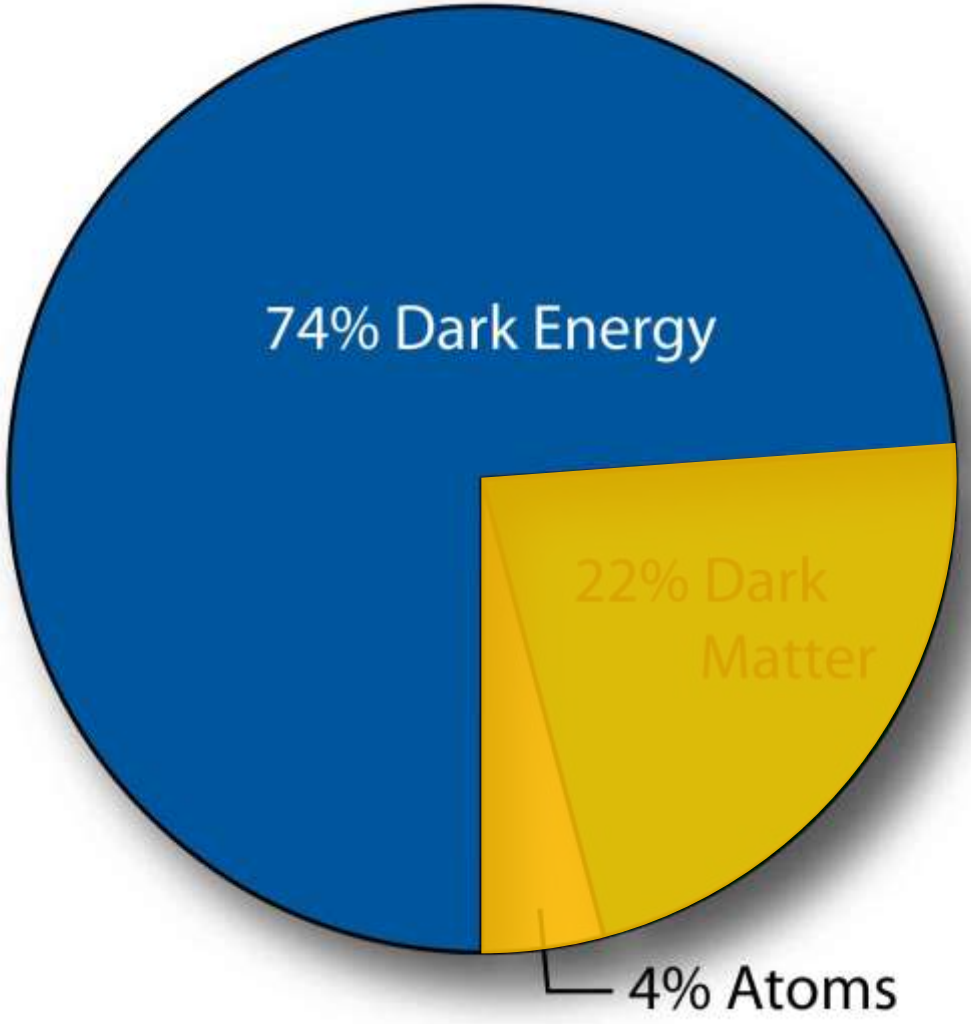
Motivation



Most of the matter is dark

Map all the matter in the local universe, by measuring the peculiar velocity field.

Measure the Peculiar Velocity Using Tully-Fisher Relation

- Tully-Fisher relation provides the redshift independent distances for spirals.
- Peculiar velocities (PV) can be estimated from these redshift independent distances.

$$v_{pec} = cz - H_0 r$$

- Use the peculiar velocity field to trace mass in the local universe.
  - Gravitational mass (visible matter + dark matter).

2MASS Tully-Fisher Survey

- Measure Tully-Fisher (TF) distances to nearby galaxies.
- Galaxies are selected from the 2MASS Redshift Survey (2MRS).
  - Near Infrared magnitudes.
  - Optical redshifts.
- High quality HI widths.
  - New observation + ALFALFA + Archival.

Advantages of 2MTF

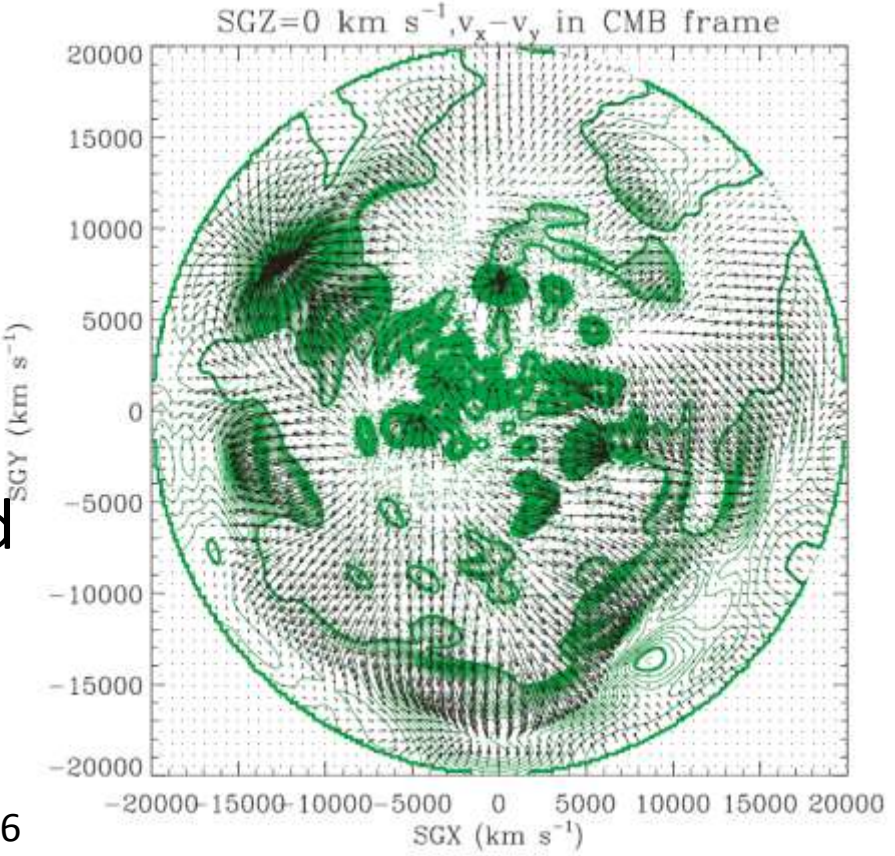
- Comparing with previous T-F surveys, we have:
  - Uniform source selection & sky-coverage
    - Better sample to measure the peculiar velocity field
  - Smaller zone of avoidance (ZoA)
    - 2MTF goes down to b = $\pm 5^\circ$
    - SFI++ covers to b = $\pm 15^\circ$
  - Near Infrared magnitudes
    - Ks, H and J band magnitudes
    - SFI++ used optical magnitudes – I band

Scientific Goal of 2MTF

- High quality Tully-Fisher distance catalog

- Peculiar velocity field & mass distribution of local universe
  - Will compare with the reconstruction predicted from 2MRS.

The 2MRS velocity field



Erdogdu et al., 2006

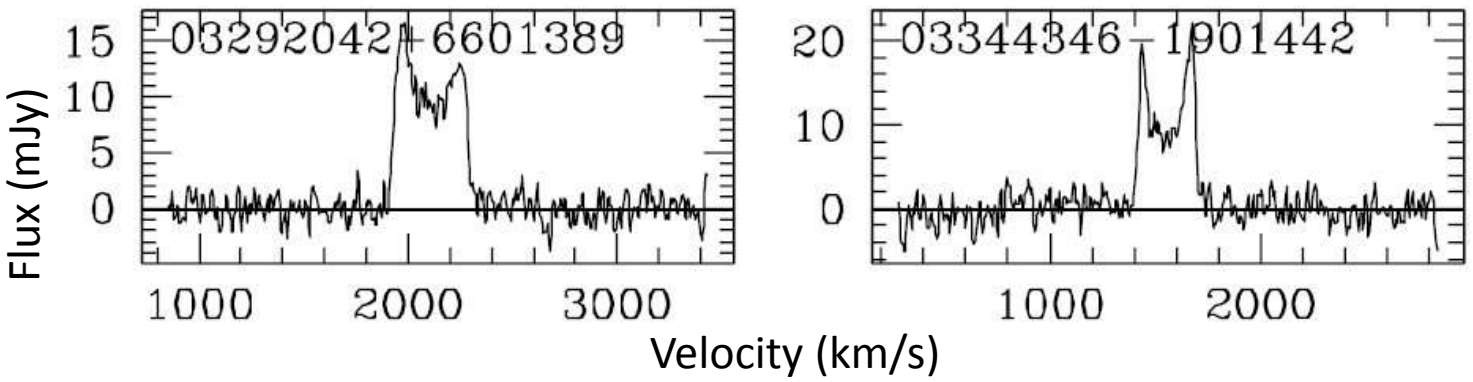
Source Selection

- Selection criteria
  - Select from 2MASS Redshift Survey.
  - ***Ks < 11.25 mag.***
  - ***cz < 10,000 km/s.***
  - ***b/a < 0.5.***
  - 6000 galaxies after the selection

