Calibration of the Mid-Infrared Tully-Fisher relation

The Tully-Fisher at 35 Workshop

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Cosmic Flows

Goal: Reconstruct density-velocity fields → need of $v_{peculiar\ radial}$

Why: New telescopes → improve **quality** (accuracy) - **quantity** (ZOA)

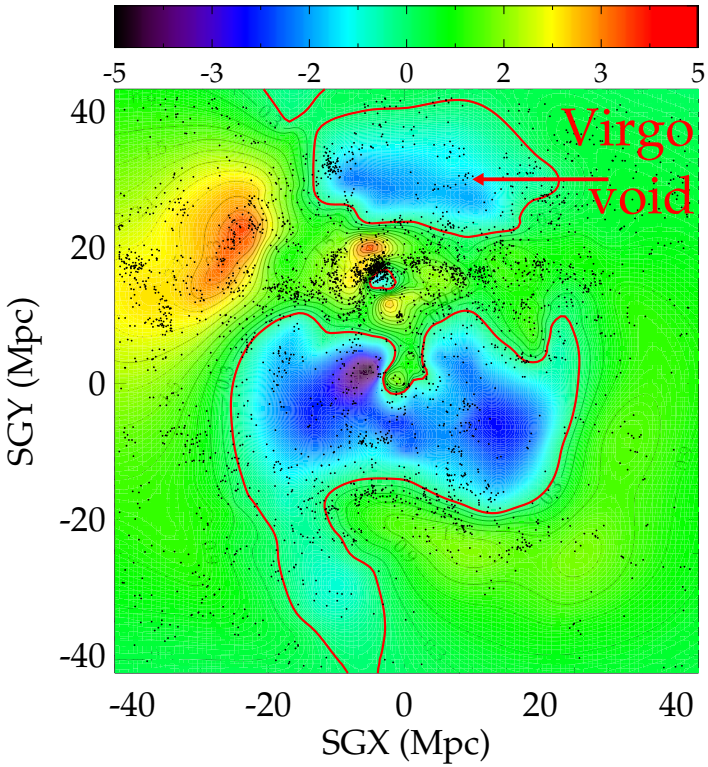


Figure: Courtois et al. 2012

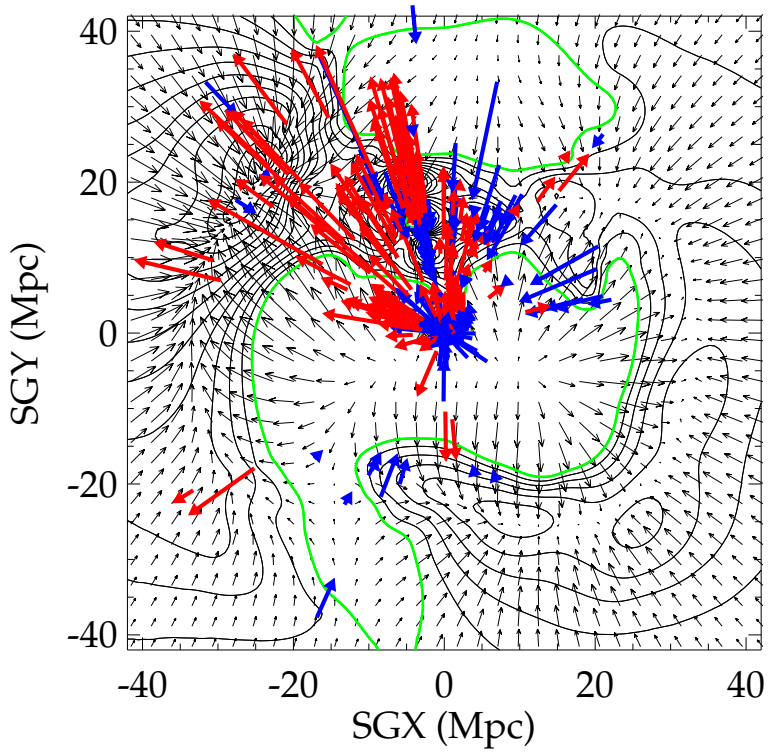


Figure: Courtois et al. 2012

1.a Spitzer Space Telescope

$$v_{CMB} = H_0 \times d + v_{peculiar\ radial} \quad (1)$$

$$m - M = 5 log_{10}(d(Mpc)) + 25 \quad (2)$$

1. m $\leftrightarrow$ Photometry
2. M $\leftrightarrow$ Tully-Fisher relation:

$$L \propto v_{HI}^{\alpha}$$

$\hookrightarrow$ **d** $\rightarrow$ $v_{peculiar\ radial}$
$\rightarrow$ Cosmic Flows

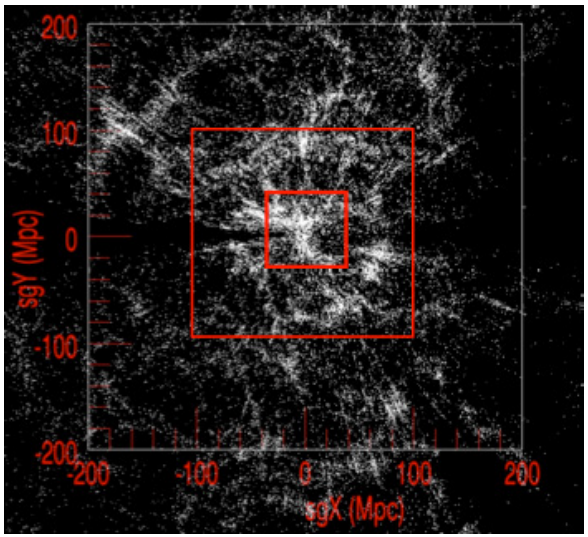


Figure: Courtesy of H. Courtois

1. homogeneous data set
2. space $\rightarrow$ no atmosphere
3. infrared $\rightarrow$ TF less scatter, reduced extinctions and ZOA

