Virus Parallel Mode -- Stars

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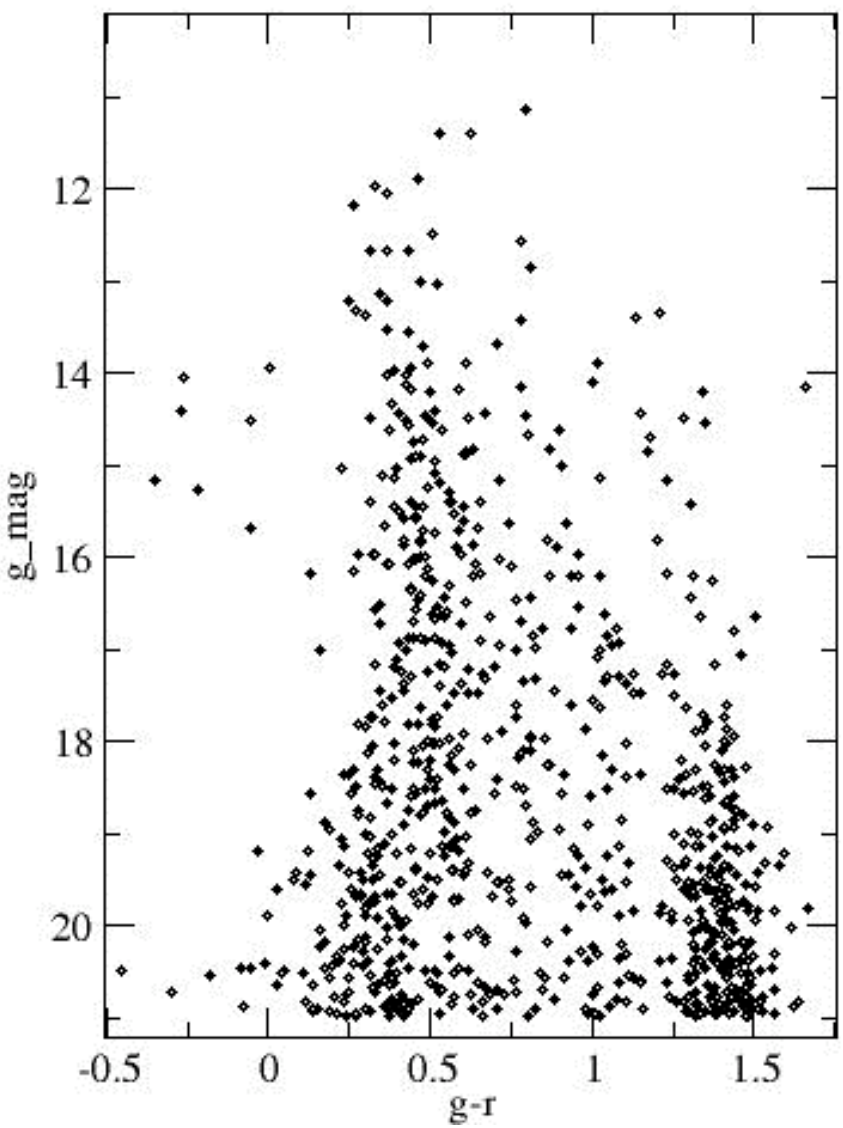
What makes VIRUS on HET such a powerful instrument for stellar research?