Northern Observation

- Green Bank Telescope
  - 368 hours (Feb 06 – Feb 07)
  - Position switching mode
  - 12.5 MHz band width with 8192 channels
- 1194 galaxies observed
- 484 well detected

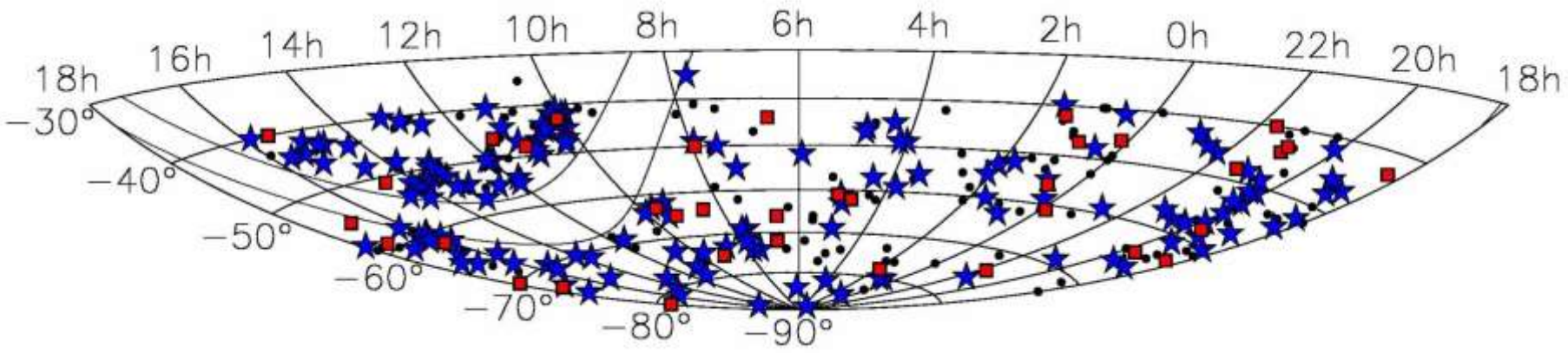
Masters et al., to be submitted



Southern Observation

- Parkes 64m Telescope
  - 650 hours (Nov 06 – Mar 12)
  - Beam switching mode (7 beams)
  - BW = 8 MHz, N_{chan} = 1024
- 305 galaxies observed
- 152 good widths

Hong et al., 2013 (MNRAS)



ALFALFA Data

- The Arecibo Legacy Fast ALFA Survey
  - 30,000+ extragalactic HI line sources out to z~0.06.
  - Completed in late 2012.
- 40% data release
  - Released in 2011. (Haynes et al., 2011)
  - ~15,900 HI sources in total.
  - 376 useful widths for 2MTF.
- Waiting for the full data release.

Archival Data

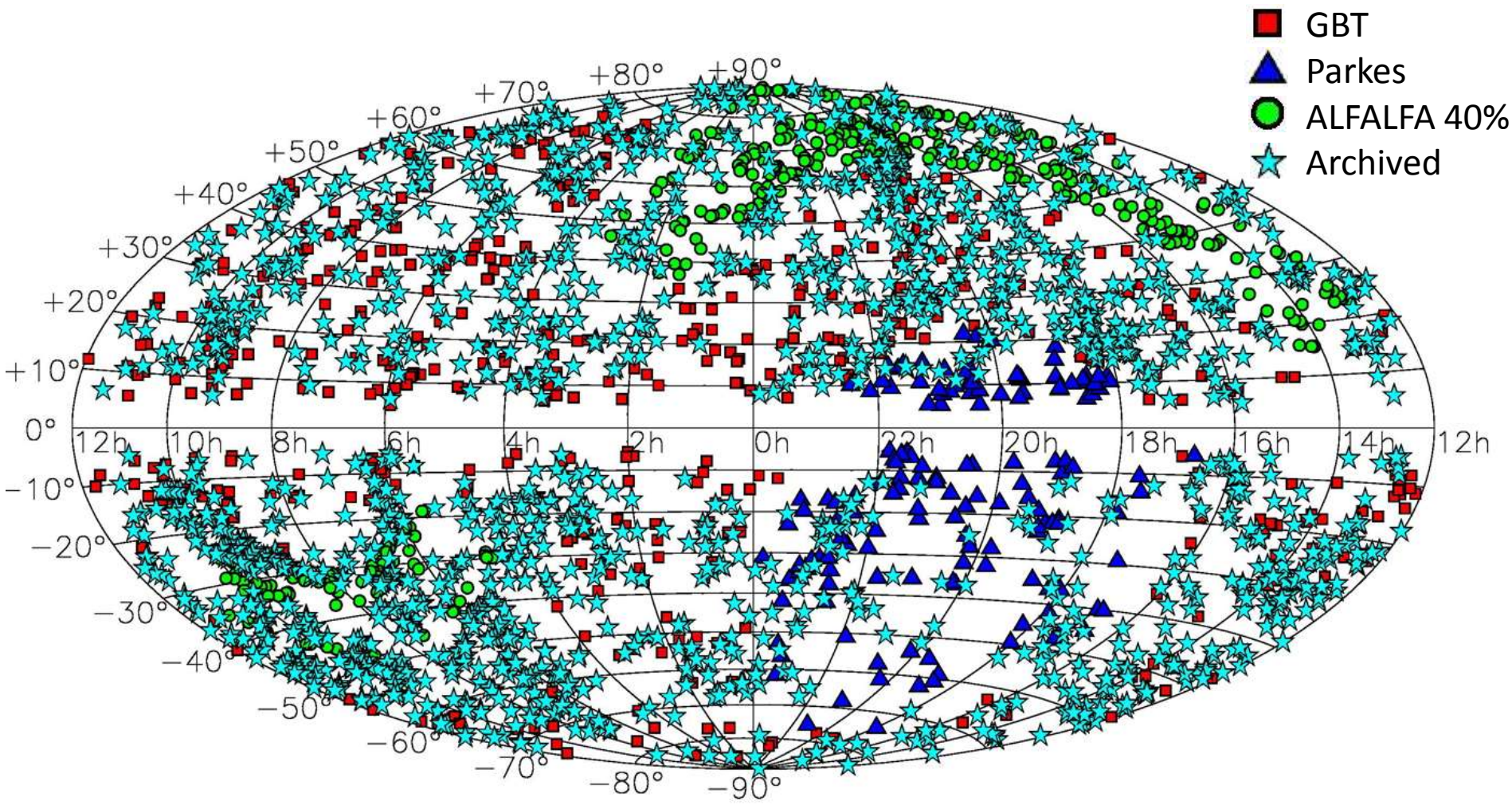
- Mainly from Cornell EGG Archive.
- Also from HyperLEDA and other literatures.
- About 1600 matched HI widths

- Parkes data has been published. Hong et al., 2013 (MNRAS)
- GBT data will be published soon.

More detailed descriptions, check our website: ict.icrar.org/2MTF/

Final 2MTF Sample

- 2,600 galaxies with uniform sky-coverage.