$\hookrightarrow$ Spitzer: **IRAC - L band 3.6** μm

1.b Archangel - Surface Photometry Software

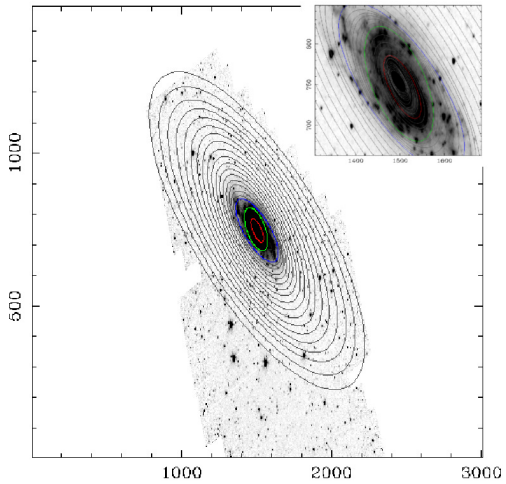


Figure: Isophotes

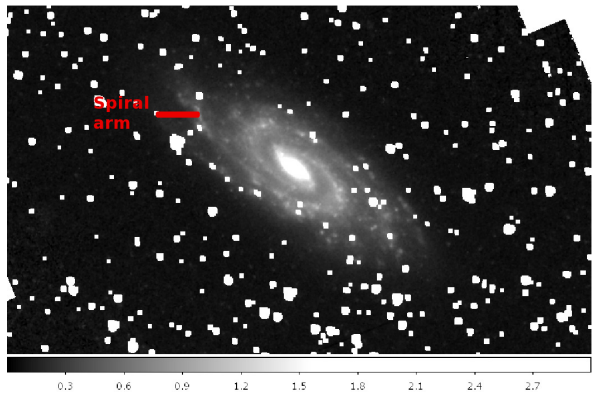


Figure: Masking

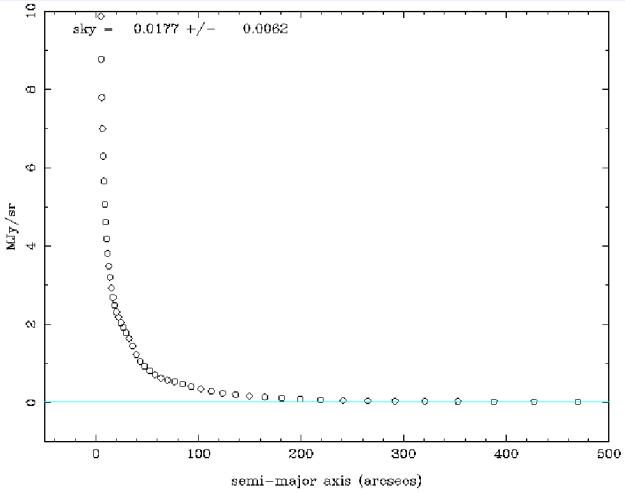


Figure: Sky

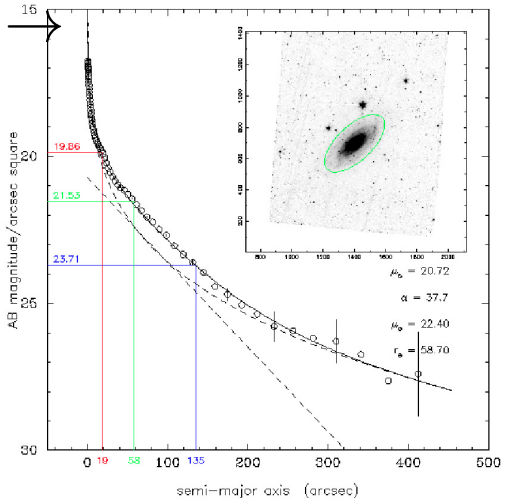


Figure: SB

Growthcurve

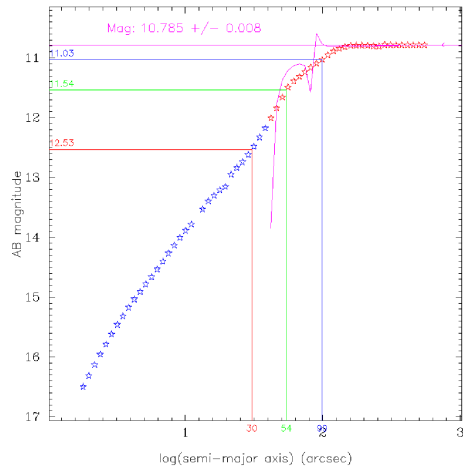


Figure: Asymp. mag.

