SEGUE*

Connie Rockosi

UC Santa Cruz, UCO/Lick Obs.

with lots of stuff from the

SEGUE collaboration

*Sloan Extension for Galactic Understanding and Exploration

SEGUE by the numbers

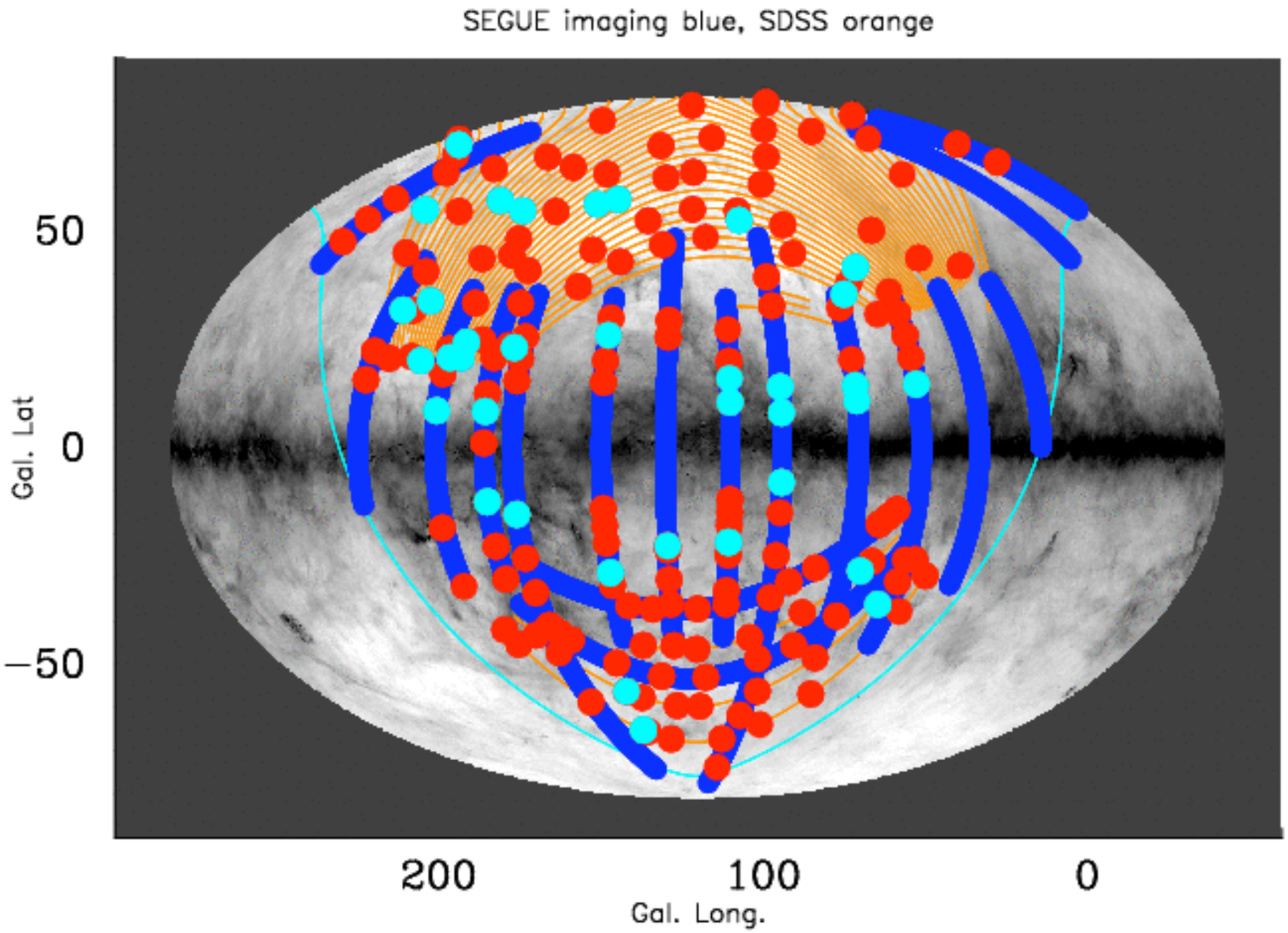
Spectroscopy:
240,000 stars

200 pointings,
7 deg^2 each

distant galaxy:
14<g<20
1 kpc < d < 40kpc+

color, magnitude
sub-selection

Imaging: 3500 deg^2
@ |b|<35°



SEGUE @DR7, July 2008
http://www.sdss.org/dr7

SEGUE by the numbers

SEGUE-2:

Aug 2008 - June 2009

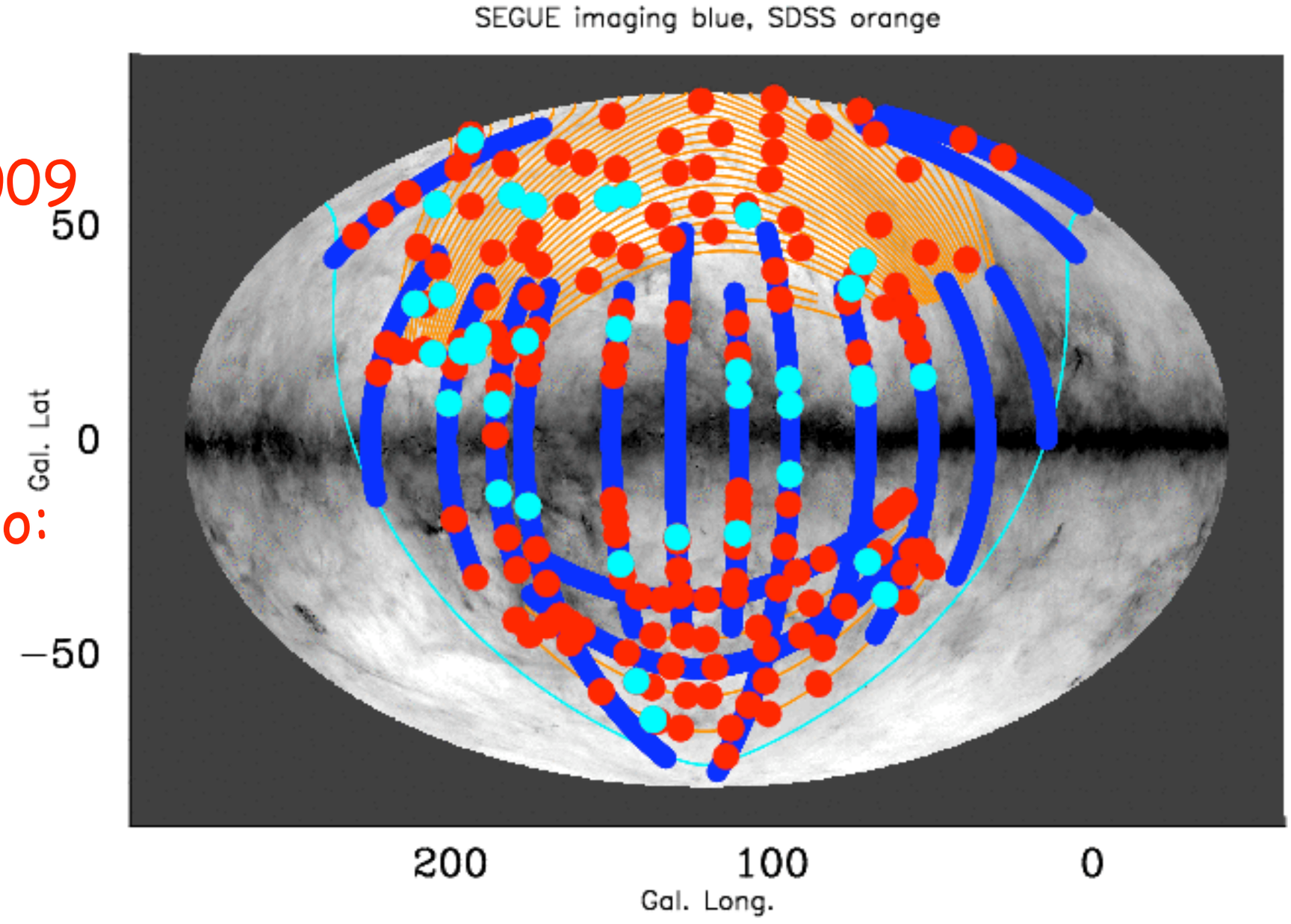
240 LoS, 1680 deg^2

140,000 stars, <d> further into the halo:

-fainter <g>

-lessons learned targetting distant tracers

DR8: Dec 2010



SEGUE @DR7, July 2008

http://www.sdss.org/dr7

Spectra → Physical Parameters

5000K<Teff<7500K
S/N > 10 per pix

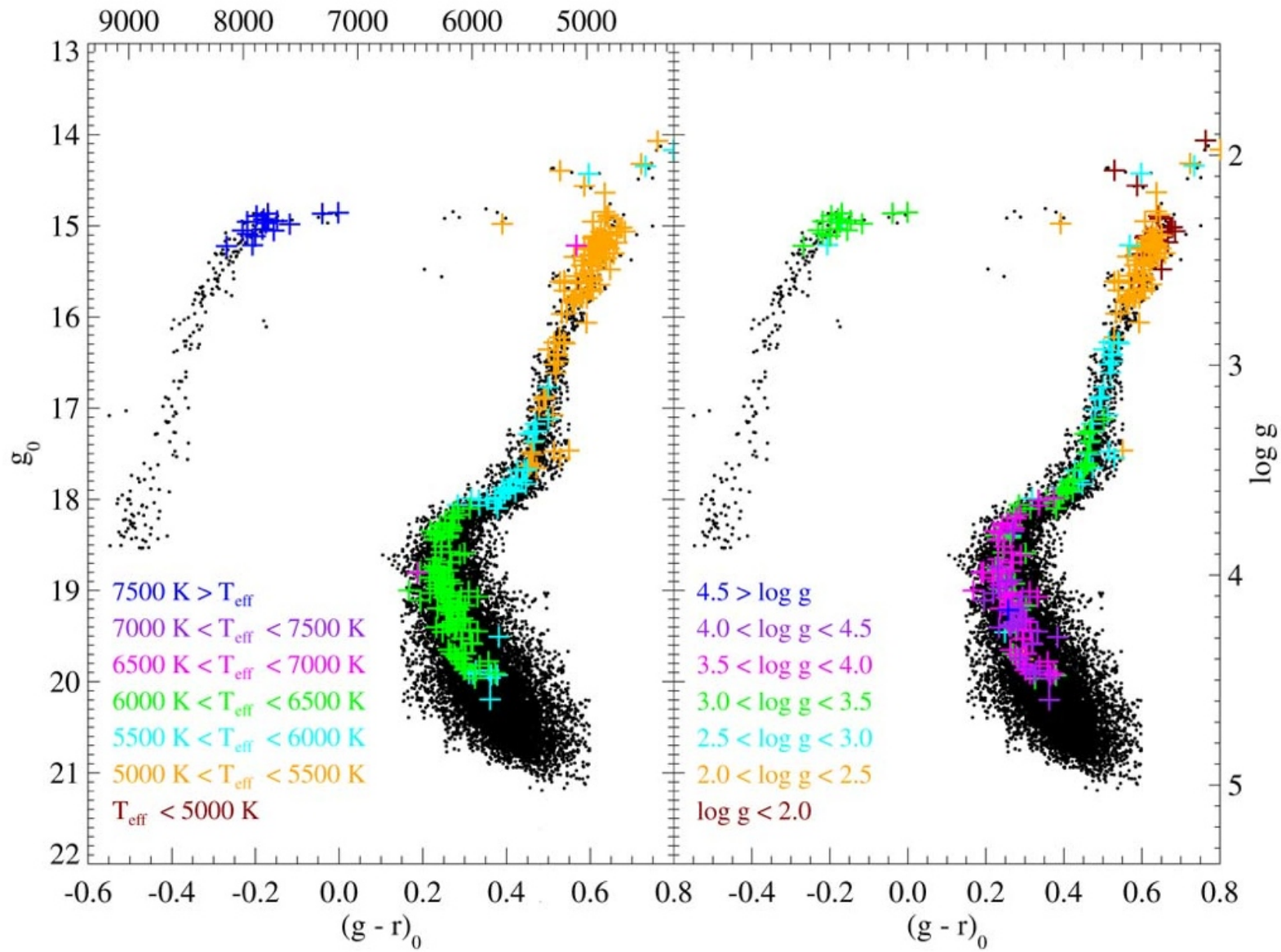