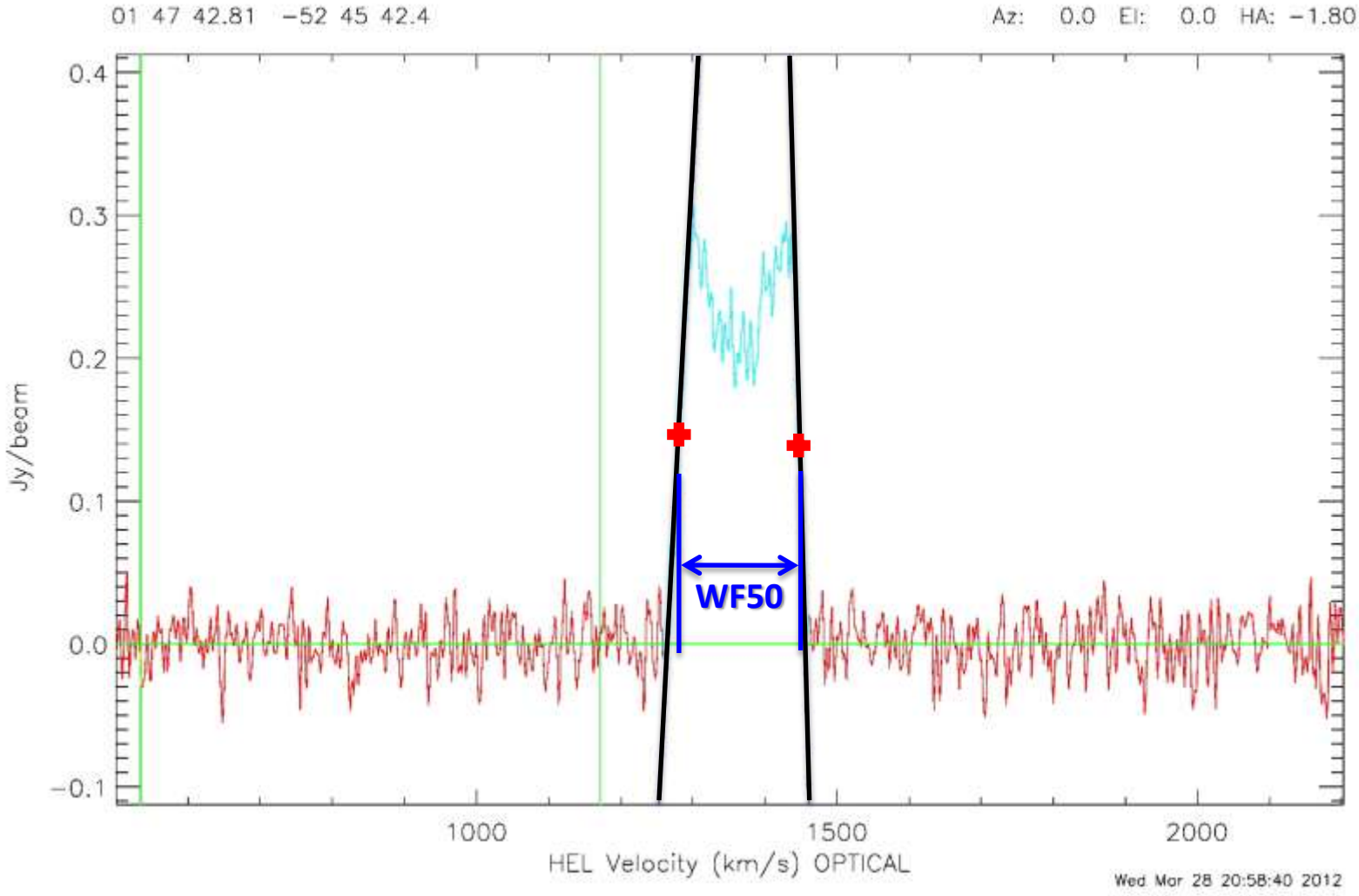


Width Measurement

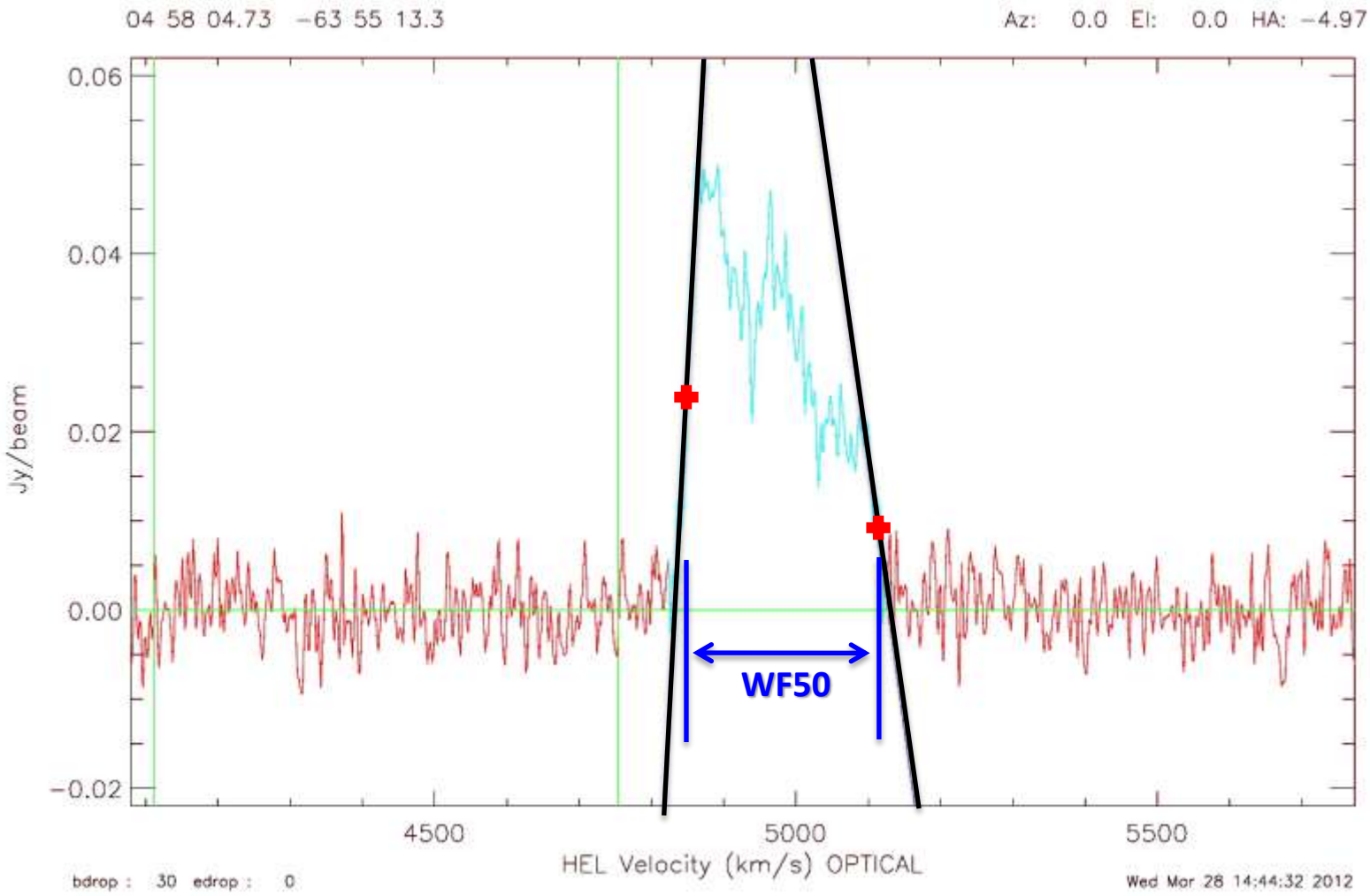
- WF50 widths are adopted (Giovanelli et al. 1997)
- 50% of the value of $f_p - \sigma_{rms}$ on a linear fit of both sides of the profile
  - Reduce the dependence on the S/N of the spectra
  - Work well on asymmetric profiles

