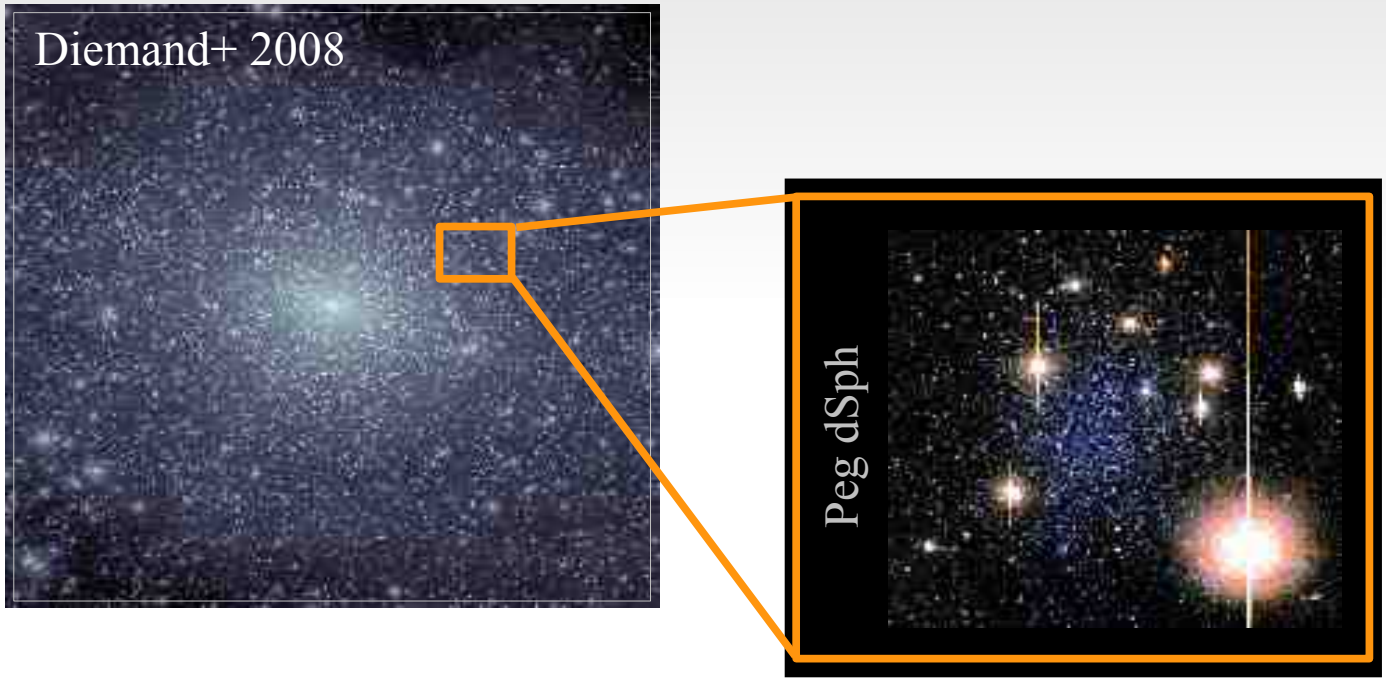
A Homogeneous Photometric Characterization of Sixteen M31 dSphs

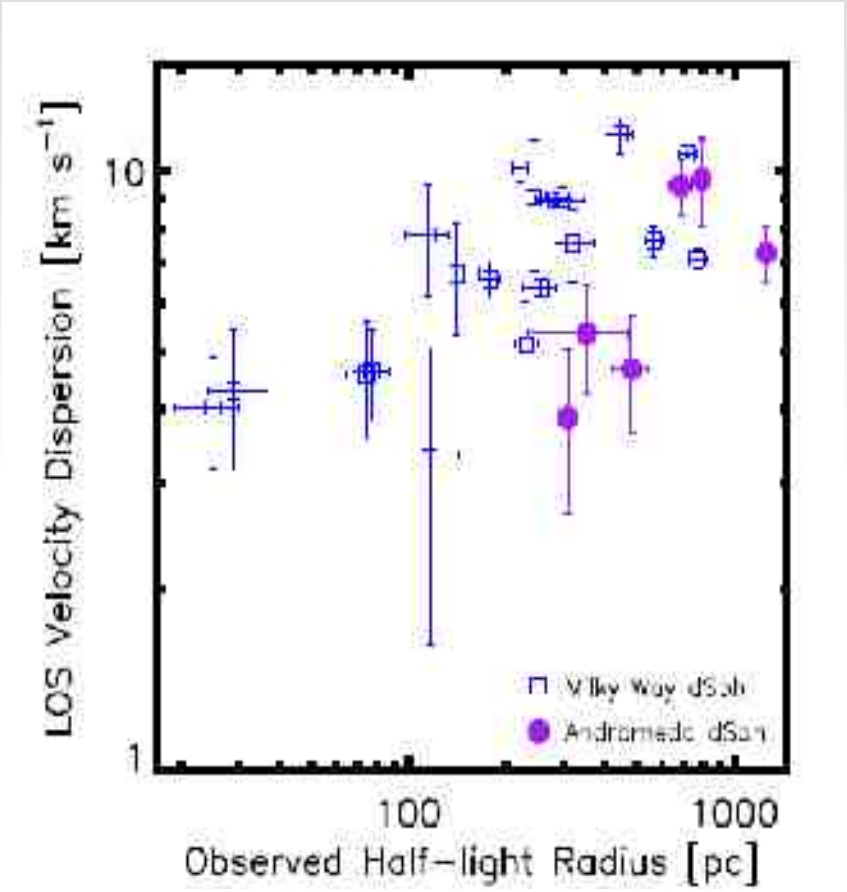
Science with RGB stars and NOAO data.