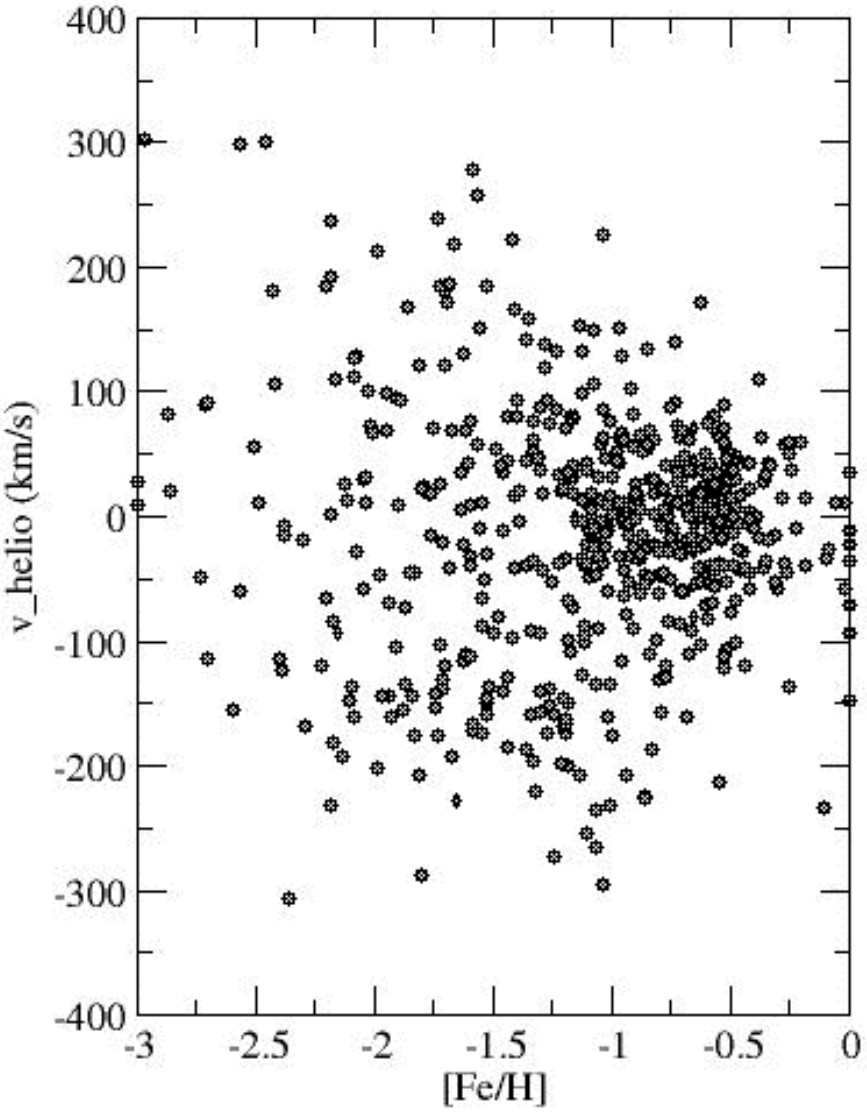
- It will be able to probe, spectroscopically, to greater depth than ever before.
- Supply large samples of stars which are important for statistical analysis
- Most importantly, it can supply a complete, magnitude-limited, unbiased sample of stars which can than be used to probe specific frequencies across populations.

Parallel Mode will supply a pencil surveys for a large number of directions through the halo and thick disk of the Galaxy