- New observed, ALFALFA and Cornell archival data

Width Measurement

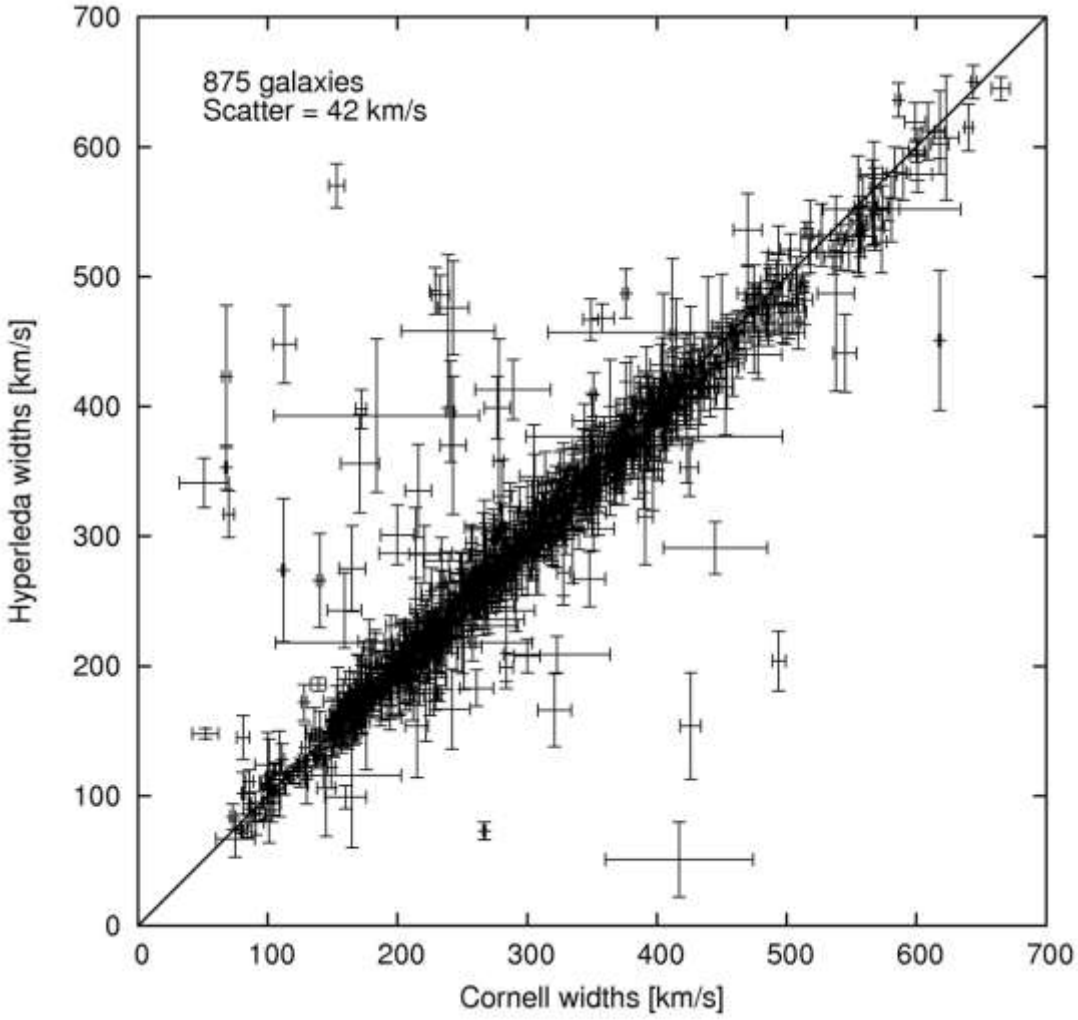


Width Measurement



Width Measurement

- WP50
  - Widths at 50% of the maximum intensity of the line
- Adopted for ~200 archival galaxies
  - HyperLEDA
- Agree with WF50



Width Errors

- Monte-Carlo Method (Donley et al., 2005)
  - Smooth the spectrum using a low pass filter
    - 17-channel Savitzky-Golay filter
  - Add Poisson noise to the smoothed spectrum
    - Same rms level with the 'real' spectrum
  - Measure widths using same routine
  - Repeat 50 times
  - Get standard deviation as the error
- Only for Parkes new observed galaxies right now

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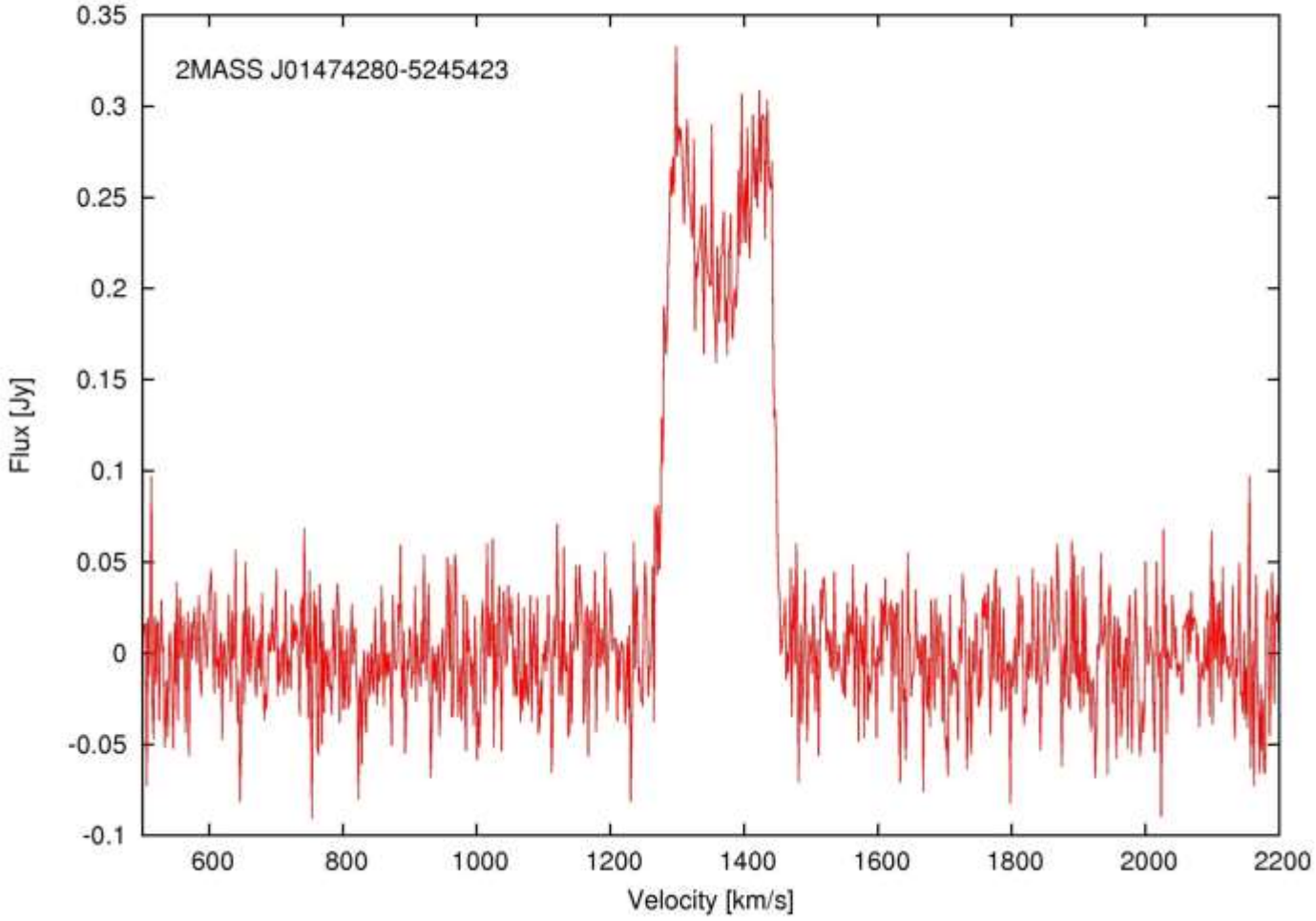
Width Errors



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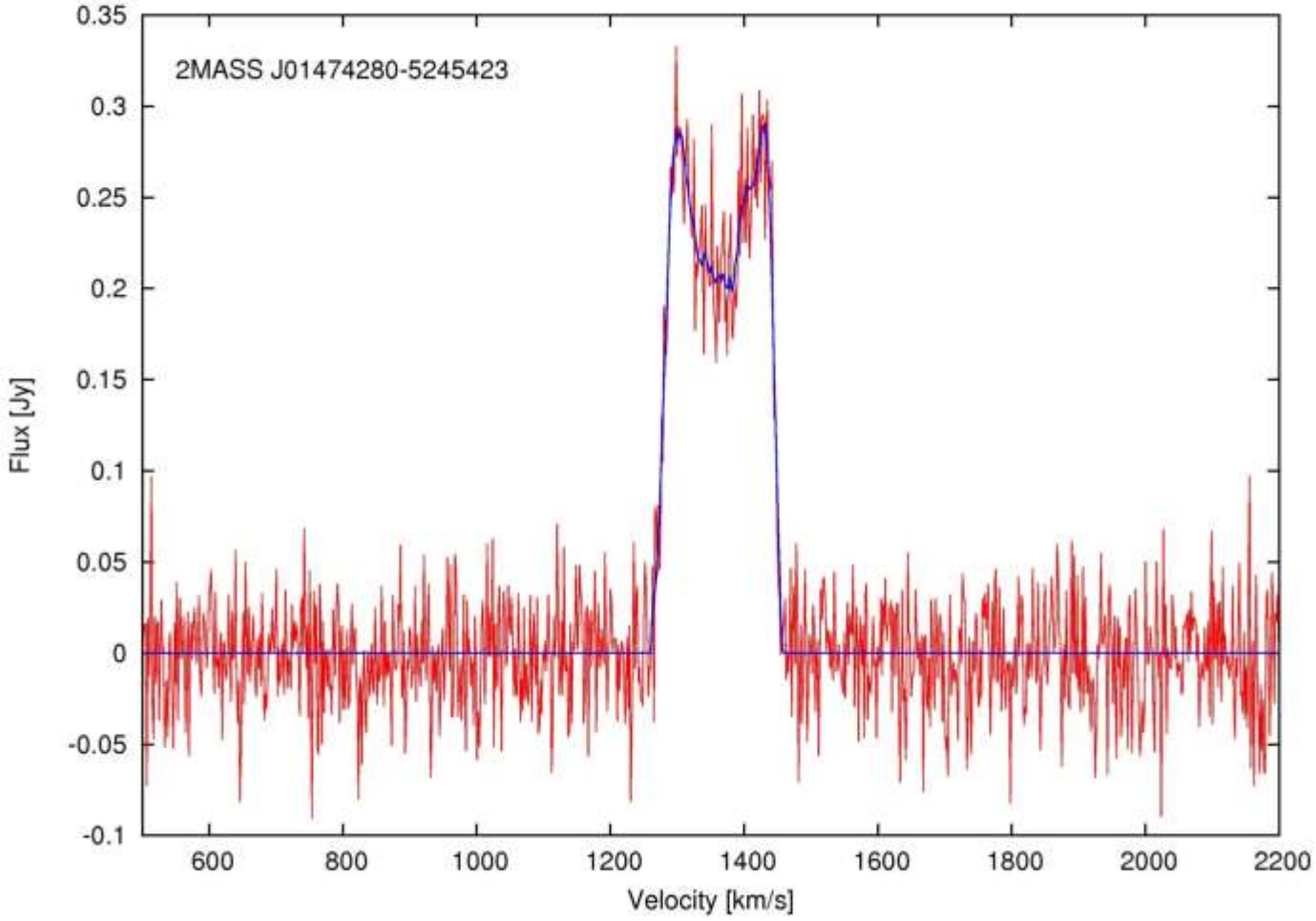