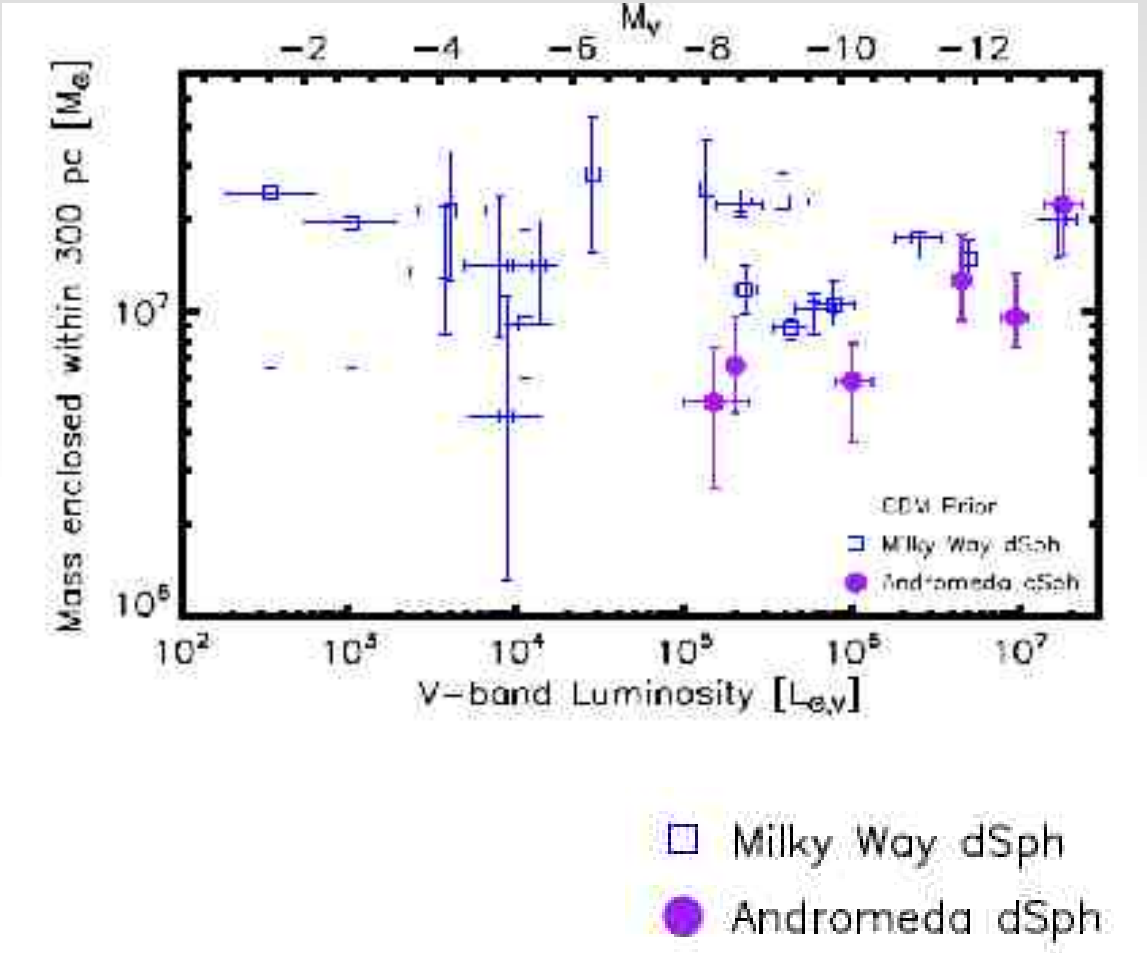


Rachael L. Beaton, Steven R. Majewski, Richard J. Patterson, James C. Osthemier
at the University of Virginia
and the **S**pectroscopic & **P**hotometric **L**andscape of the **A**ndromeda **S**tellar **H**alo collaboration

19 June 2012, Great Andromeda Workshop

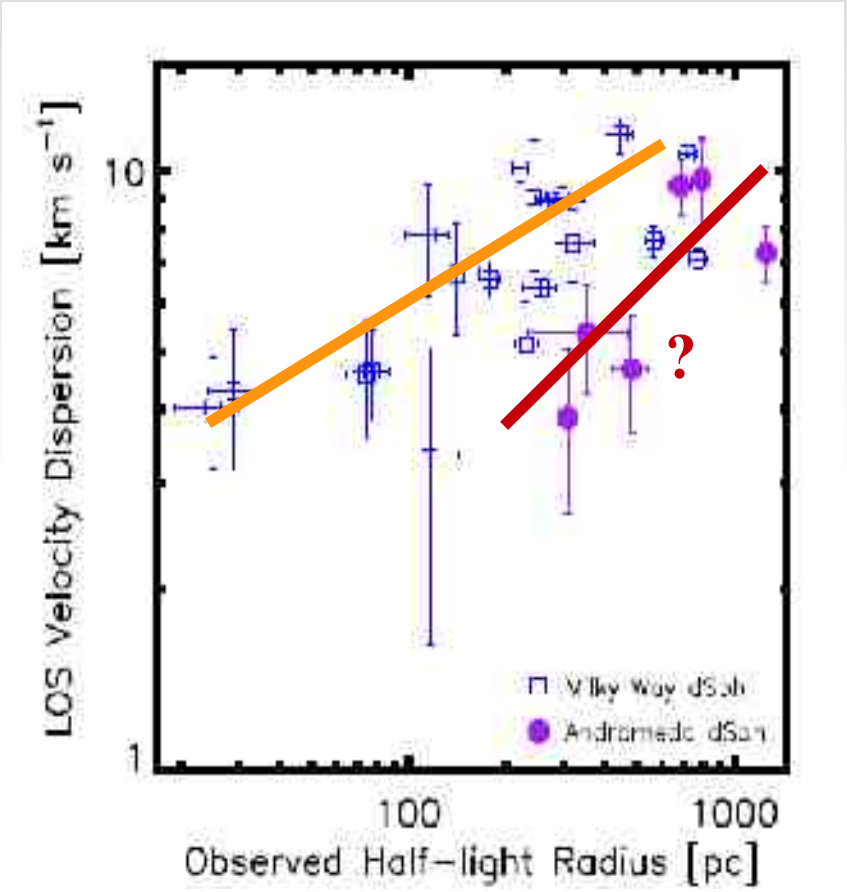
What do Observations tell us?