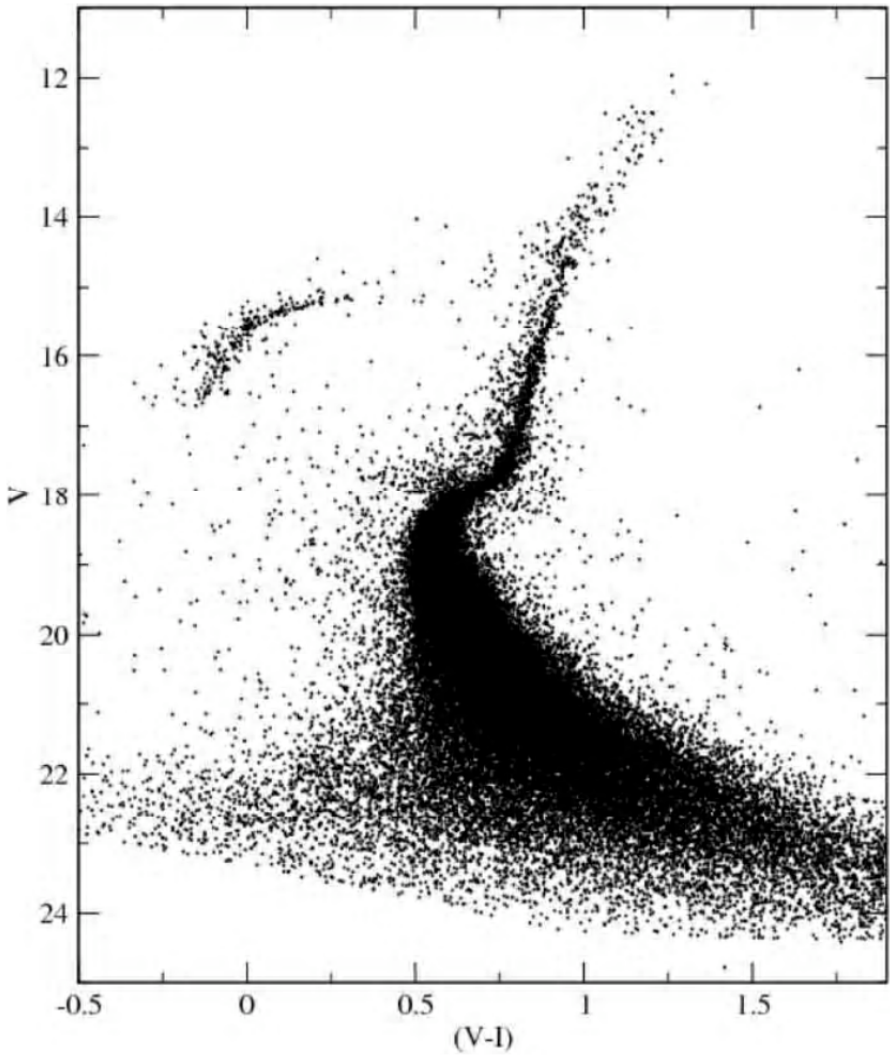
- High proper motion surveys – Kinematically biased sample (e.g. Carney, Latham and Laird)
- Abundance selected surveys – Abundance biased sample (e.g. HK objective prism survey)
- SDSS – unbiased in photometric survey but spectroscopic sample is selection biased
- VIRUS sample – complete spectroscopic sample which is only magnitude limited

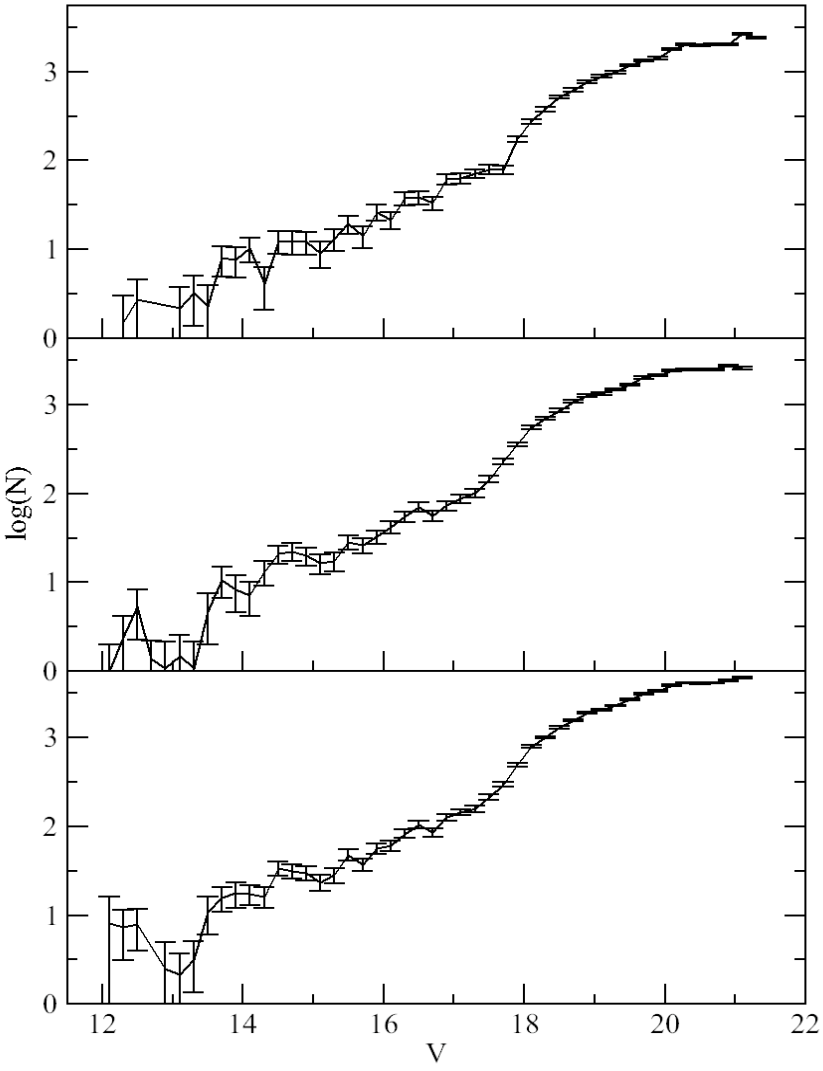
One square degree field in SDSS (left) and results for similar number of stars from SEGUE (right)