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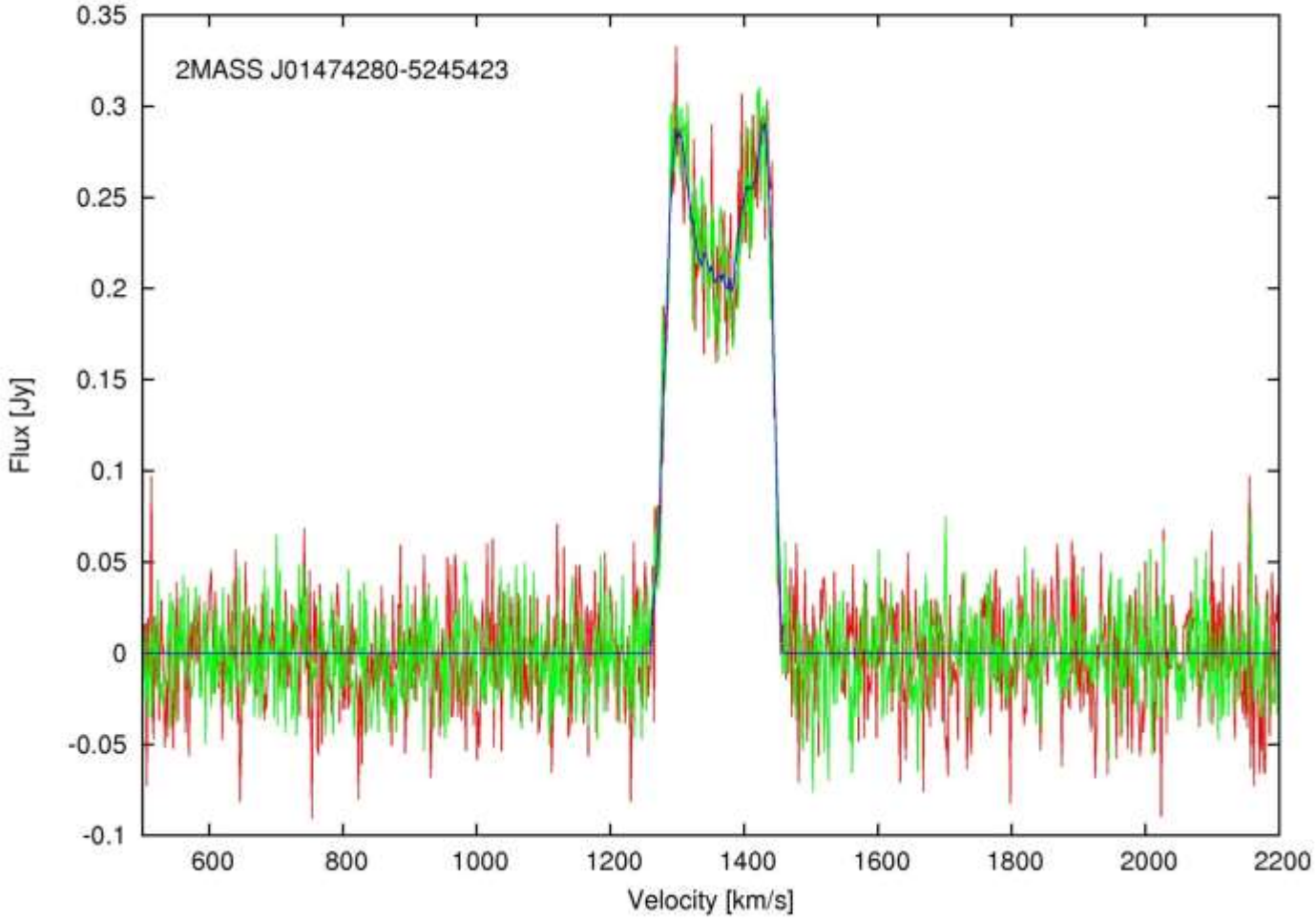
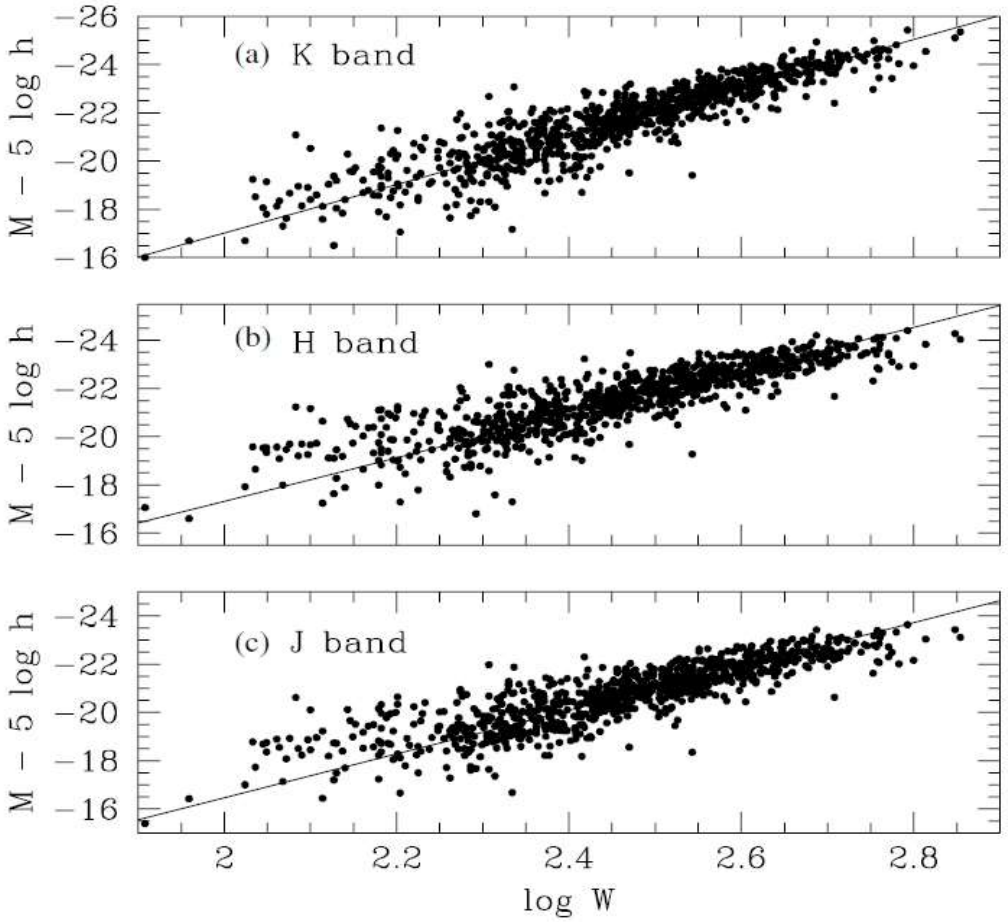


Near-IR T-F Template

- 888 galaxies in 33 clusters.
- SFI++ radio data & 2MRS Near-IR magnitudes.