σ(Teff) 157K

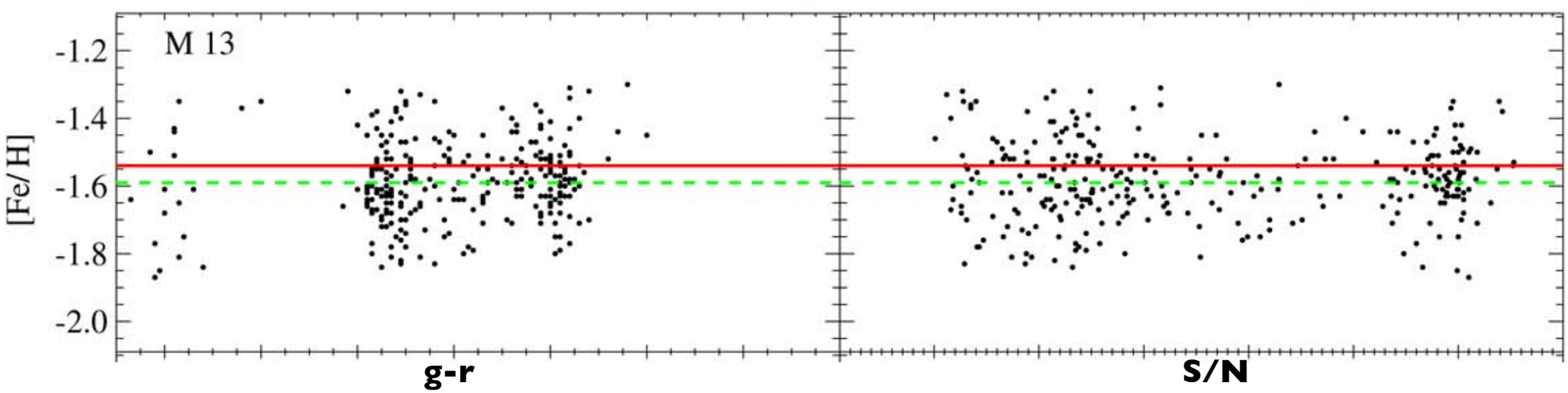
σ([Fe/H]) 0.29

σ(logg) 0.24

Lee et al (2008) a,b

Allende Prieto et al. 2008





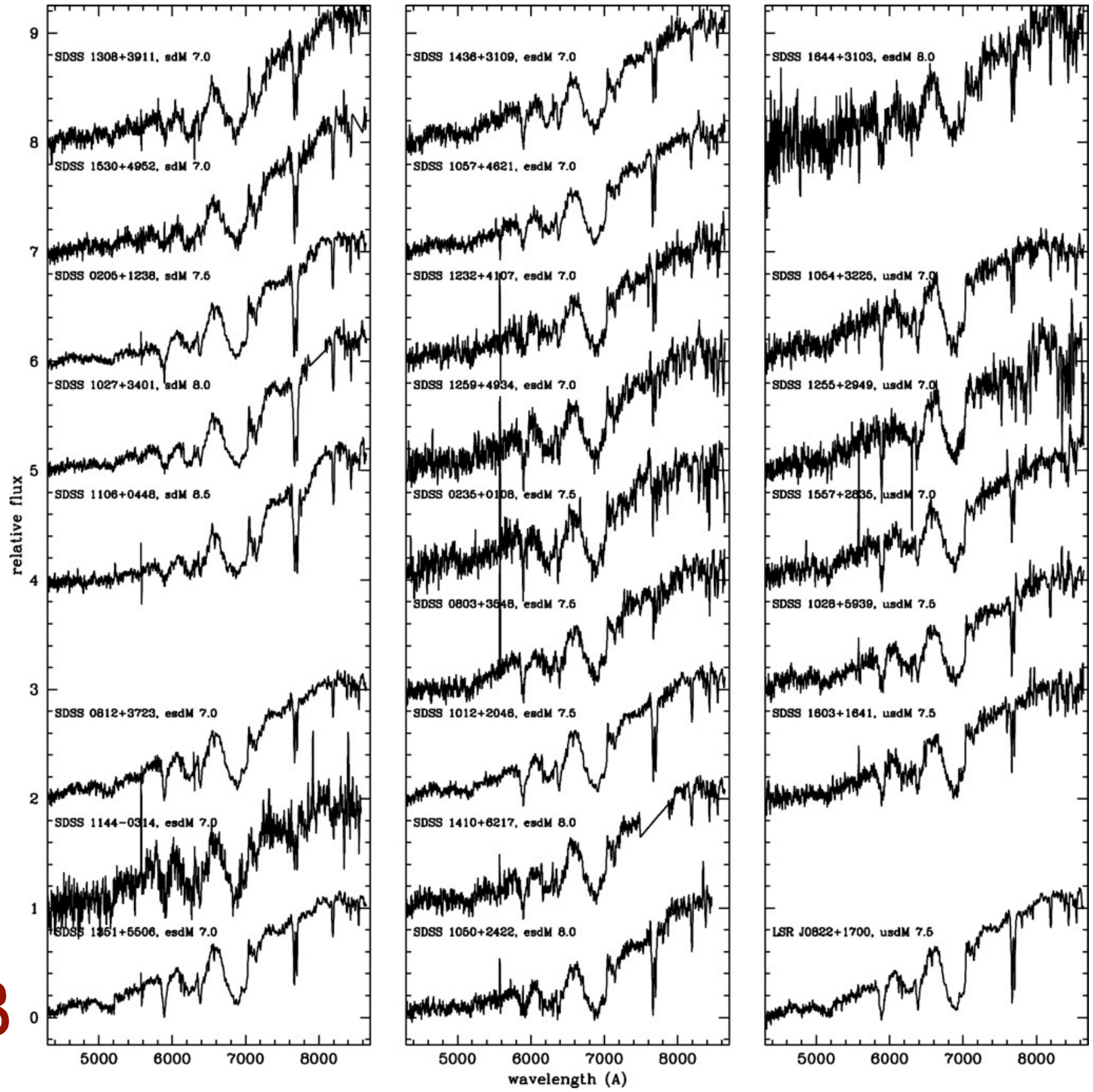
New Ultra-Cool Subdwarfs