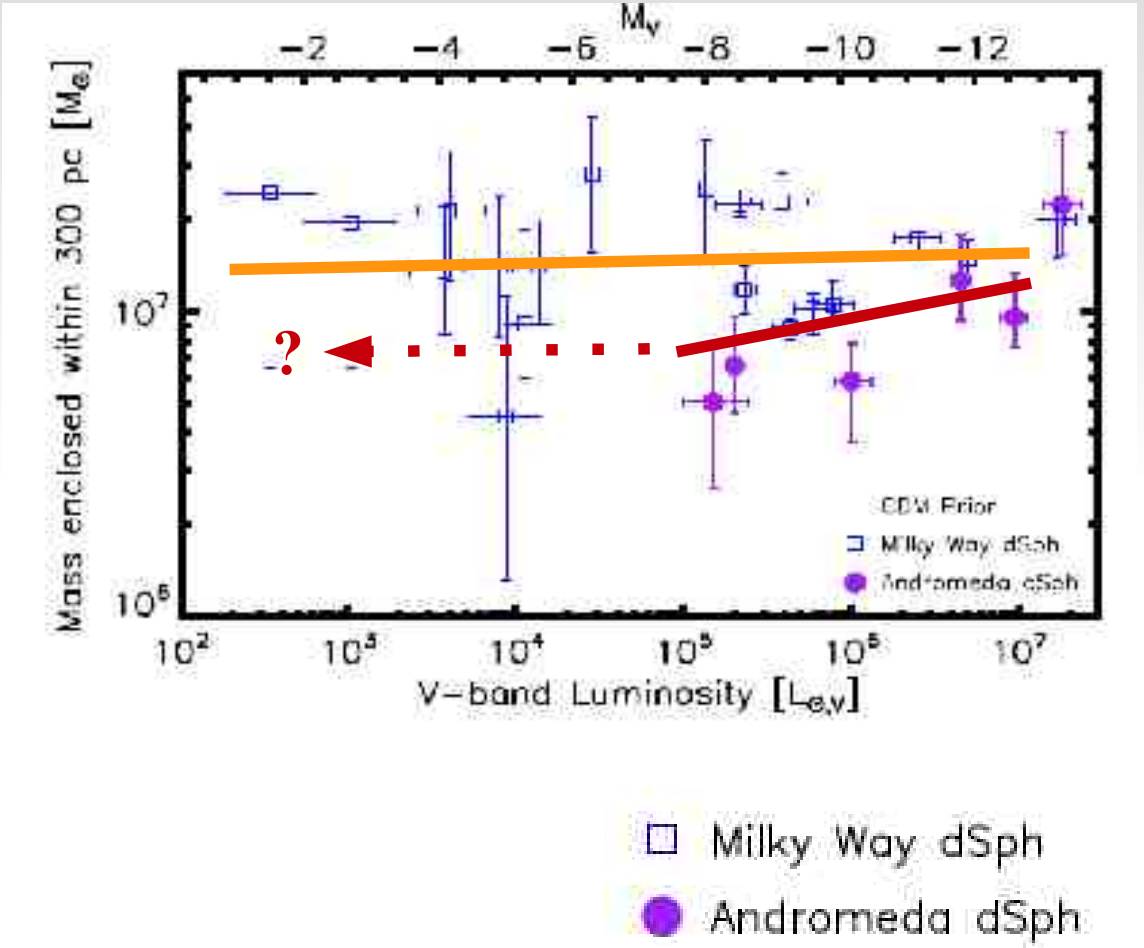




The MW galaxies seem to have a “common mass threshold” at ~10^7 M_solar (Strigari et al. 2008).
This implies a “stochasicity” to galaxy formation at these mass scales.
But this plot is really only “one data point” in our understanding of dSph systems within a larger halo.

Trends? Or Poor Statistics?



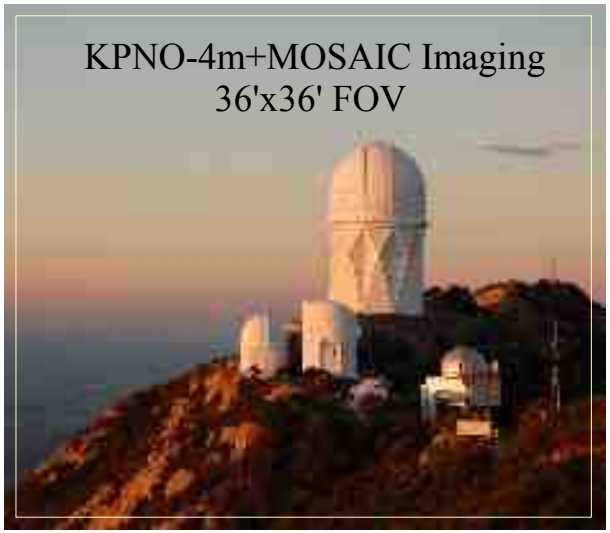


Based on a small number of M31 dSphs, we see some *hints* of differences between the two populations.
Is this small number statistics? Or something real?
If its real, then this indicates a potential key difference in the formation of the MW and M31.