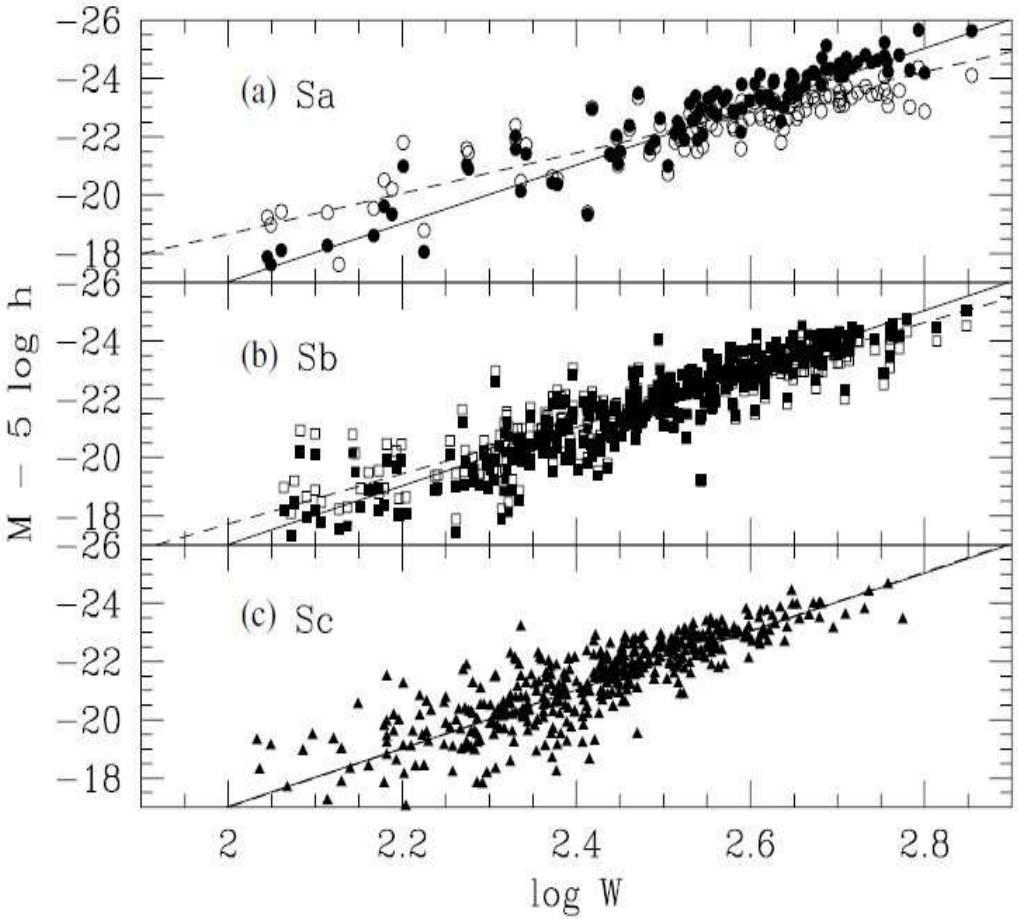
- Slope and zero-point vary with band and morphological type

Masters et al., 2008

Near-IR T-F Template

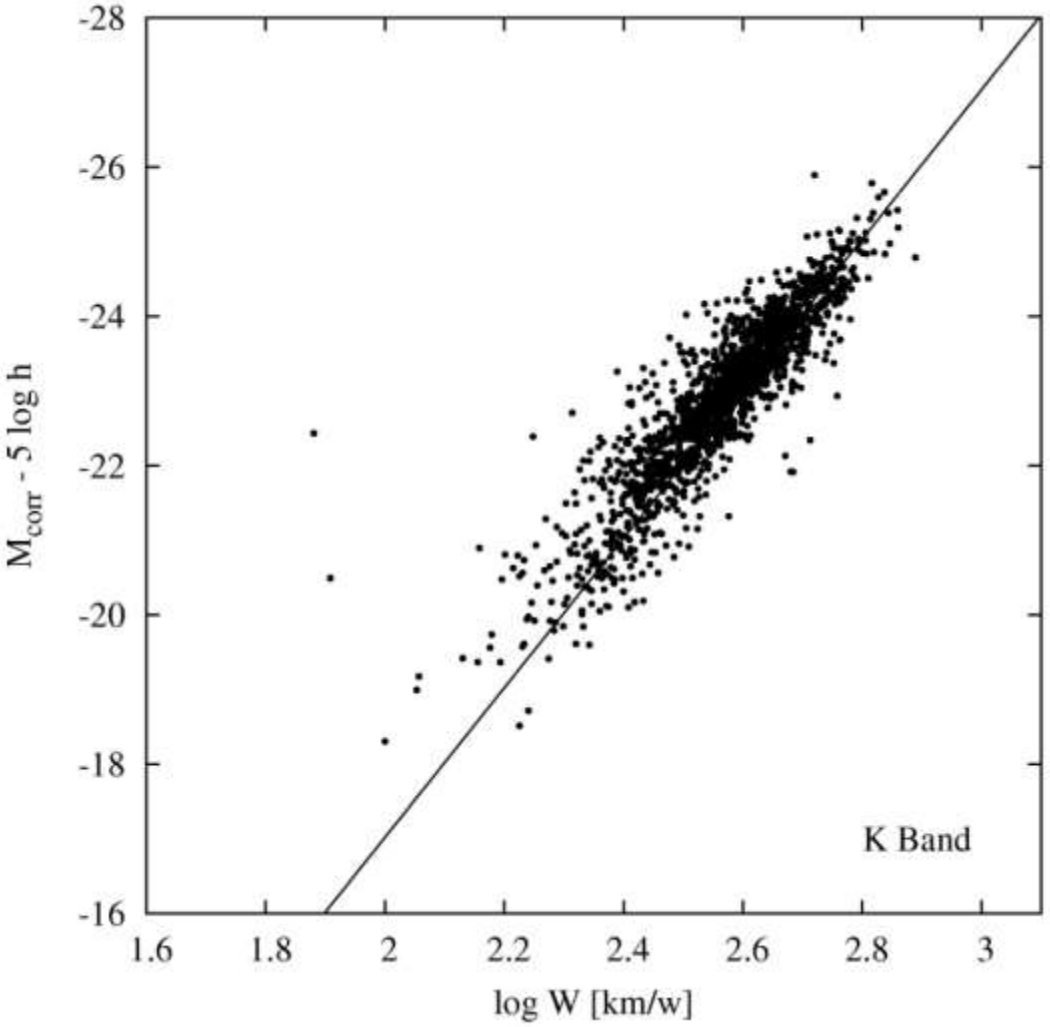
- 888 galaxies in 33 clusters.
- SFI++ radio data & 2MRS Near-IR magnitudes.

- Steeper slope for later-type galaxies.
- Dimmer zero point for later-type galaxies.



Masters et al., 2008

Preliminary 2MTF Results



- Further cutoffs
  - Morphology
    - Sa - Sd
  - Radio SNR > 5
  - $\sigma_W/W < 10\%$
- 1790 Galaxies so far
  - More ALFALFA?

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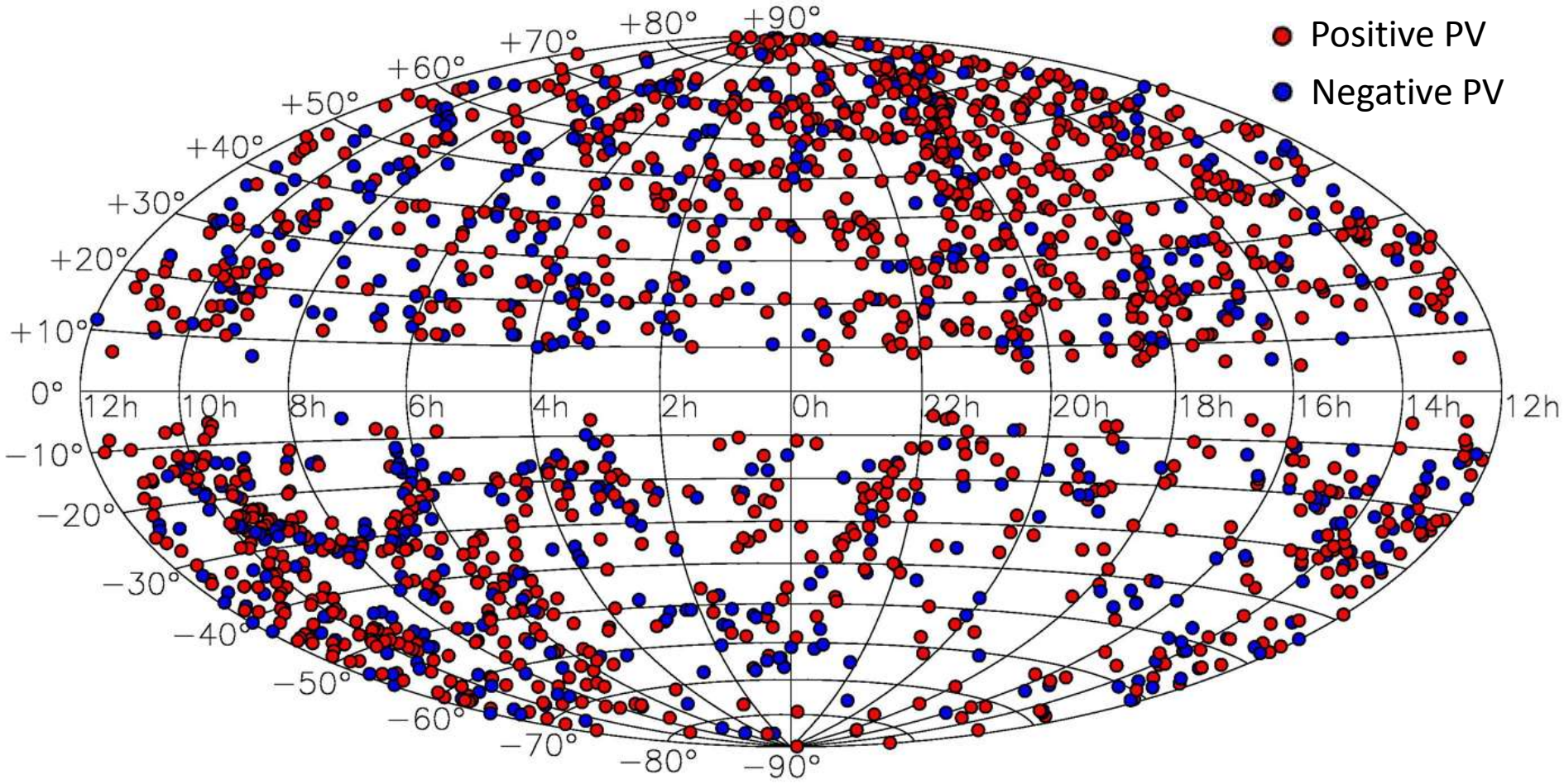