Doubles known sample below M7

ID by template matching: robust for faint objects

Explict search in SEGUE-2

Lepine et al. 2008



Halo Mass Profile

SDSS+SEGUE BHBs

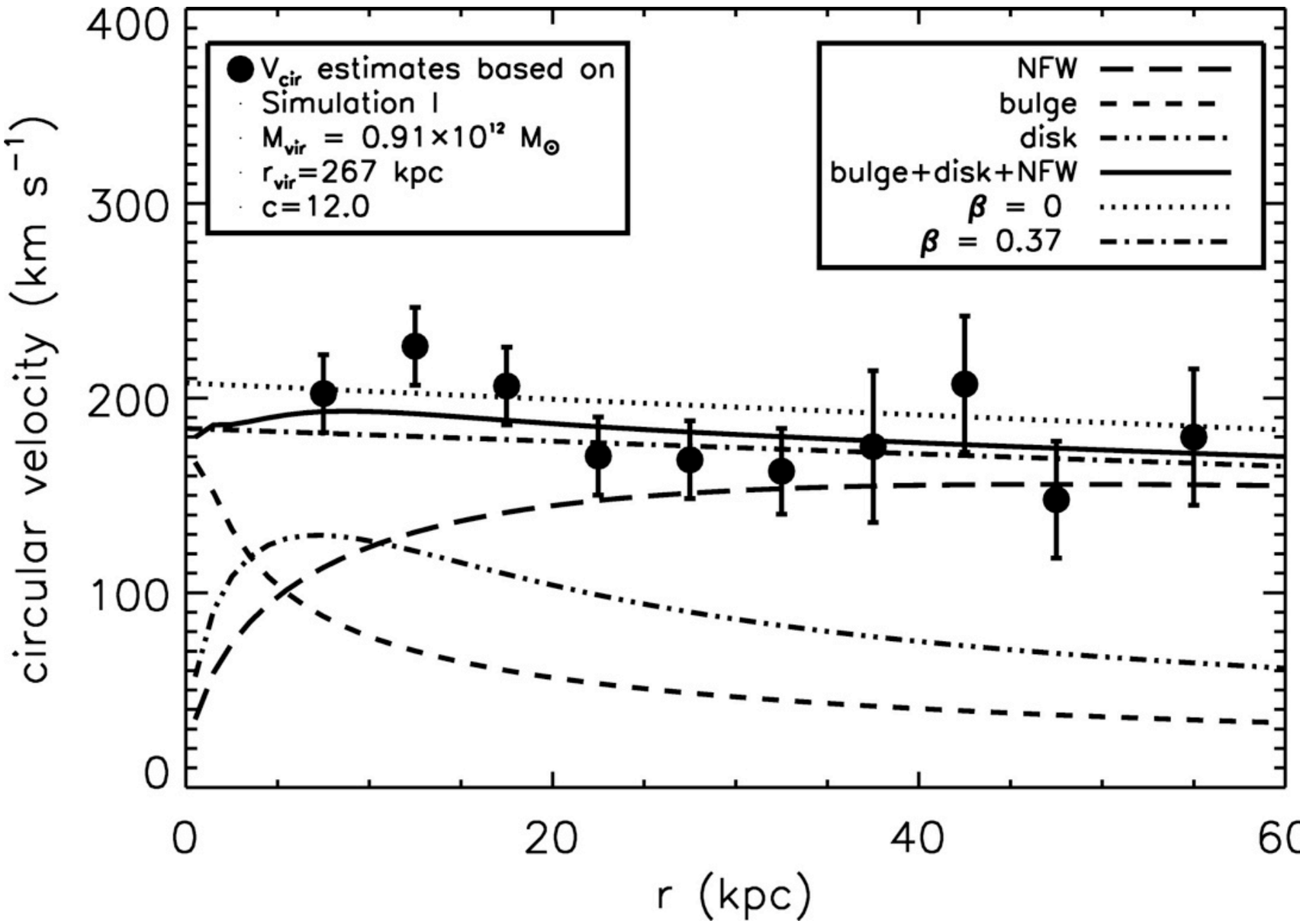
M(r<60kpc):