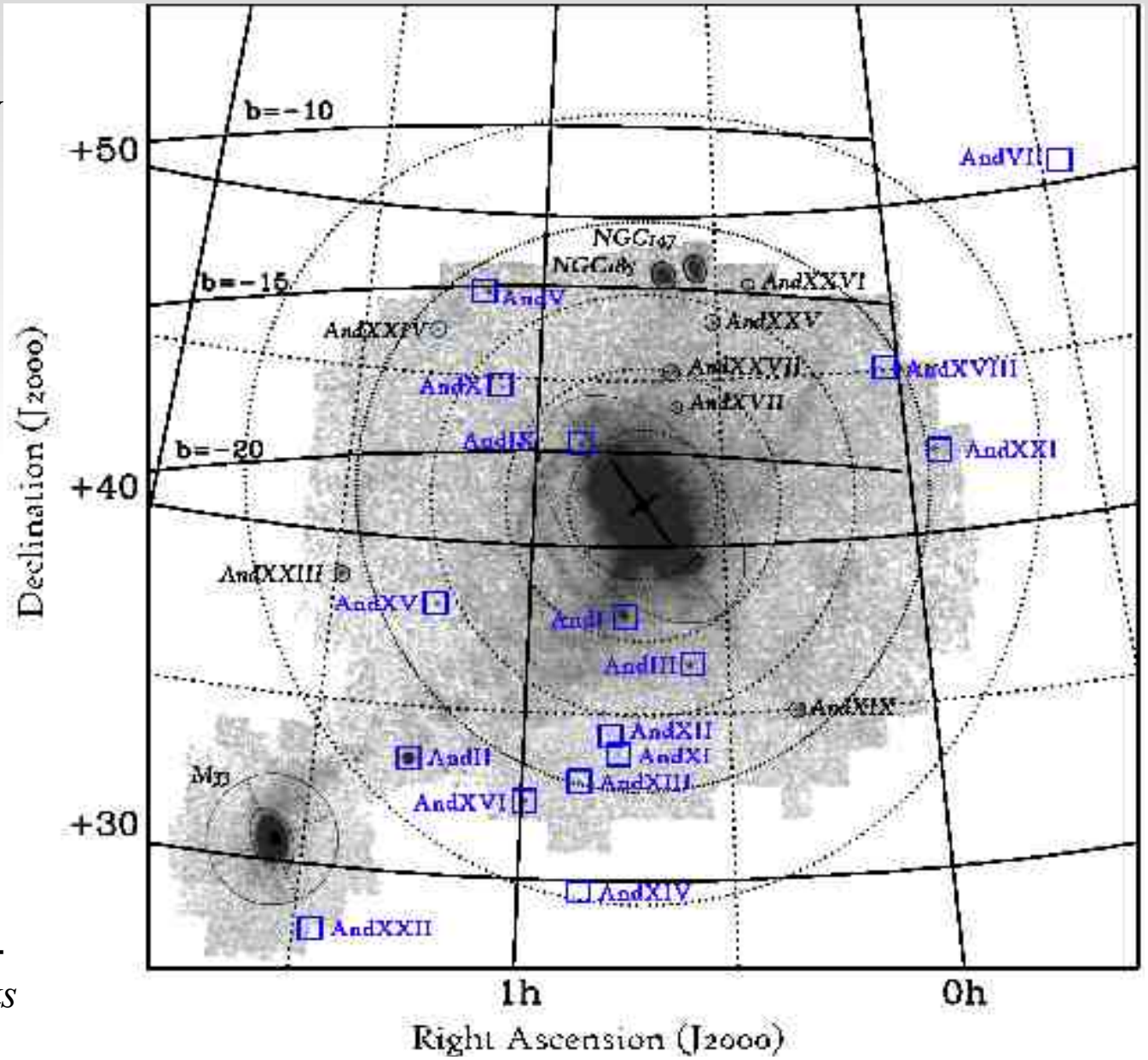
SPLASH: KPNO-4m+MOSIAC

Goal: Study M31 Substructure on par with MW Substrcuture

Two Phase Approach -
Photometry: This work.
Spectroscopy: Tollerud et al. 2012

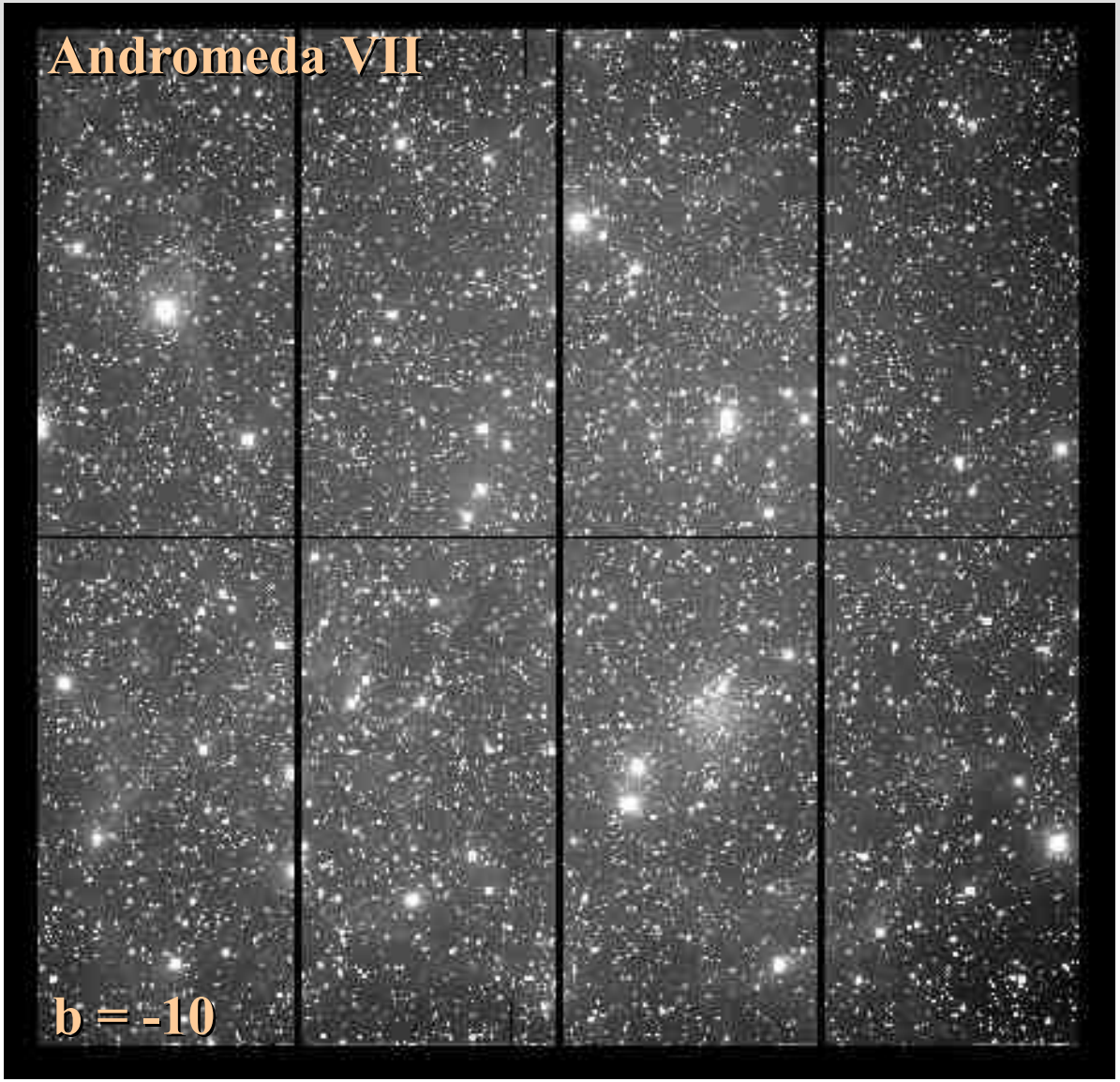


For the SPLASH Halo Survey -
See Guthathakurta & Gilbert talks later today.



PAndAS Survey Map adaptedfrom Richardson et al. 2011

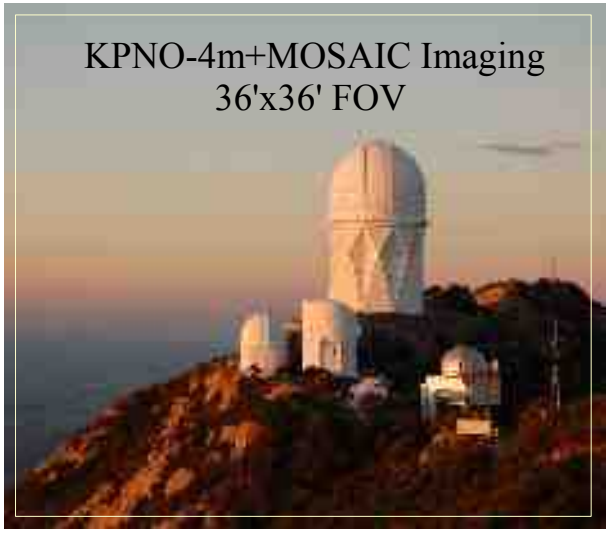
Observational Reality



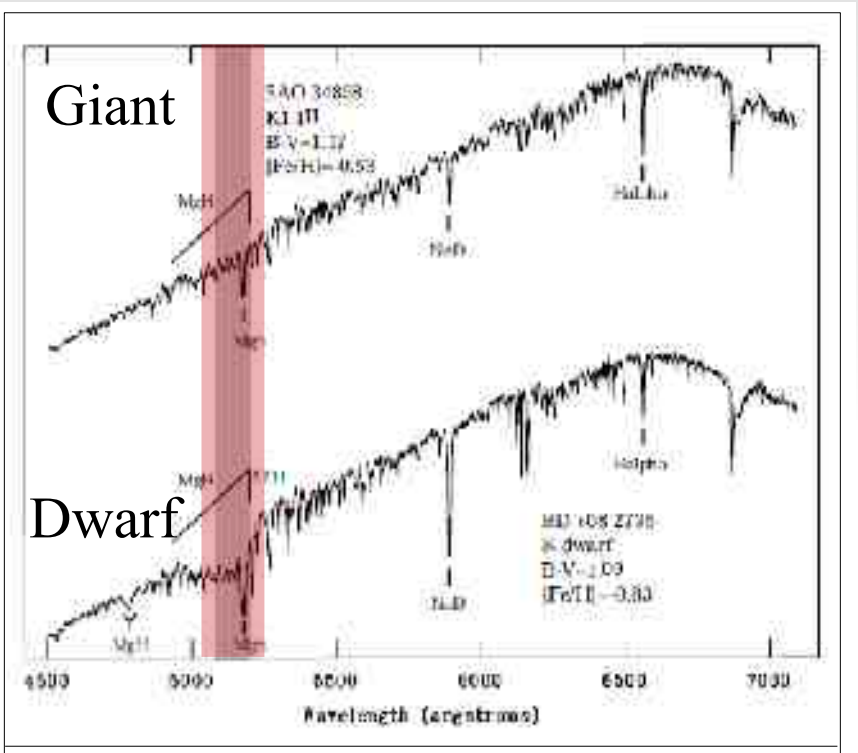
Example image from KPNO-4m+MOSAIC Suvery of Andromeda VII.