1.c Corrections and Uncertainties

$$L_s^{b,k,i,a} = L_s - A^b - A^i - A^k + A^a \quad (3)$$

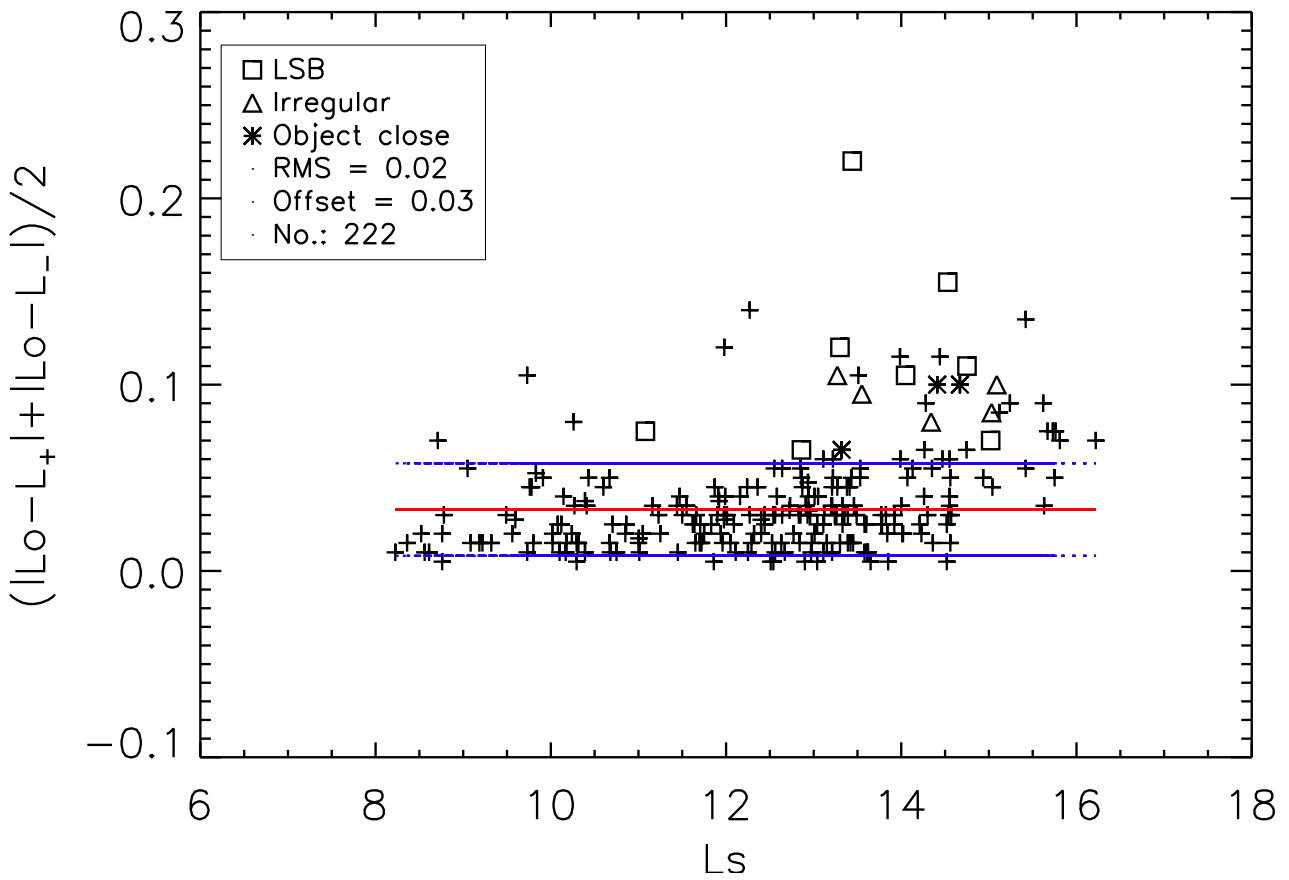
$\hookrightarrow$ **small** *corrections*

Uncertainties:

1. IRAC ch1. photometric calibration: $\pm$ 0.02
2. corrections: $\pm$ 0.02
3. sky: $\pm$ 0.03

Total Uncertainty:

0.04 - 0.05



2.a HI/Inclination

At EDD, *HI profile width at 50 % of the mean flux within the velocity range encompassing 90 % of the total HI flux.*

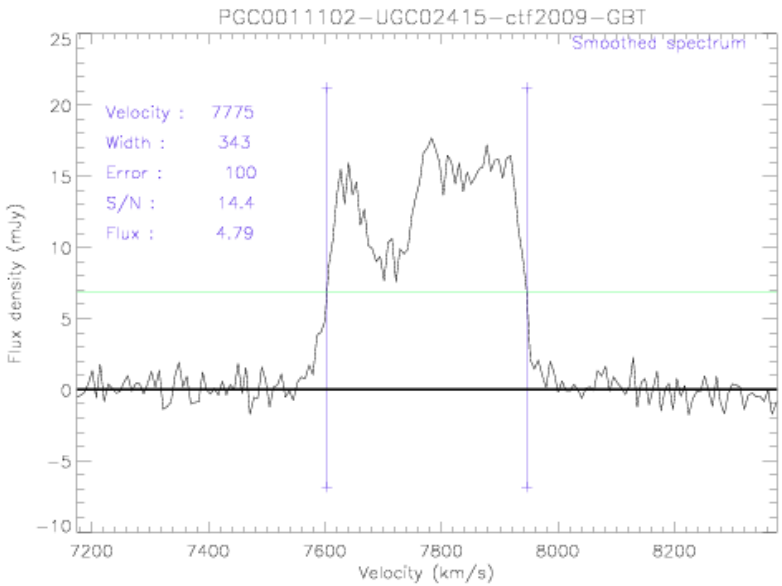


Figure: Calibrator in UMa. GBT observation. Courtesy of H. Courtois.