$4.0 \pm 0.7 \times 10^{11} M_{\odot}$

comp. Battaglia et al. 2005

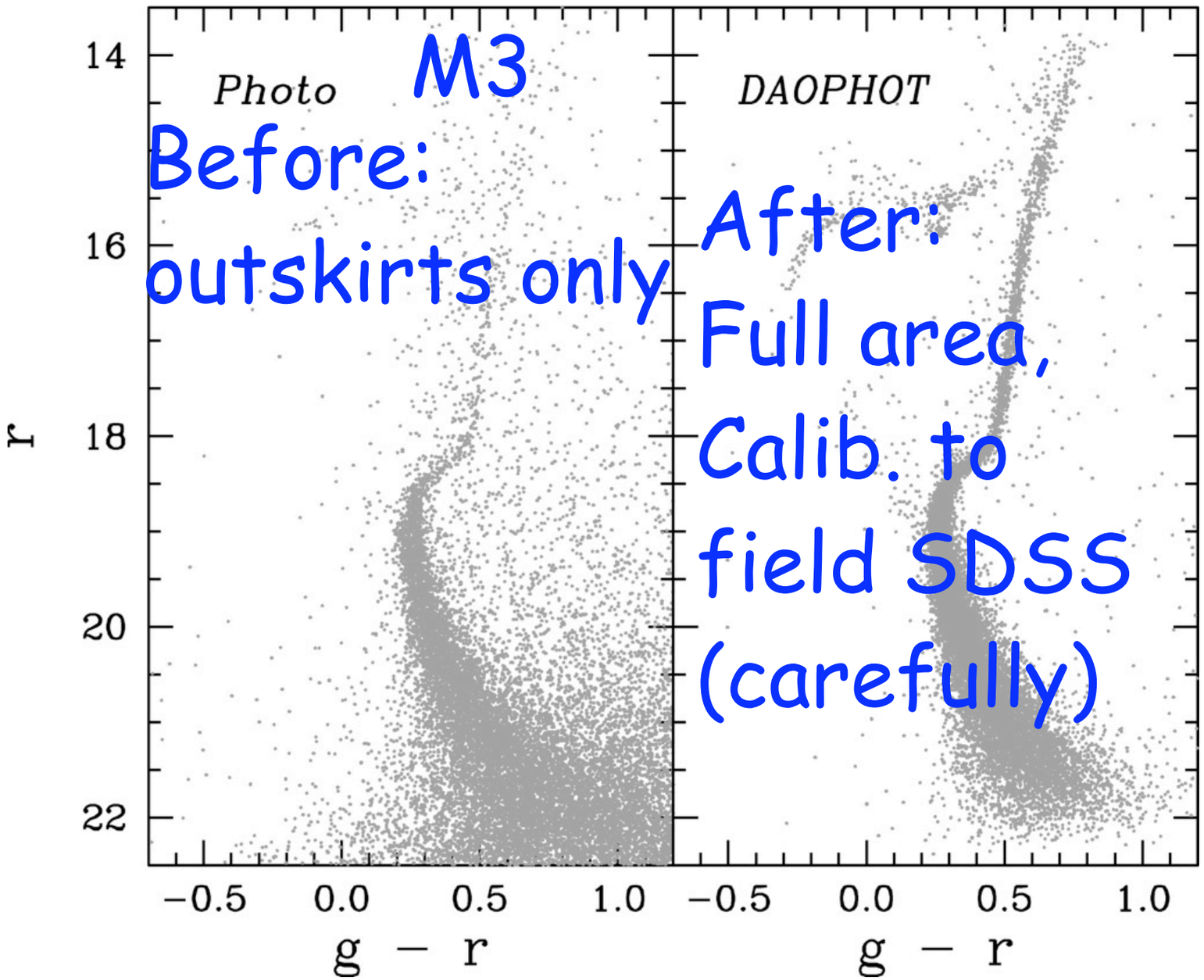
model-dependent extrapolation beyond 60 kpc