Working with dSphs at M31 distance is akin to working with Ultra-Faint dSphs in the MW.

MW dwarfs dominate the star counts.

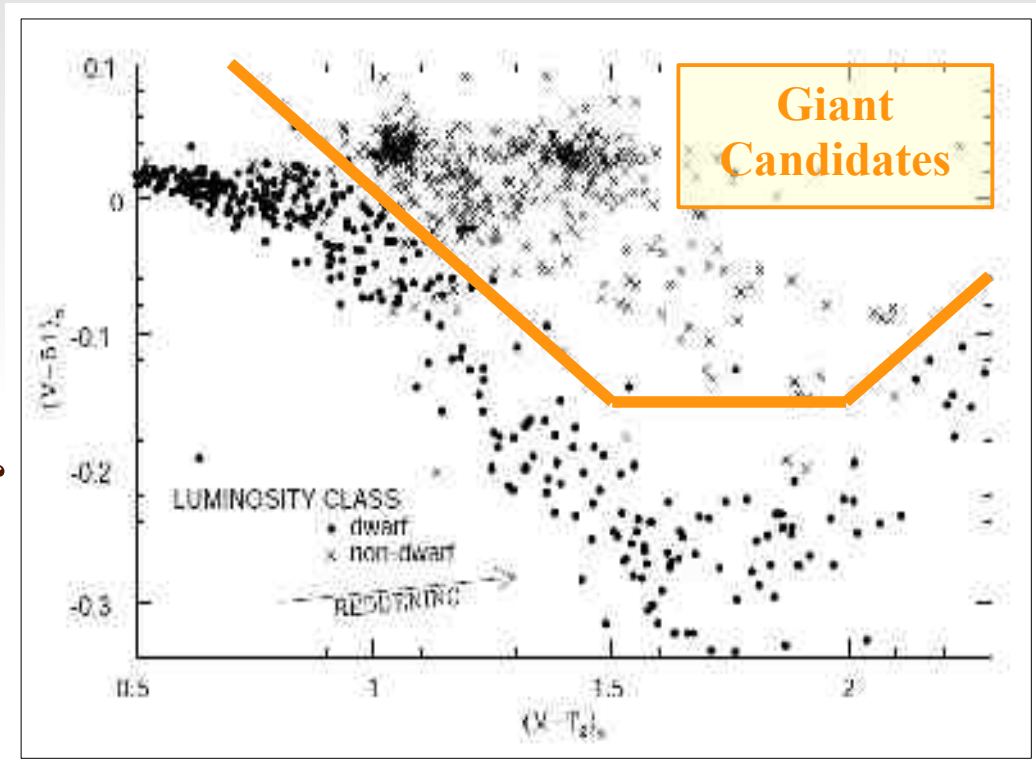


Washington+D51 Method



The DDO51 filter is centered on the MgH feature at 505.1 nm. This feature is sensitive to the surface gravity of the star.