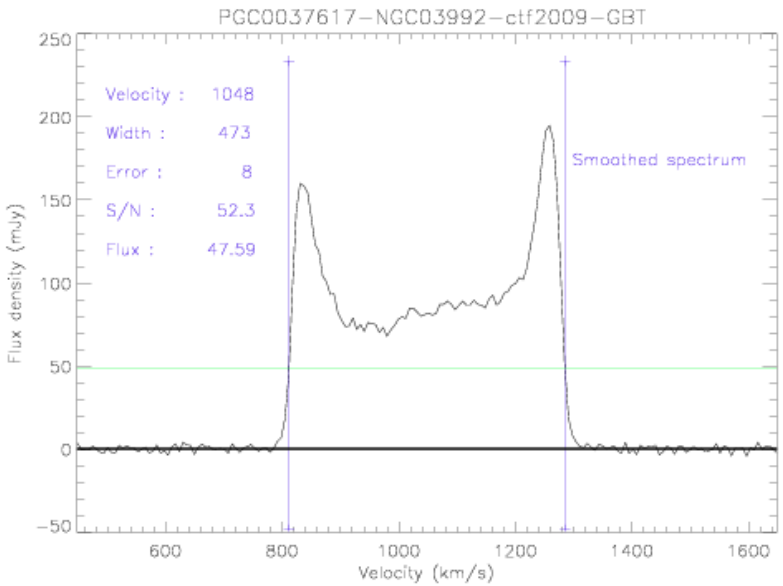
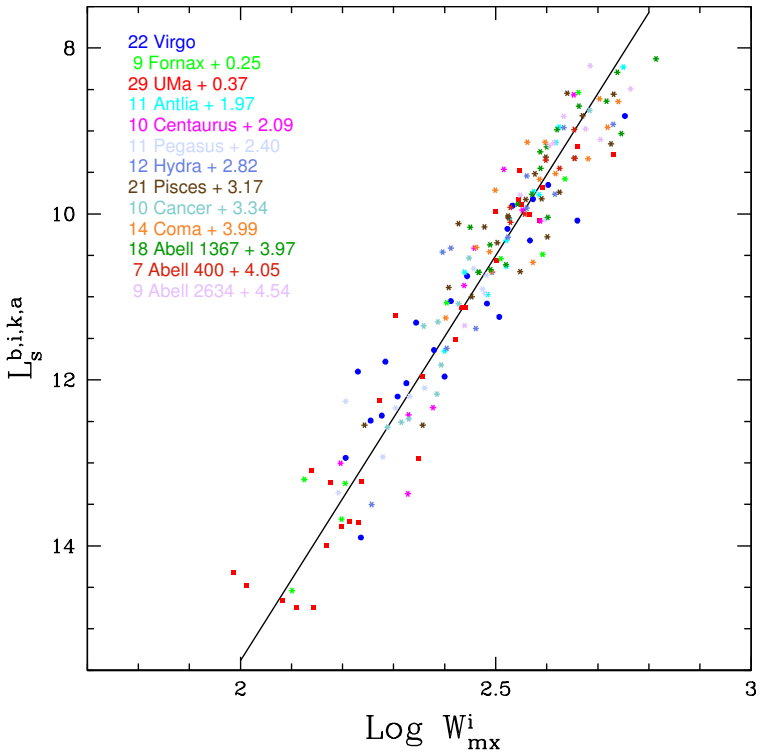


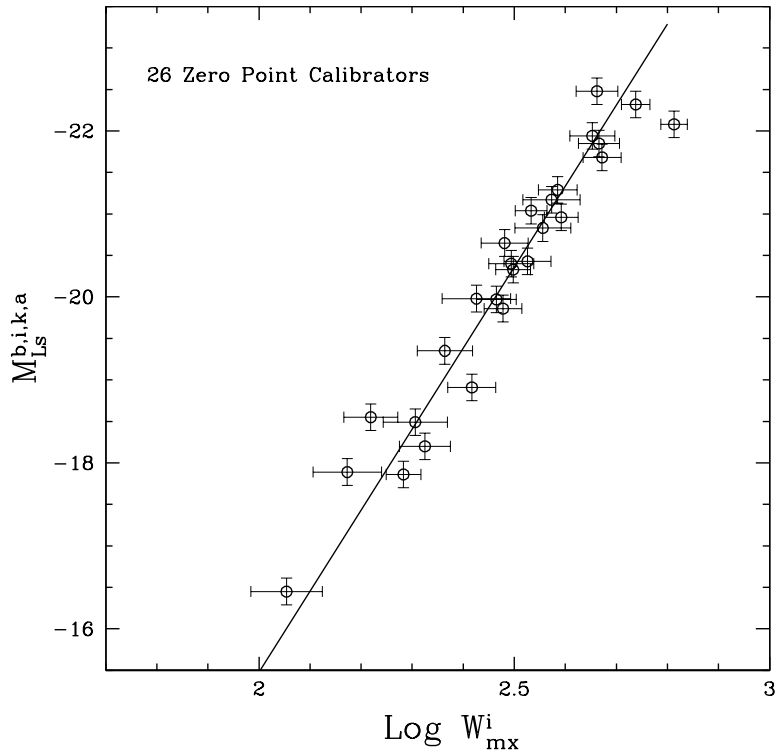
Figure: Calibrator in Abell 400. GBT observation. Courtesy of H. Courtois.