Conclusions

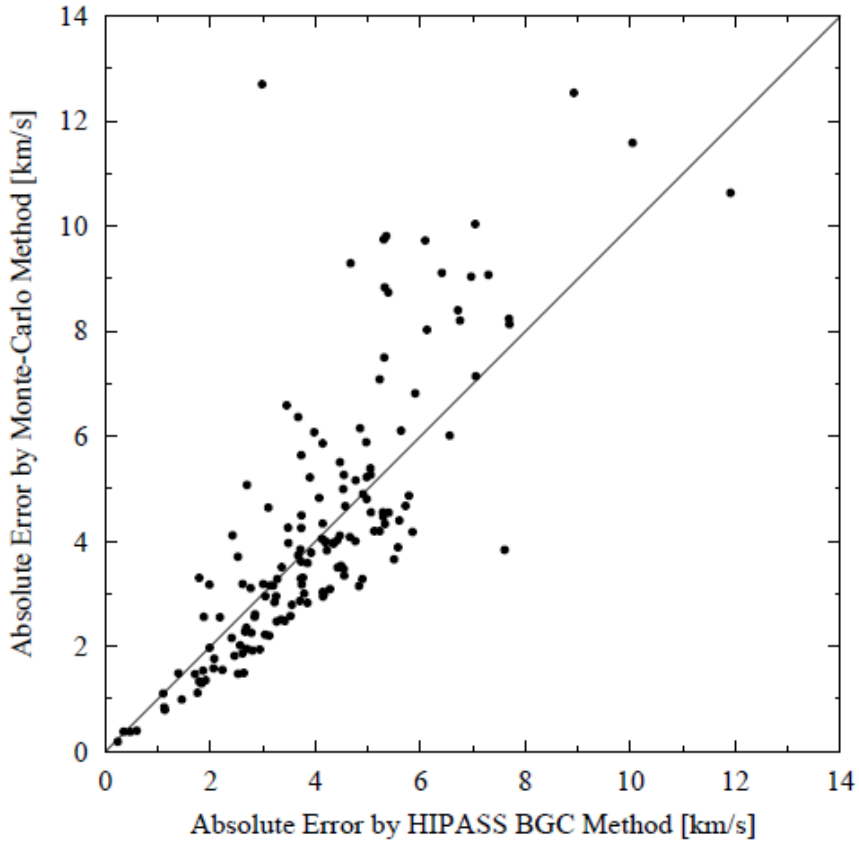
- 2MASS Tully-Fisher Survey
  - More even sky-coverage.
  - Smaller “Zone of Avoidance”.
  - New observed HI widths.
  - New Near-IR Tully-Fisher template.
- Measure the peculiar velocity field and mass distribution of local universe ($cz < 10{,}000$ km/s).

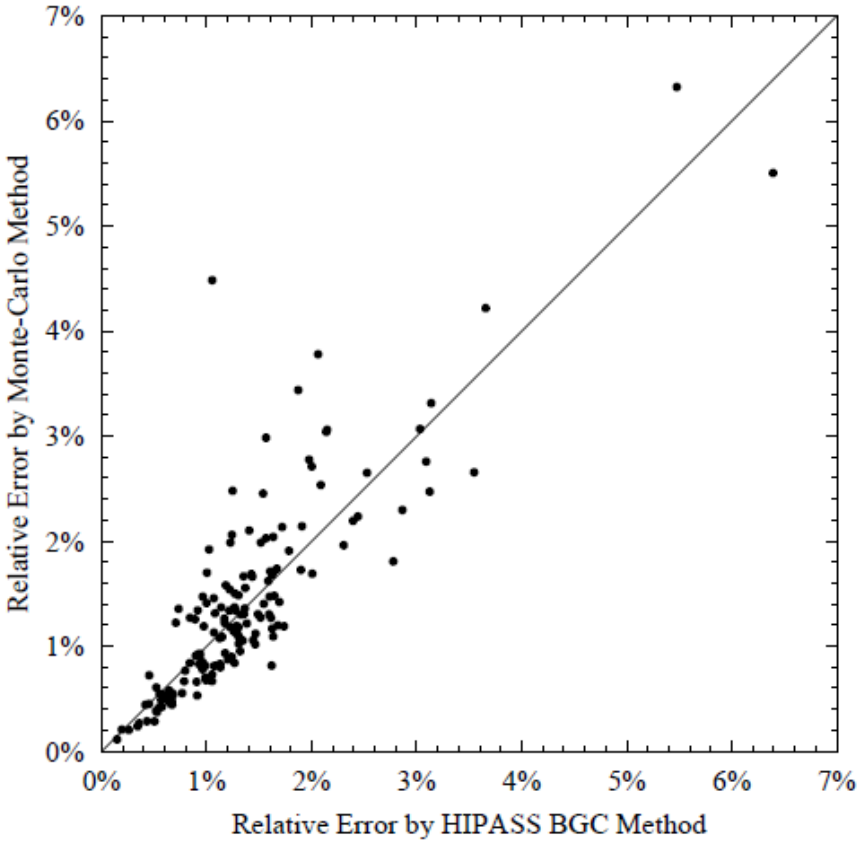
- All observations and data reductions are finished.
- Cosmological analysis in progress, results will come out soon.

Thank You!

Compare with HIPASS BGC Errors

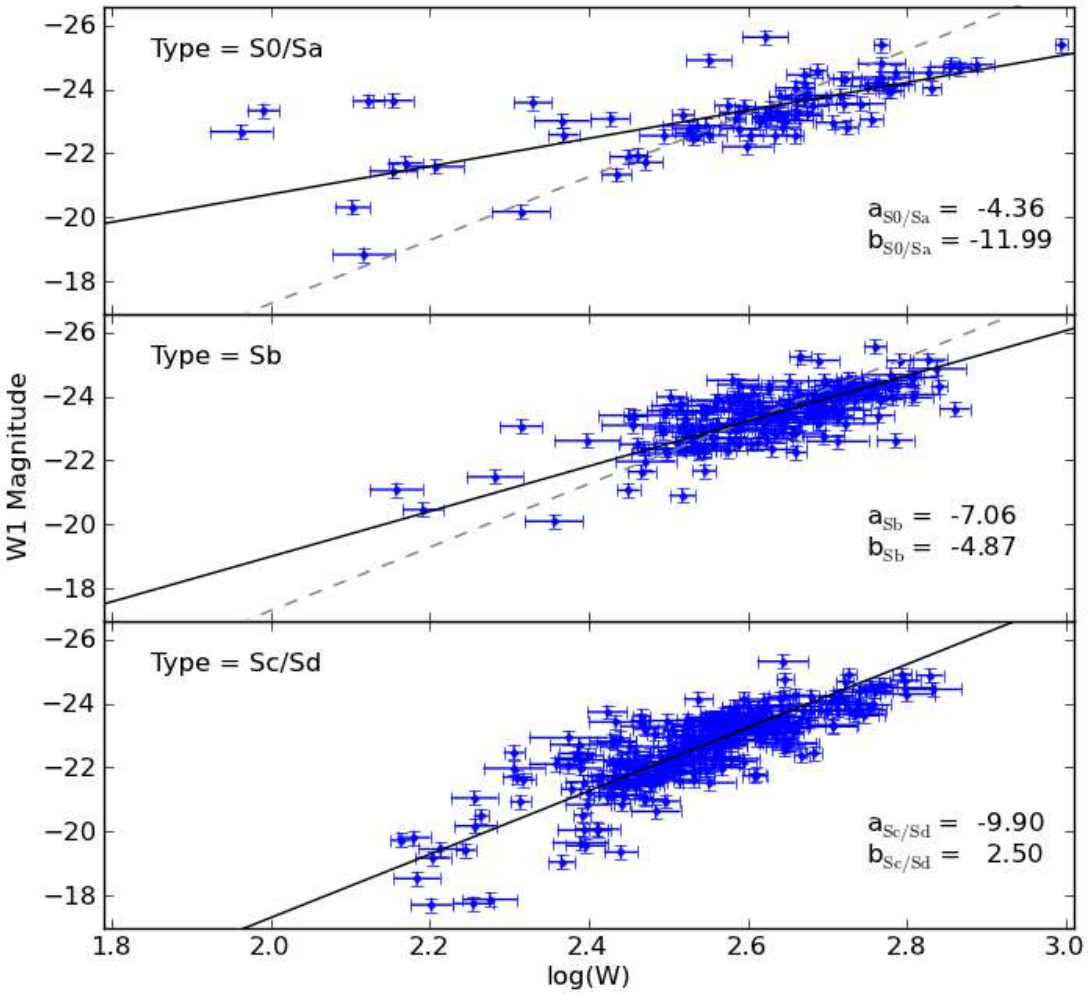
- $\sigma(v_{sys}) = 3(S/N)^{-1}(P\Delta_v)^{1/2}$, $\sigma(w_{50}) = 2\sigma(v_{sys})$ Koribalski et al. (2004)