Color-Color Diagram

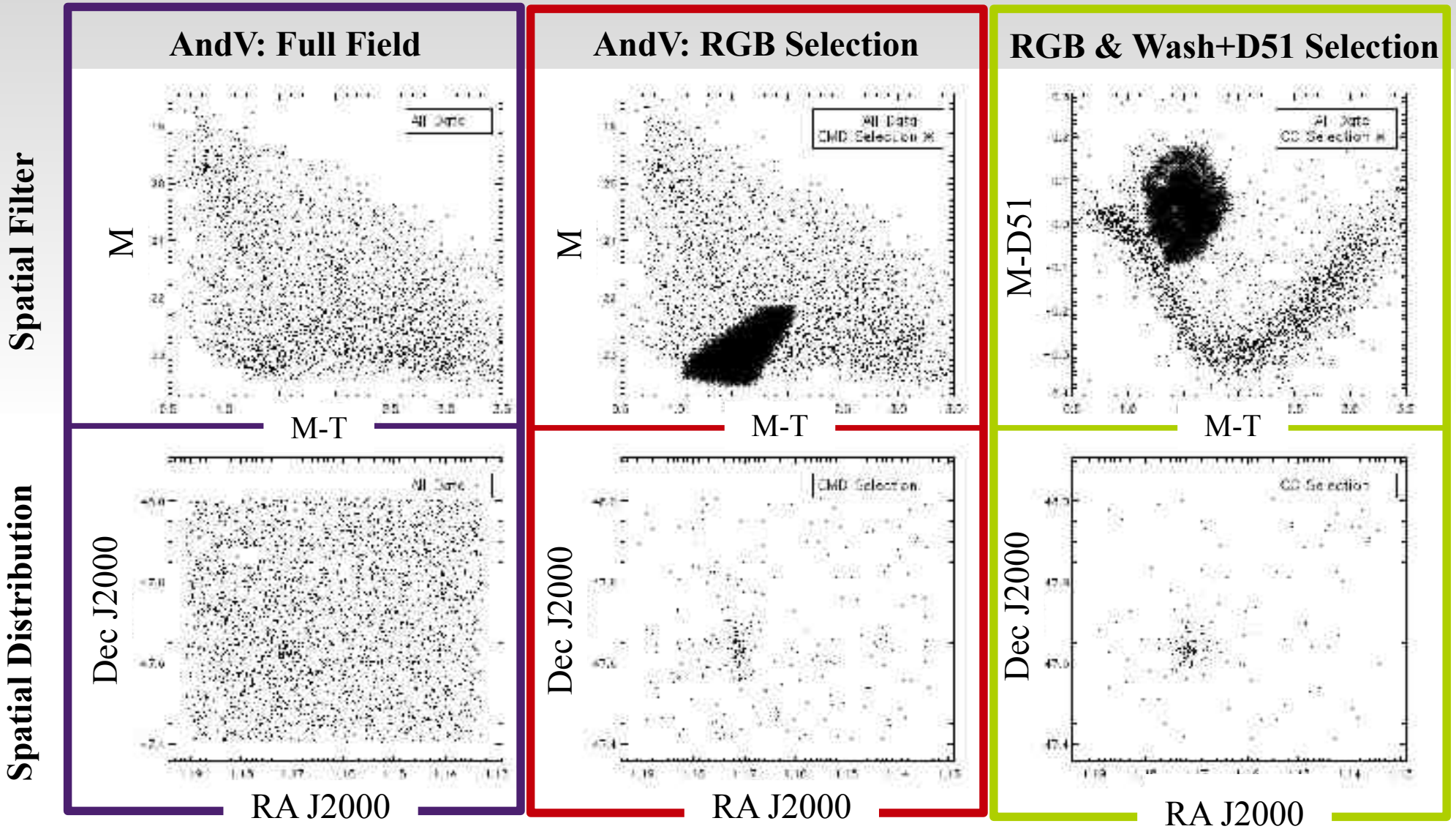


For fixed temp. Surface Gravity

Temperature

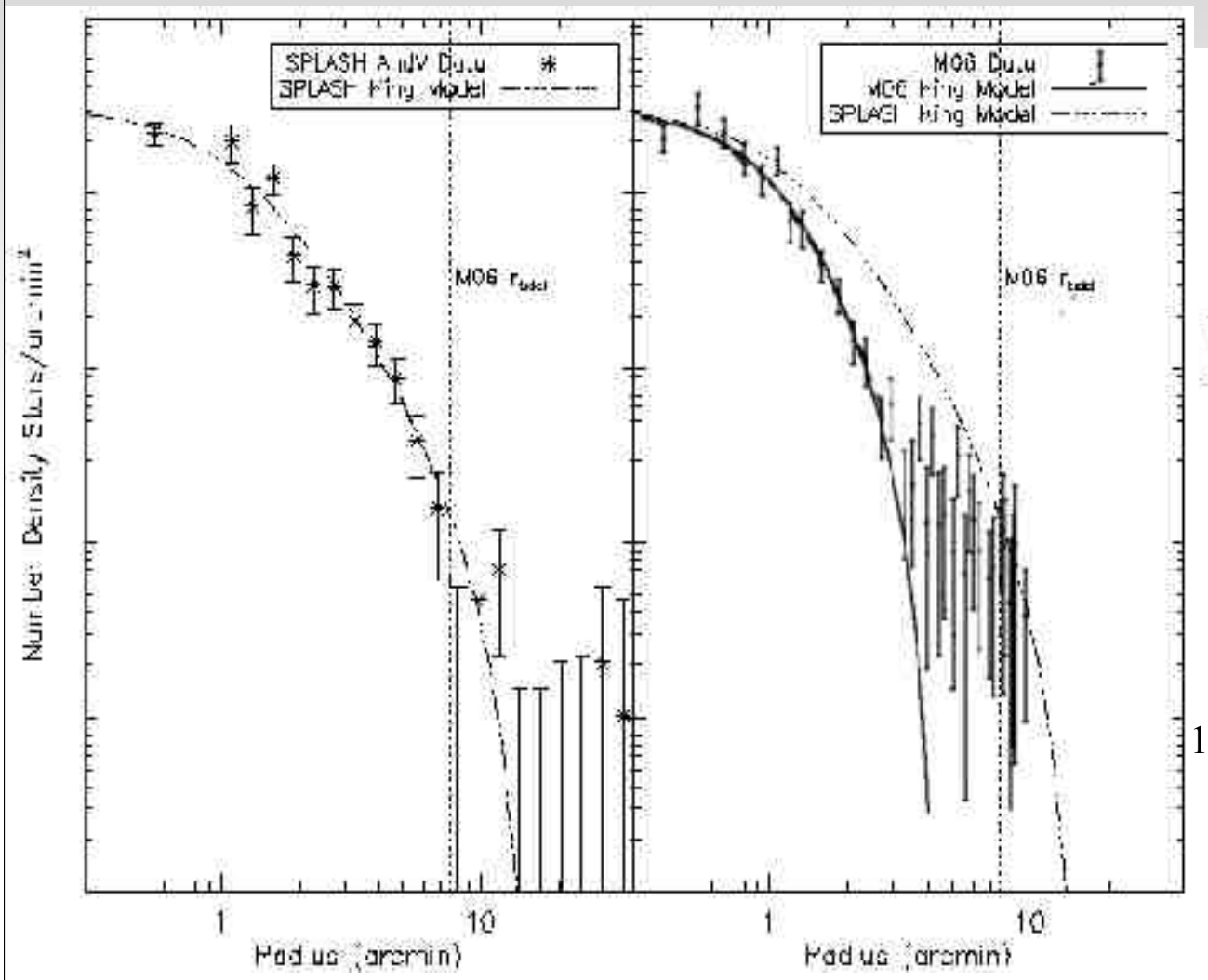
For more details on method see: Majewski et al. 2000
Currently verifying with log(g) derived from R~22,000 spectra from APOGEE.

(Simple) Method Visualization

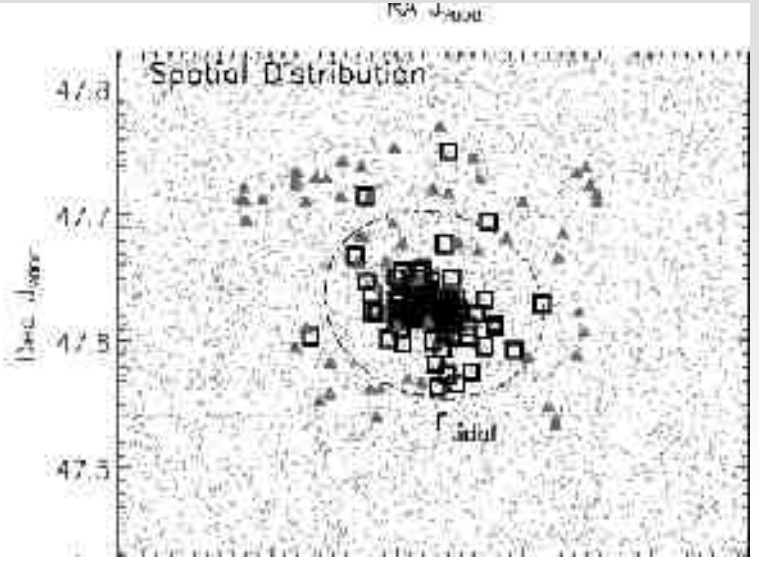


Wash+D51 photometry techniques provide significant leverage dSph by
(1) improving spectroscopic efficiency and (2) improving the background for profile fitting.