Recent I band calibration by Tully & Courtois 2012 → **same** material

2.b Slope and Zeropoint

Inverse TFR for each cluster → compatible with a **Universal** TFR, offset estimates

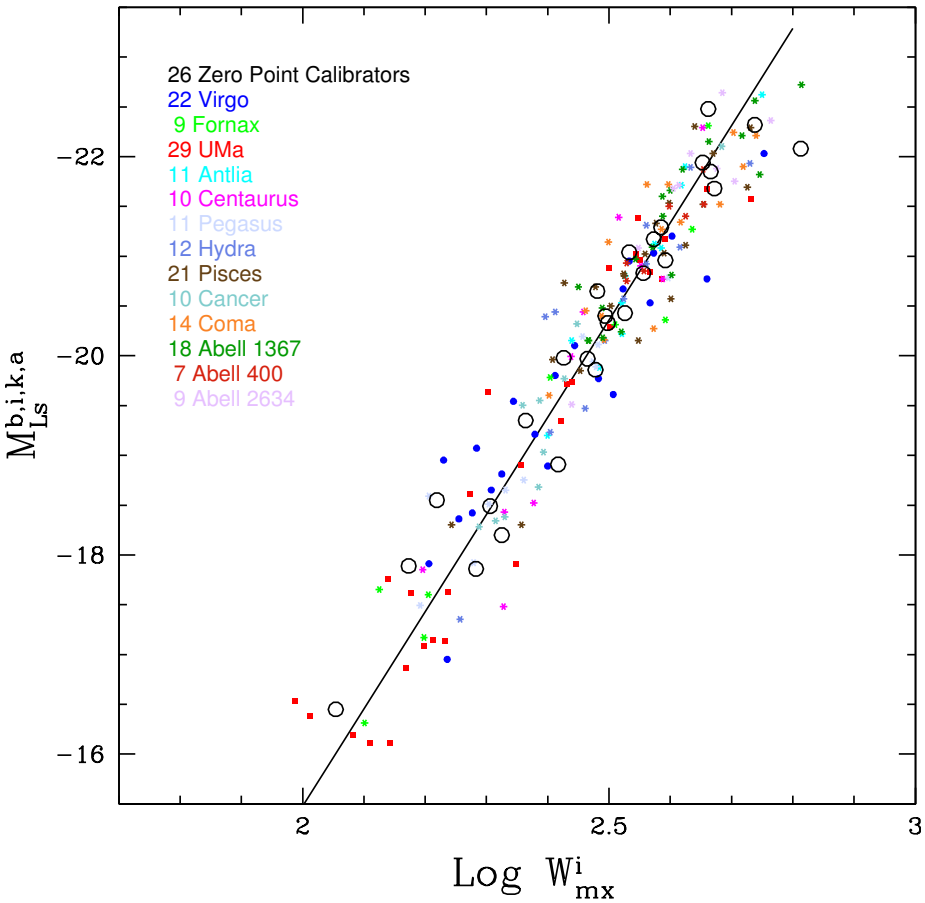




Template cluster, offset with respect to Virgo → slope

Fixed slope, Cepheid P-L and TRGB distances → zero point

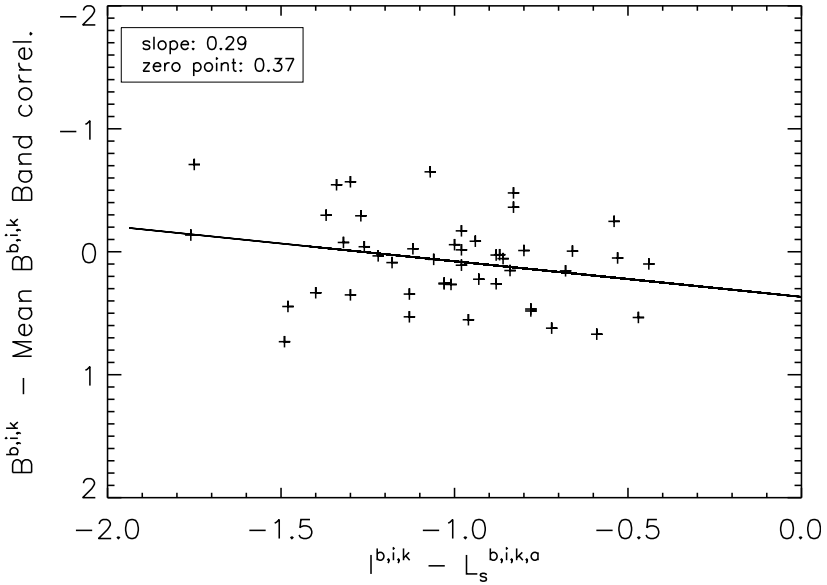
2.b Universal template TFR

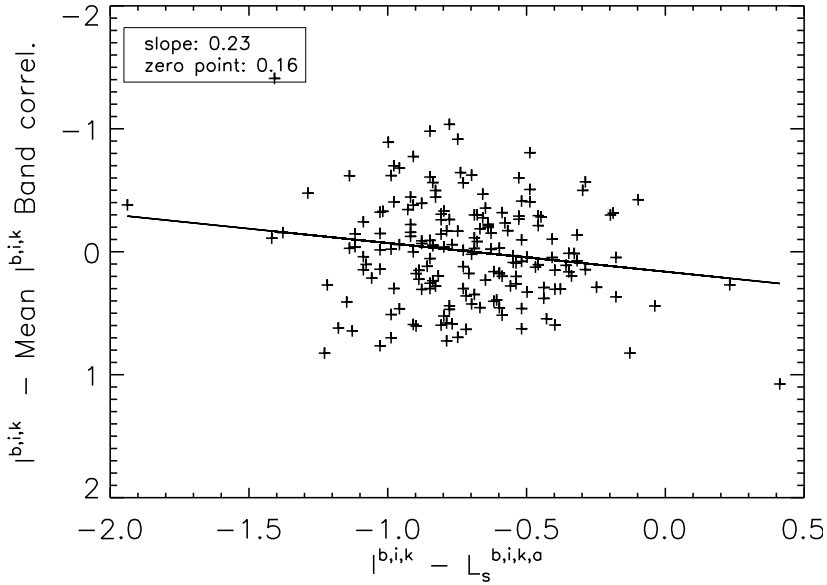


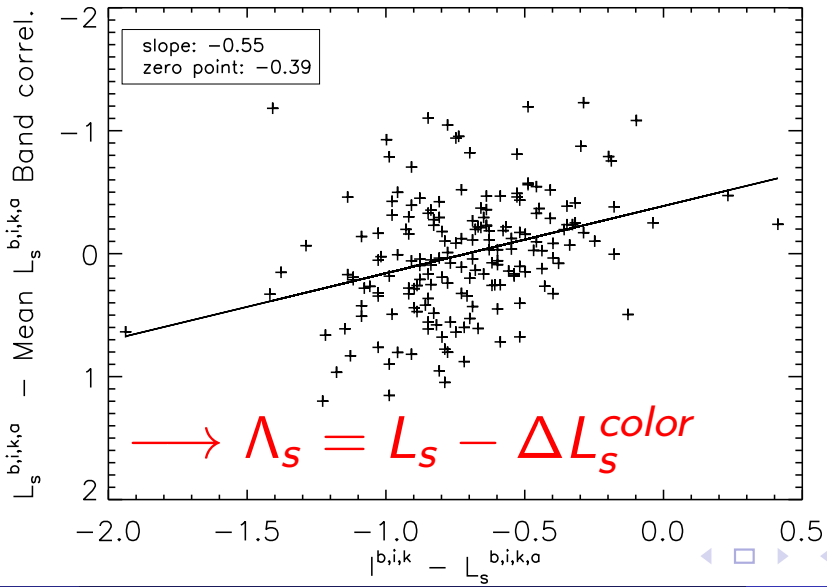
1. $-9.77 \times (logW^{i}_{mx} - 2.5) - 20.36$
2. steeper slope (B: -7.27, R: -7.65, I: -8.81)
3. scatter: *0.49* **High !!!**