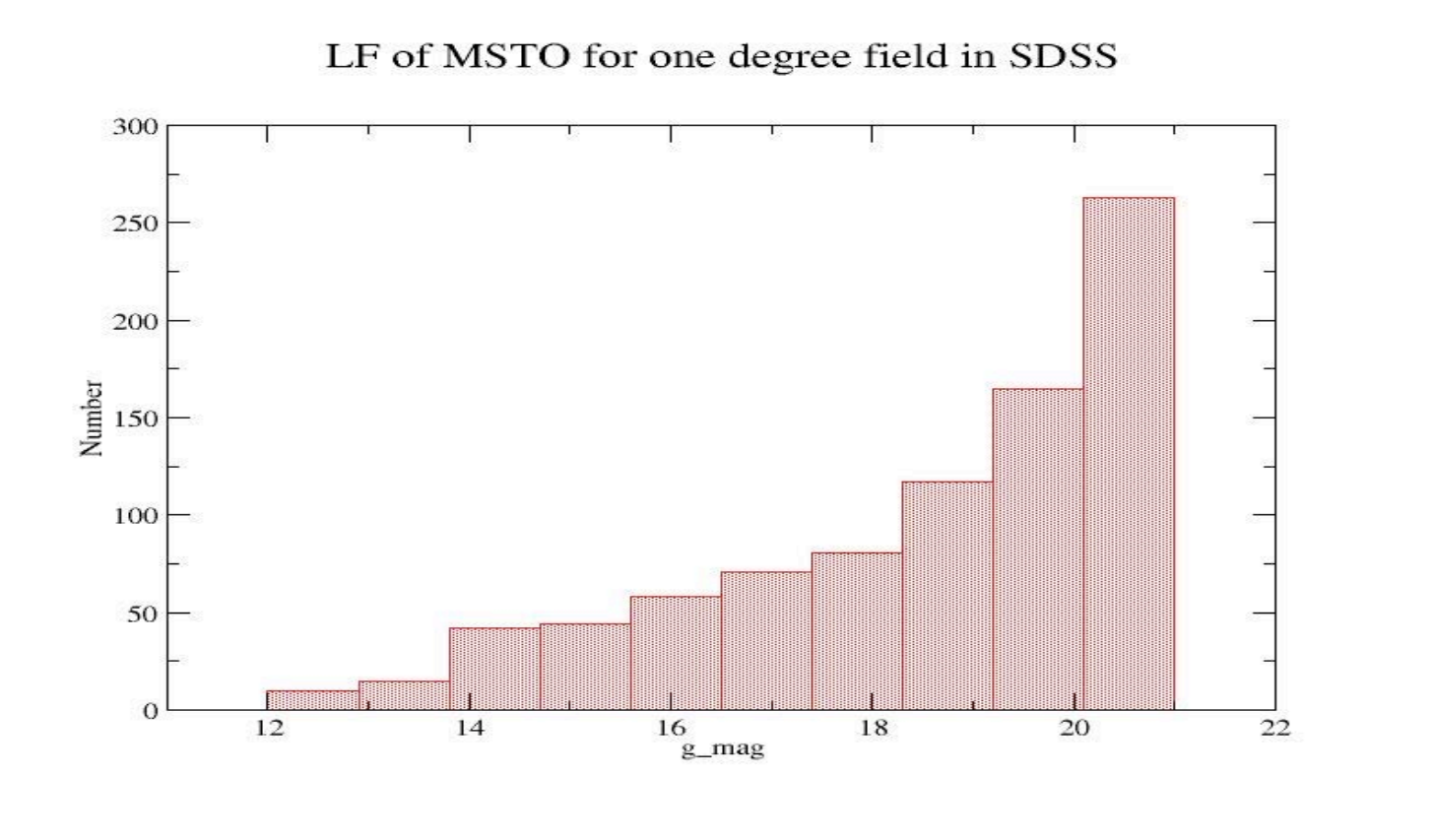
M92 CM and LF diagram from Paust et al. 2007