dSphs Structure



Comparison radial profile from McConnachie et al. 2006

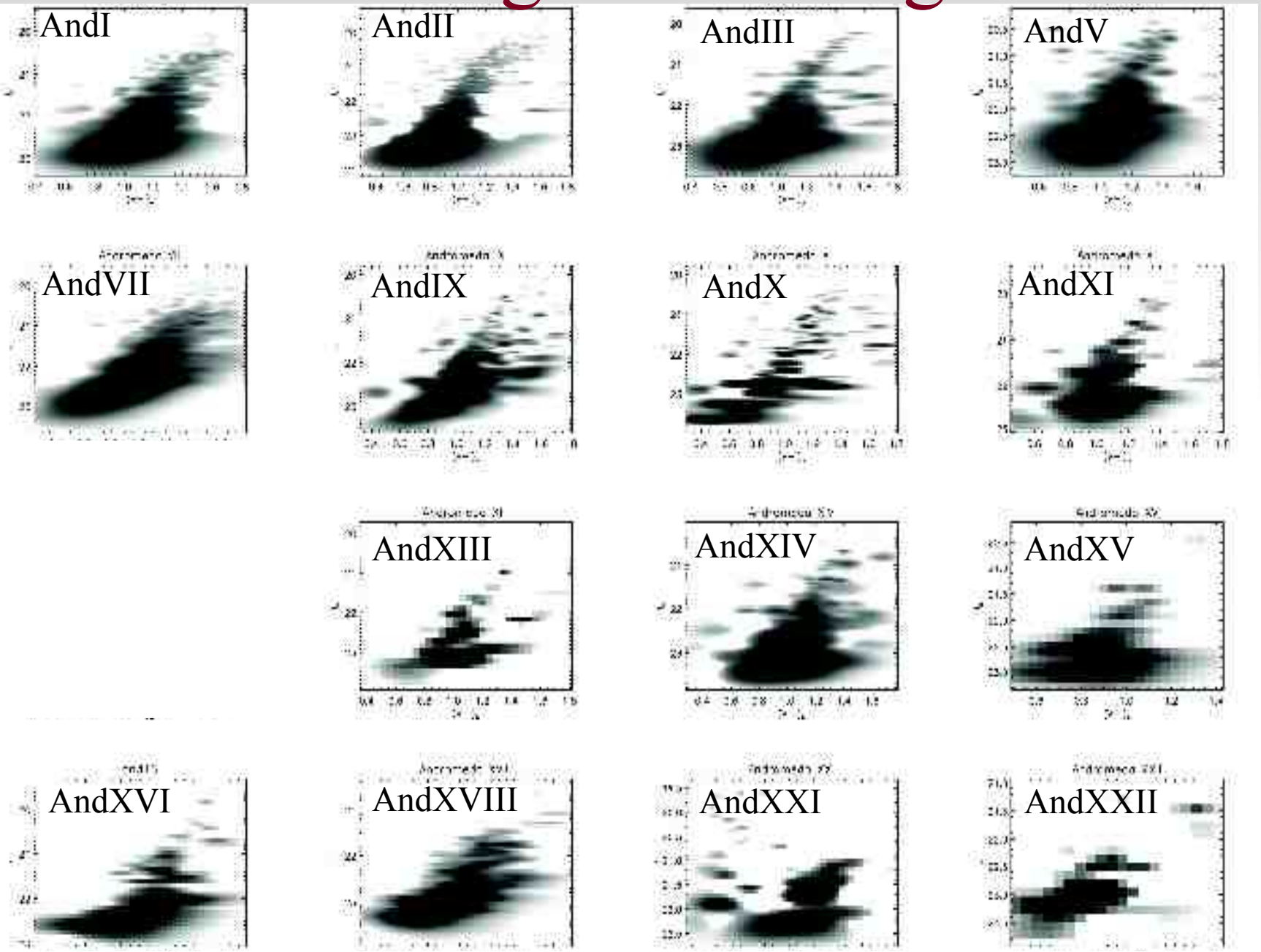


Keck+DEIMOS Results

1 hour of observation: precision velocities to ~few km/s to I=21.5 mag
See Tollerud et al. 2012 for Spectroscopy

Wash+D51 photometry techniques reduces the background surface density and greatly improves the potential for profile fitting.