↪ vertical offsets... not the **only** explanation

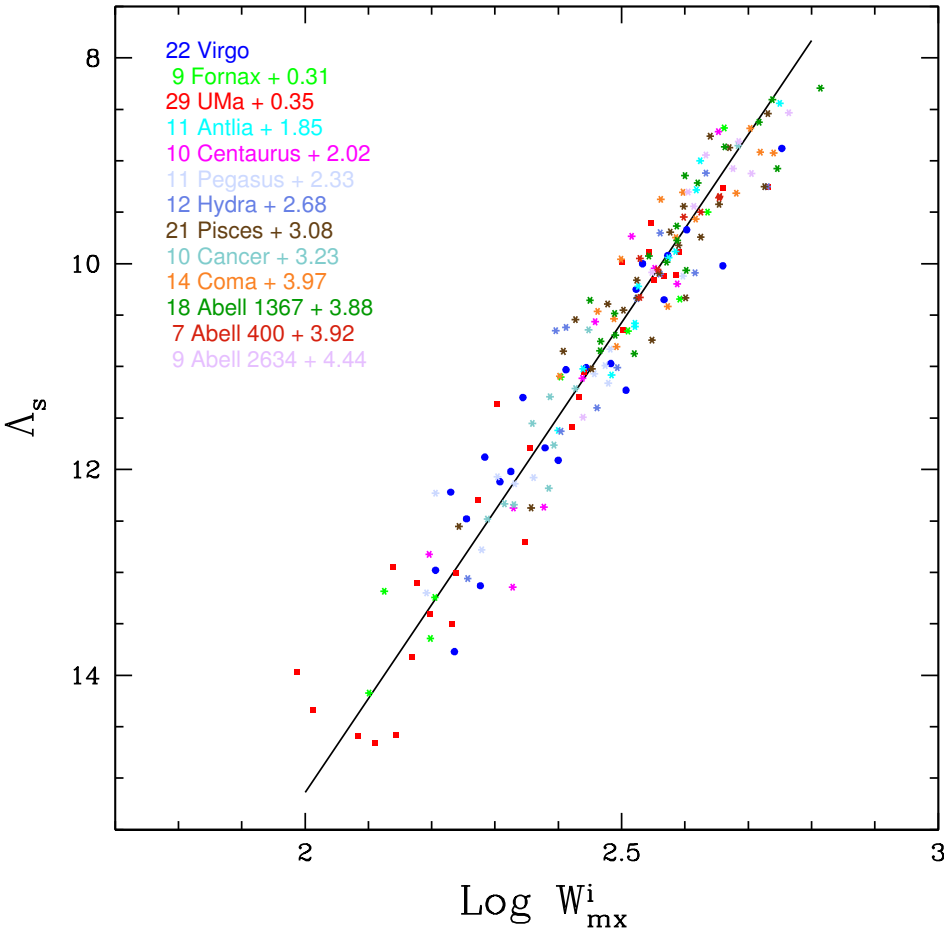
3.a.a A Color Term

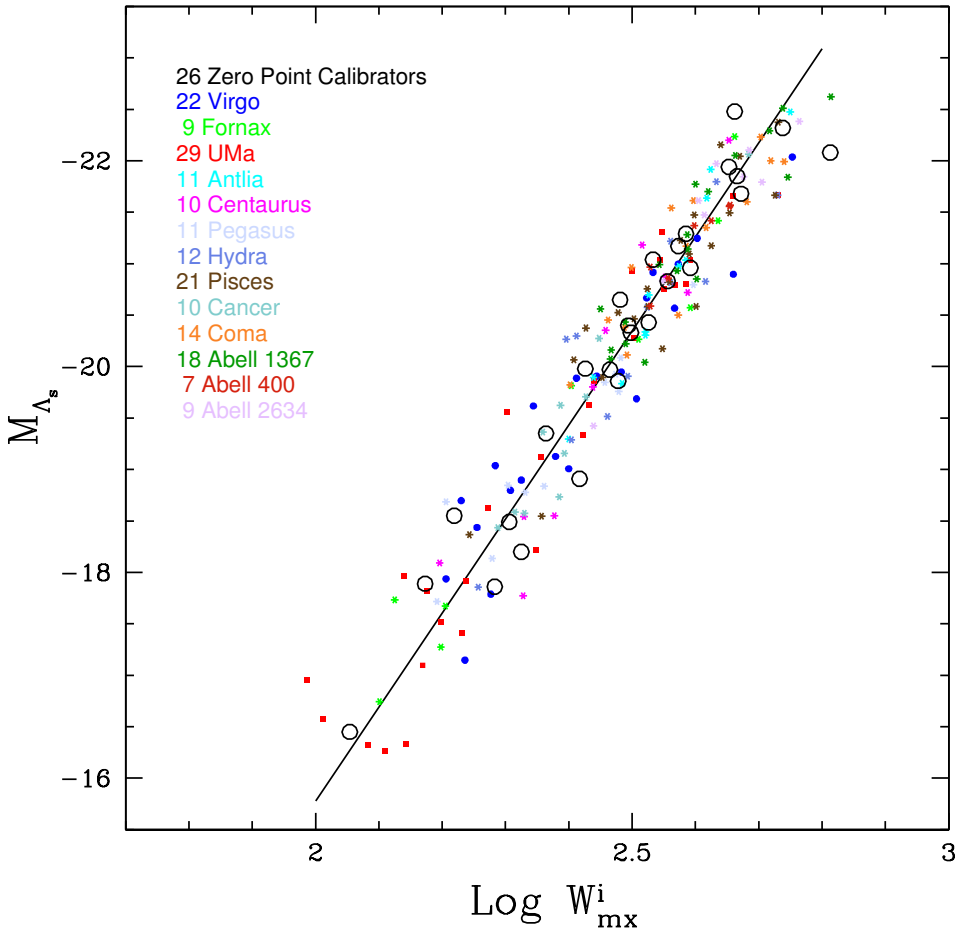






3.a.b A Second Calibration



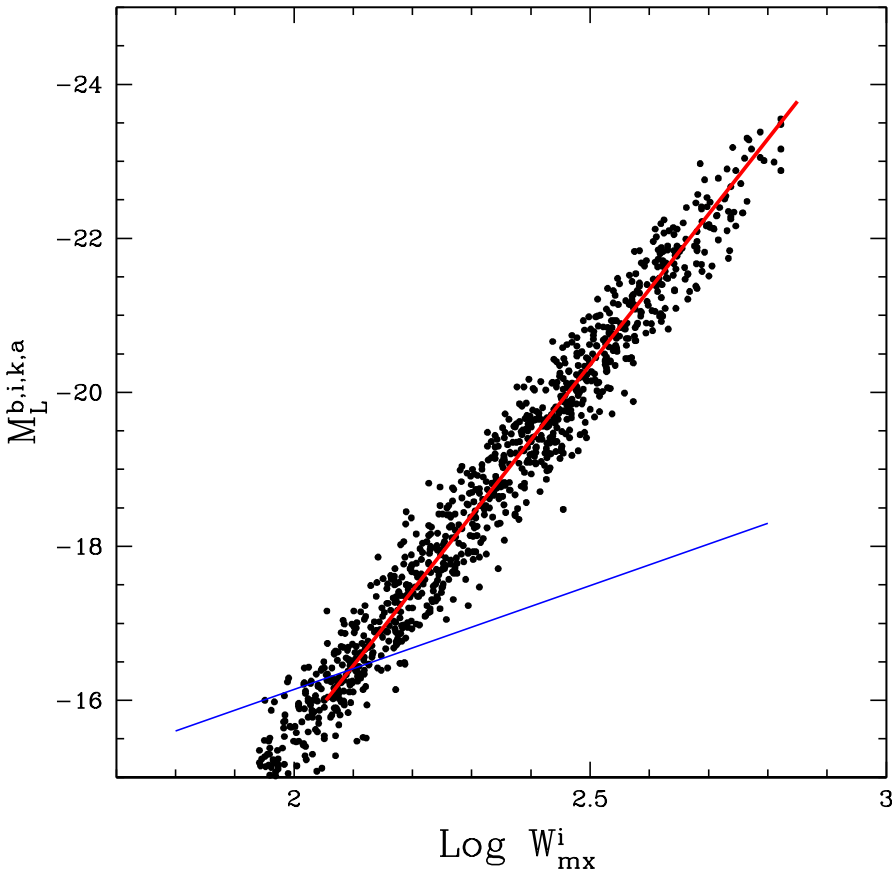


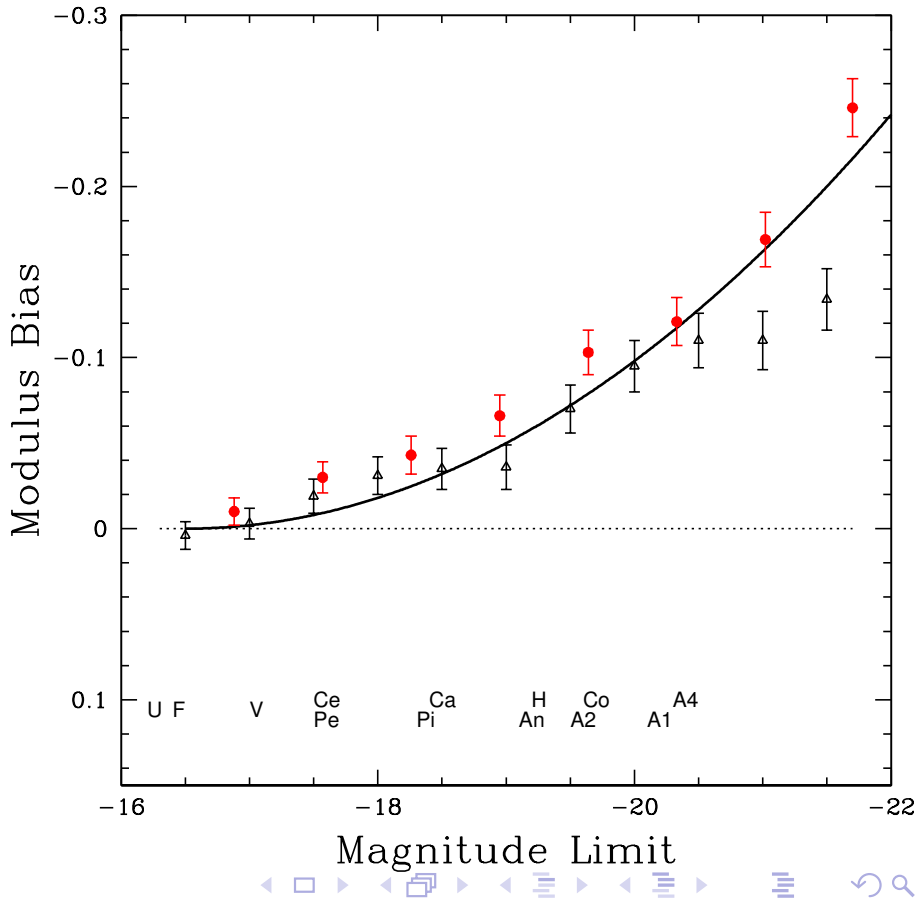
$$-9.13 \times (logW^i_{mx} - 2.5) - 20.35$$