Expected number of HB and BSS at distance of ~20 kpc

- Using the LF of M92 as a guide then we can expect HB stars to be 7% of N_{MSTO} and BSS as high 20% of N_{MSTO}



Exploring the Thick Disk/Halo Transition

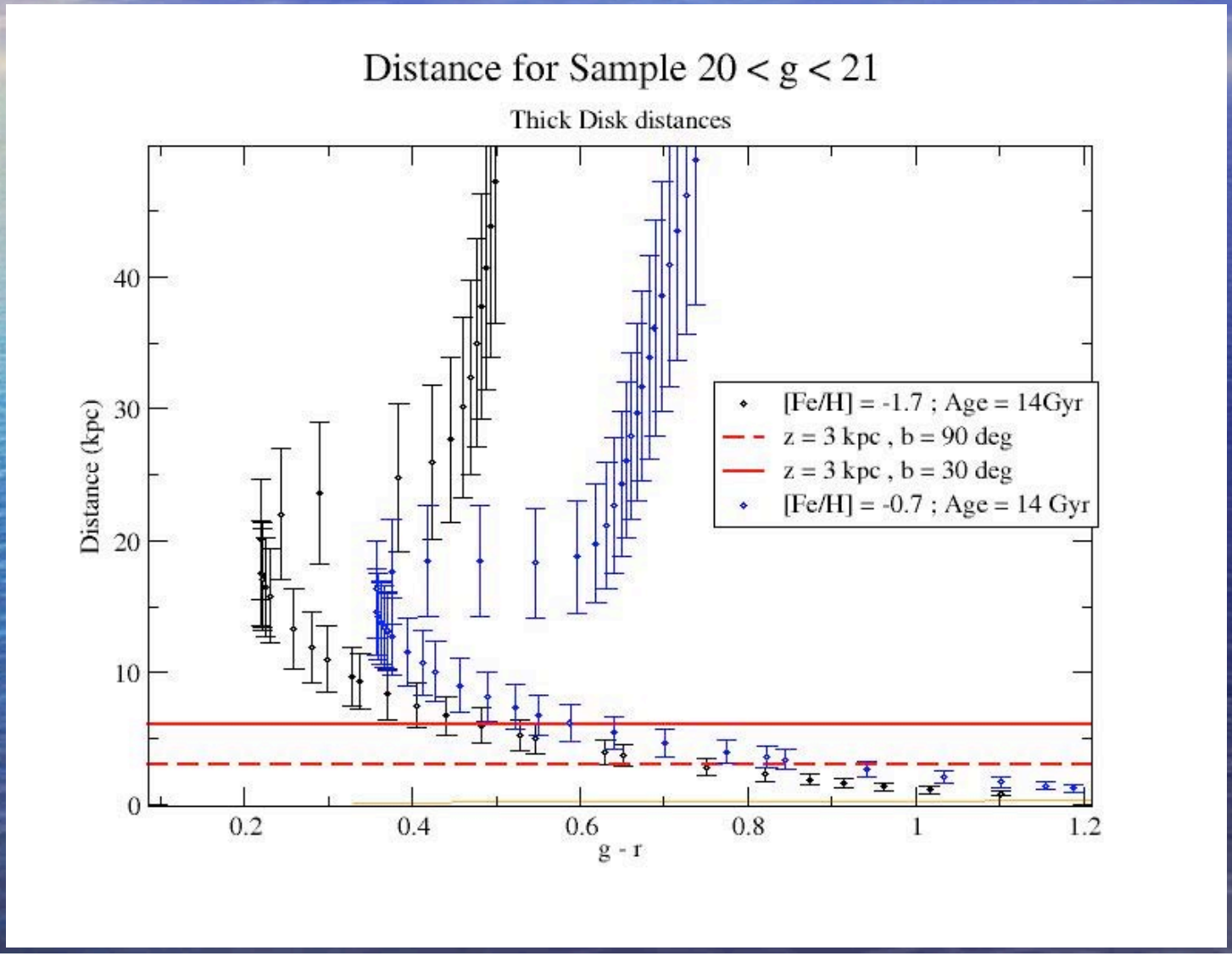
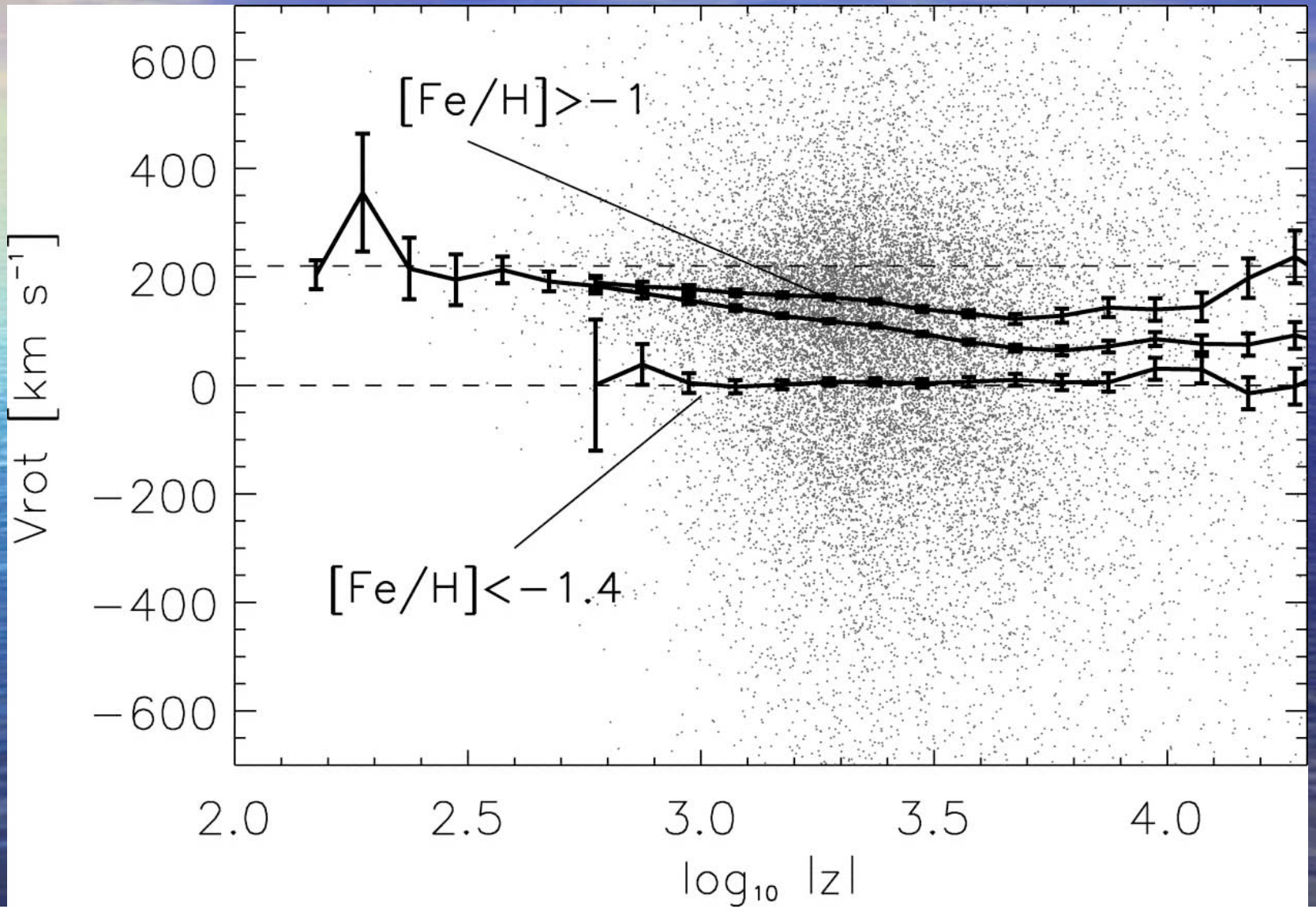