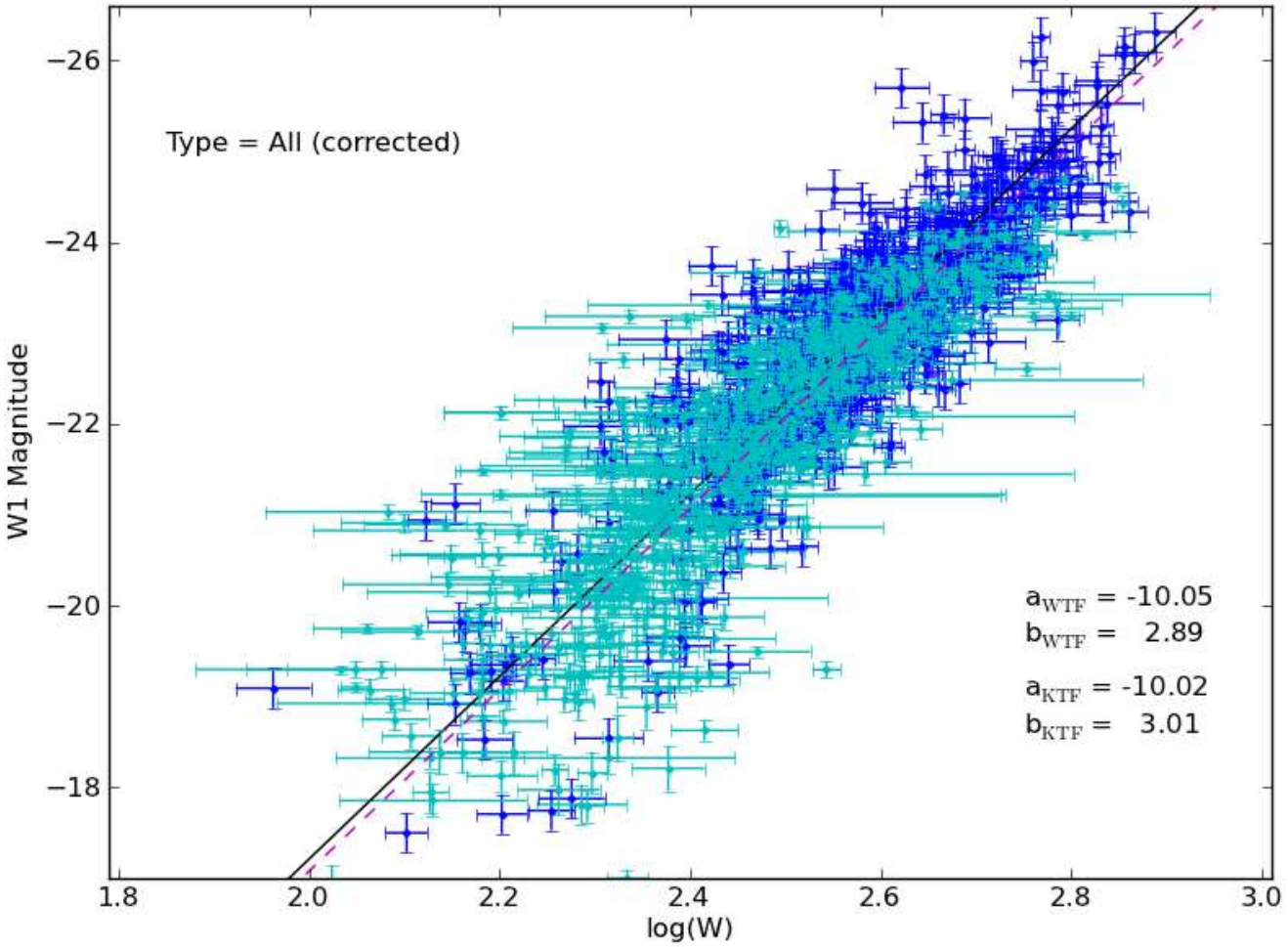
WISE 3.4 µm T-F template

- 2MTF widths with WISE W1 band mags
- Only archival widths
  - Cornell
  - HyperLEDA



Lagattuta et al., 2013

WISE 3.4 µm vs K-band



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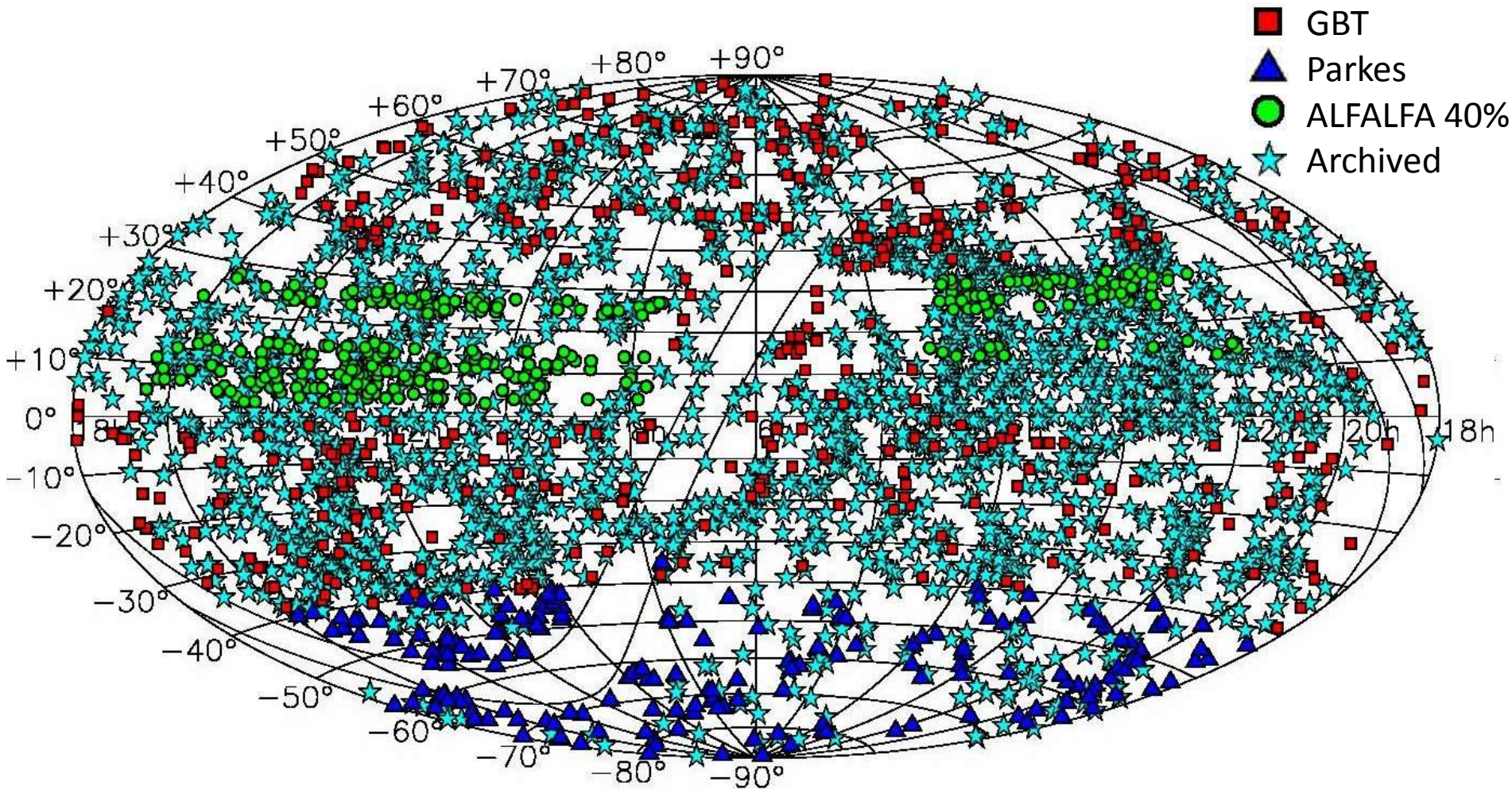

Targets Meet the Criteria

- ~ 6000 nearby spirals. 35% with available widths.