Scatter : 0.42 !!!

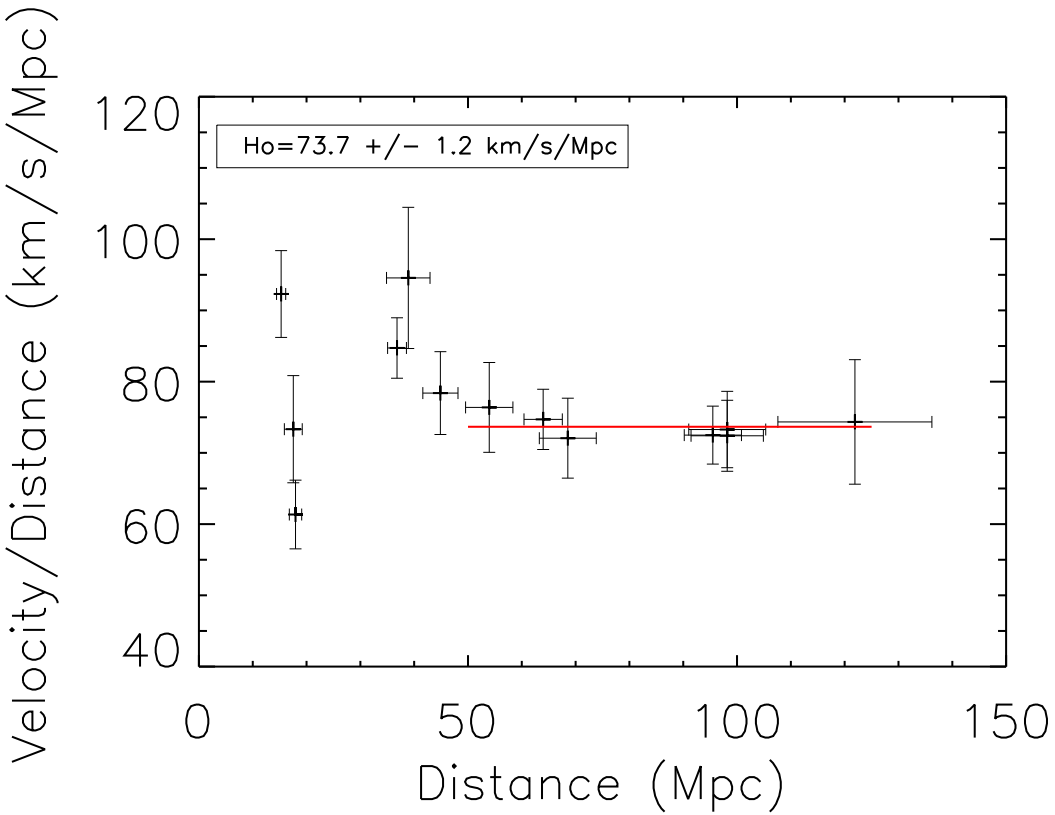
3.b Bias

1. **Inverse** fits → bias ∼ **null**
2. But Schechter luminosity function and B selection
3. Simulations → **tiny** corrections to distance moduli





Conclusion



1. Numerous **advantages** of the Space Infrared
2. TFR: A **color** term, *scatter* down to 0.42 from a previous 0.49
3. Construction of a catalog of distances via the TFR, etc

Aknowledgments

Thank you

References

1. H.M. Courtois et al., *The Astrophysical Journal*, 744, 2012.
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