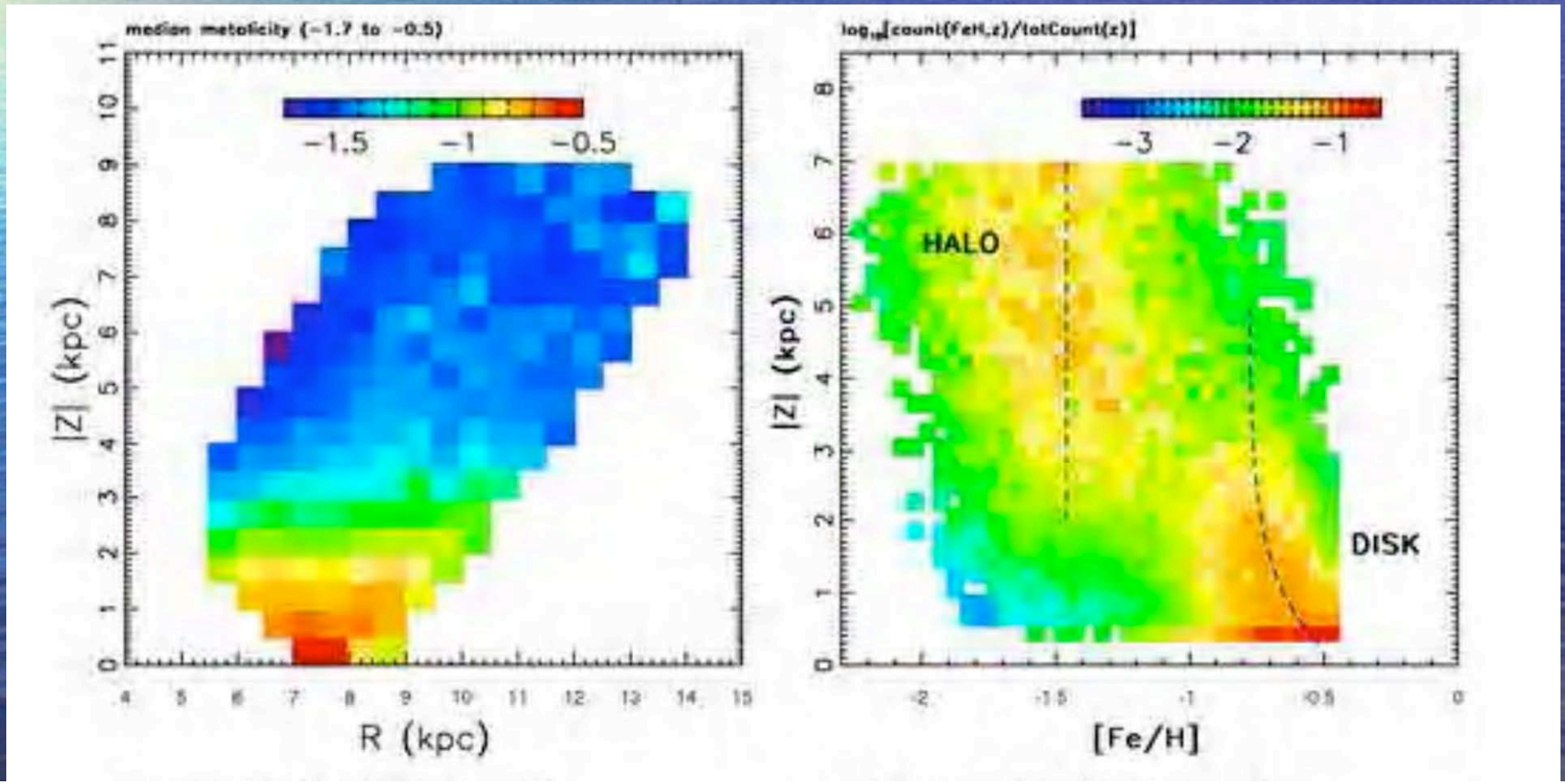
Figure 15 (Allende Prieto 2006 ApJ 636 408) Kinematics of thick disk and halo