Color Magnitude Diagrams



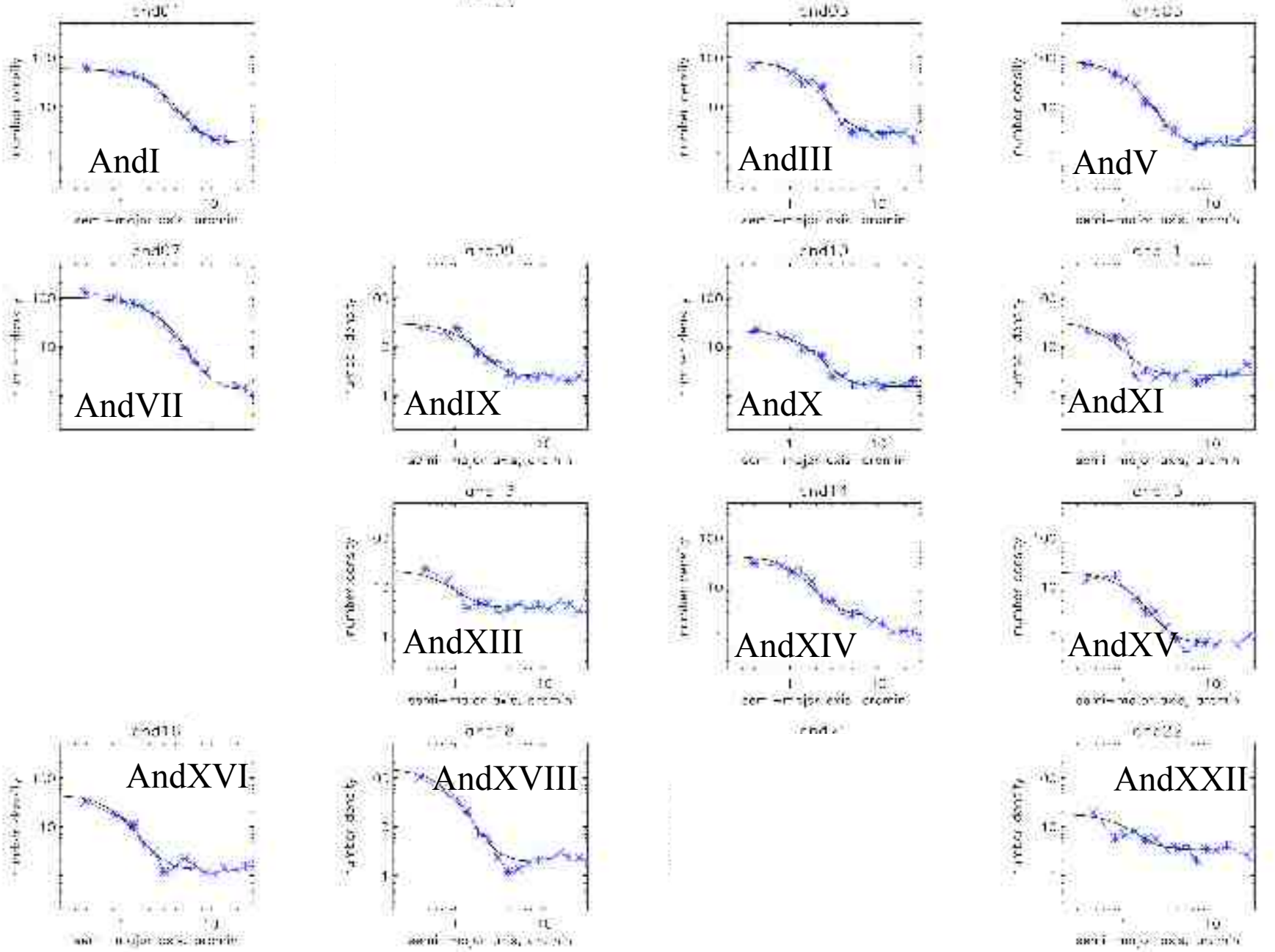
Structure Fitting

- General Method: Power Law + Core with variable index

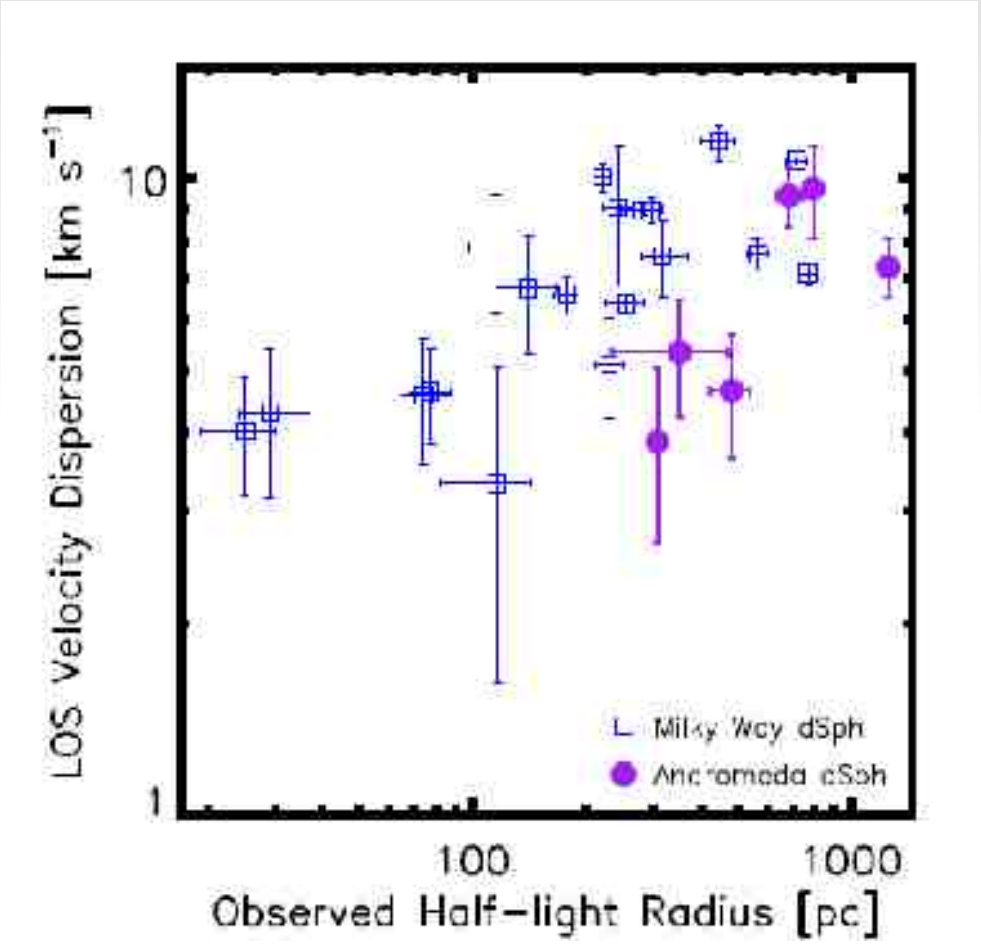
$$\Sigma_{\rm PLC}(Q) = M\left(\frac{(\nu \quad 1)}{\pi a^2(1 \quad c)[1 \mid Q^{2}\nu} + \Sigma_b\right) \qquad (5)$$

- For comparison to MW in this work, we assume $\nu = 2$ or a Plummer Profile.
- Fit structures with numerical methods similar to those of Martin et al. 2008, Sand et al. 2009 and Munoz et al. 2012
  - Bayesian + Maximum Likelihood varying in 7 parameters
  - Explore parameter space using bootstrapping and Markov Chains

Plummer Profile Fits



Comparing the M31 dSph to the MW:



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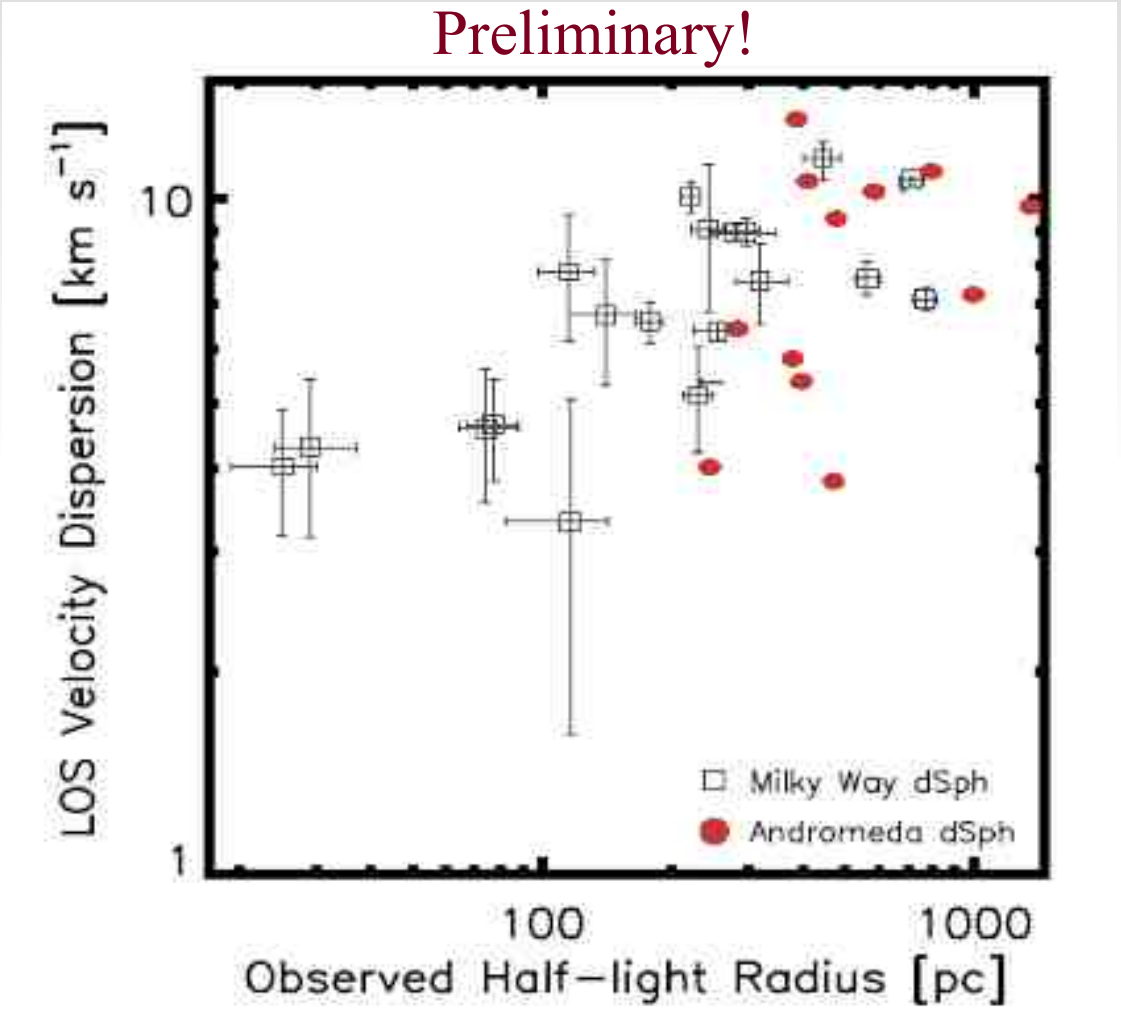

Doubled the number of galaxies with well measured sizes and dispersions.
Though, we have yet to probe the smallest galaxies in the M31 system.

Summary:

- The M31 system serves as a nearby laboratory for exploring the smallest galaxies.
- Washington+DD051 photometry is *observationally expensive*, but provides key leverage for exploring the M31 dSphs at a level comparable to the Milky Way.
- With this dataset detailed direct comparisons to the Milky Way are possible – but the intrinsically smallest galaxies remain hidden.