Important Questions about Thick Disk

- Is there a metallicity gradient as a function of z?
- Is there a velocity gradient as a function of z?
- Is there a metal-weak thick disk component? Is it the tail of the thick disk population or is it a distinct population?
- Directly explore the relative percentage of stars as a function of age in the thick disk.
- Explore the thin/thick disk connection

One caveat to this research is that it will be difficult to supersede the Juric' et al. (2008) and Ivezic' et al (2008) tomography results for the disk and halo of the Galaxy.



Exploring the distant halo

- The Parallel VIRUS data can make the biggest impact on Galactic research by exploring the more distant halo.
- The random science pointings should insure a well sampled distribution for halo research.
- Because of the sample completeness the density of BHB stars, BSS and MSTO can be used together to determine specific frequencies, chemical abundance and velocity dispersions.
- The expectation is that the halo density distribution will change from flattened to spherical starting at a distance of 20 kpc.

Explore the Two-component halo using Blue Straggler Stars (BSS)

- Carollo et al. finds outer halo in net retrograde motion
- Carney et al. (2005, AJ. 129, 1886) finds binary frequency for prograde stars to be 28% and retrograde stars 10%.
- Preston & Sneden (2000, AJ, 120, 1014) find majority of blue metal-poor main-sequence stars to be binary mass-transfer BSS.
- Expectation is to see drop-off in the frequency of BSS as a function of galactocentric distance.

Using 2nd Parameter affect in horizontal branch stars to explore age in halo

- Many of the most distant globular clusters exhibit a second parameter effect in their HB because of higher turn-off mass due to a younger age (~3 Gyr)
- By exploring the specific frequency of BHB, corrected for metallicity effects, in the halo it should be possible to discover difference in age as a function of distance.

Requirements

- Well determined stellar parameters to allow luminosity class determination and to explore changes in metallicity.
- Distances using luminosity class information
- Radial velocities with precision of at least 20 km/s

Special project – Kinematic verification of globular cluster tidal tails.

- Although a number of globular clusters have been found to have tidal tails from photometric surveys, only Pal 5 has be shown to have tails kinematically. (Odenkirchen et al. 2009, AJ, 137, 3378)
- Tidal tail research is important because it sets constraints on cluster orbits and can ultimately help to constrain the galactic potential.
- Each pointing will exceed the tidal radius of most clusters and allow determination of radial velocities for stars below the MSTO.
- Identification of extra-tidal tail stars can be a launching point for follow-up research.

Figure from Odenkirchen et al. (2009)