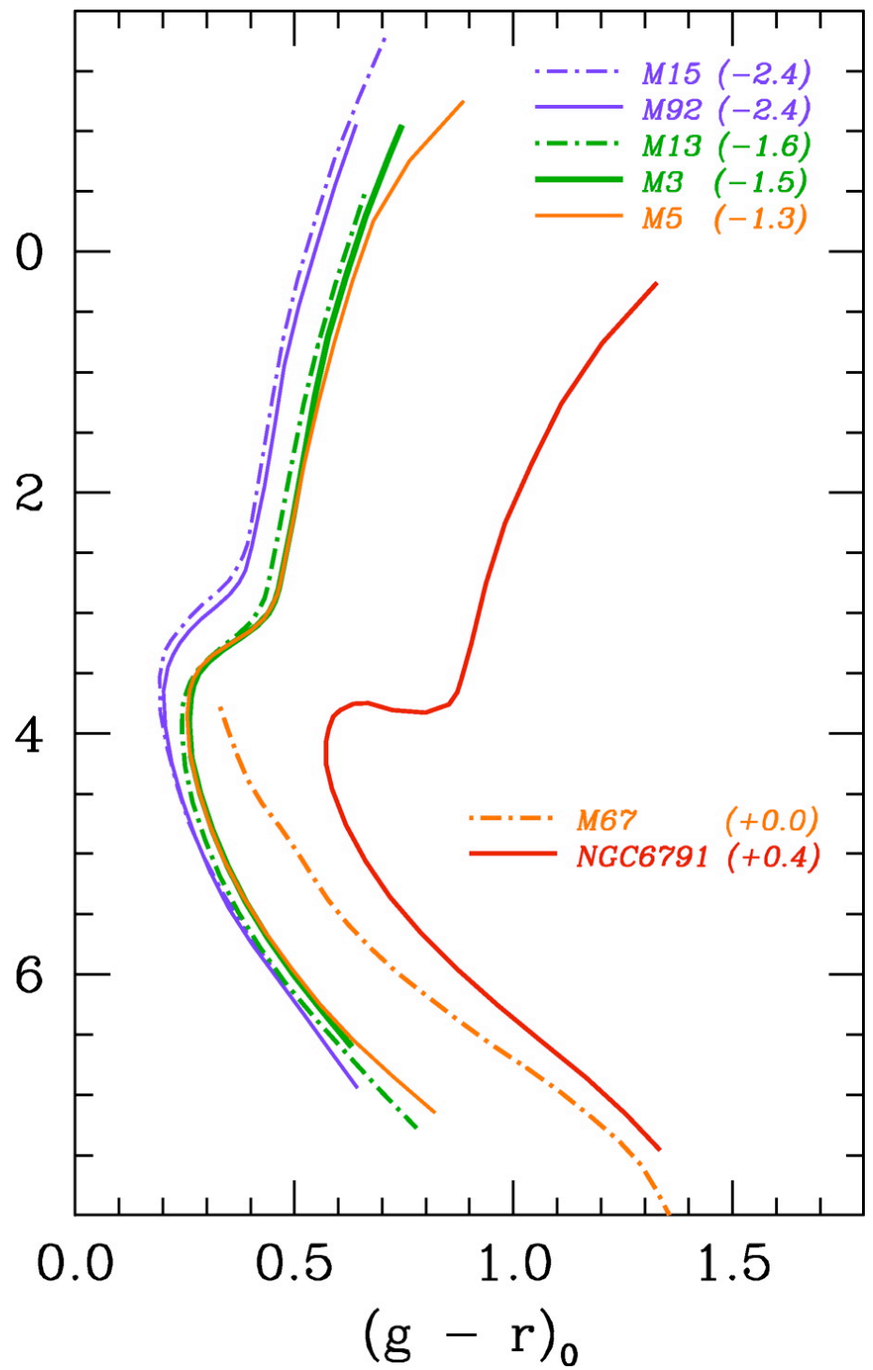
BHB density limits sample size



Xue et al. 2008

New, Improved!™ Globular Cluster Photometry





An et al. 2008

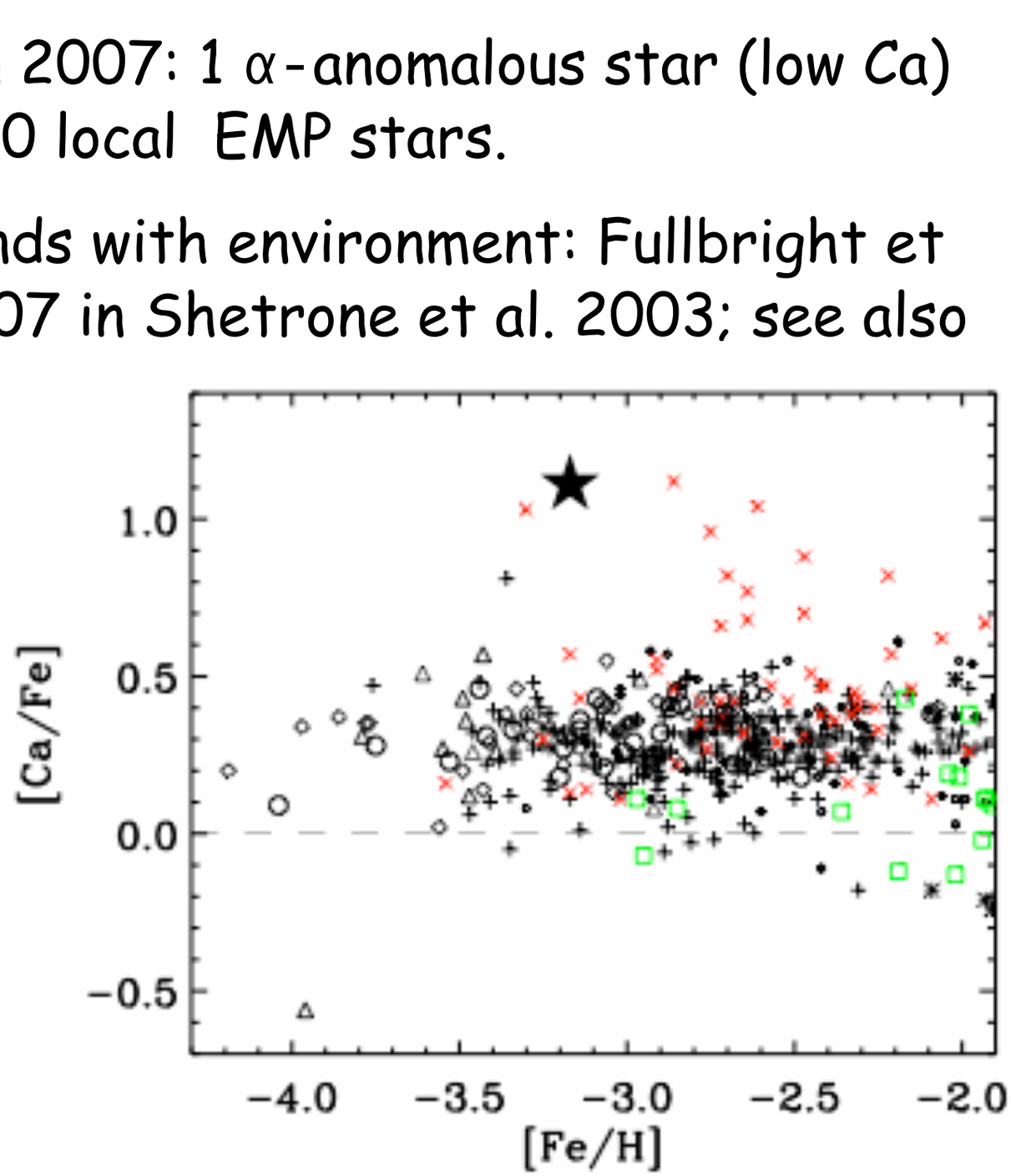
Abundance Patterns in the Outer Halo

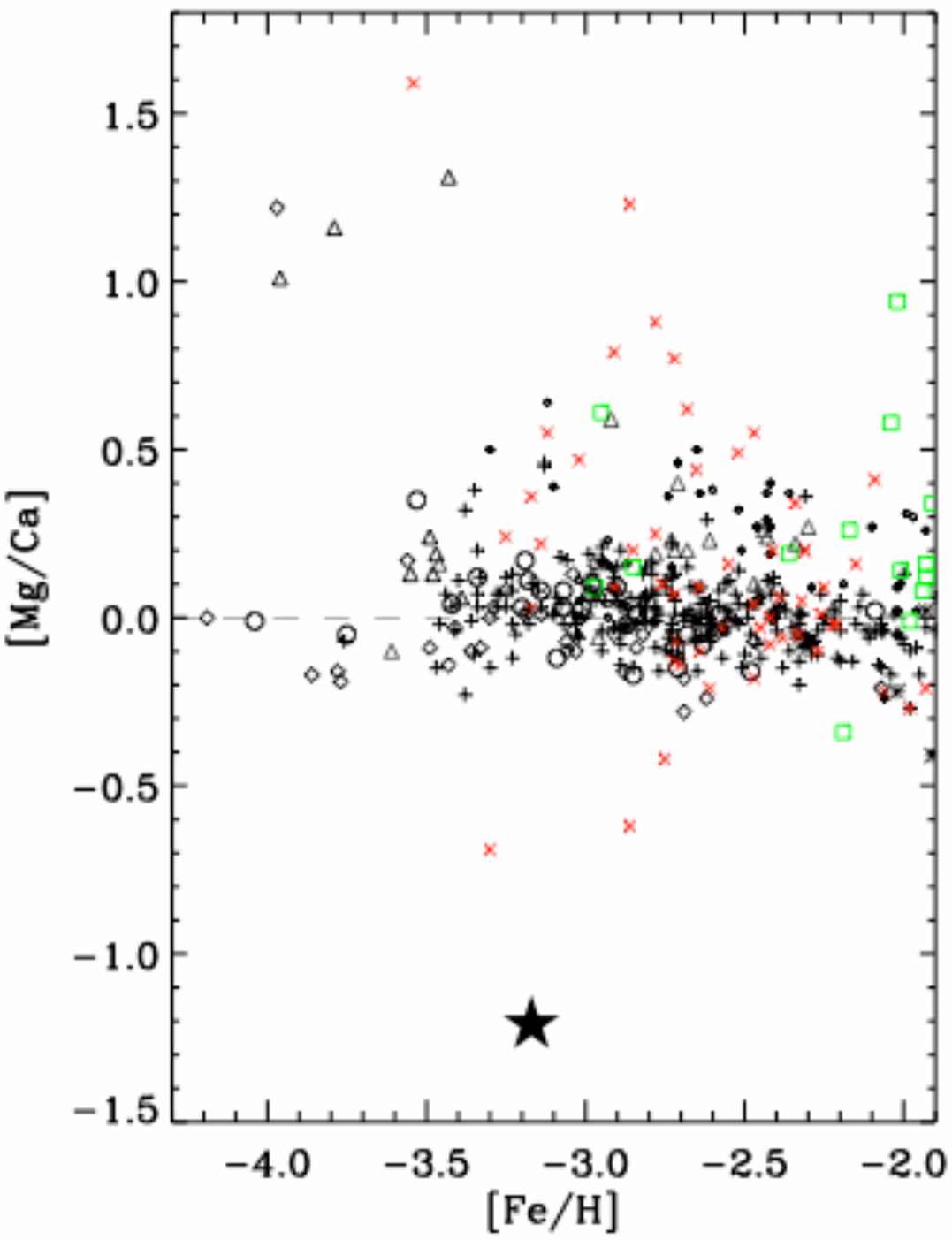
Lai et al. 2009: Keck/ESI follow-up of SEGUE MP stars: d>15kpc. N=27 and counting.

[Ca/Mg] 1.11, [Fe/H] -3.17

Cohen 2007: 1 α-anomalous star (low Ca) in ~100 local EMP stars.

α trends with environment: Fullbright et al. 2007 in Shetrone et al. 2003; see also Ivans et al. 2003





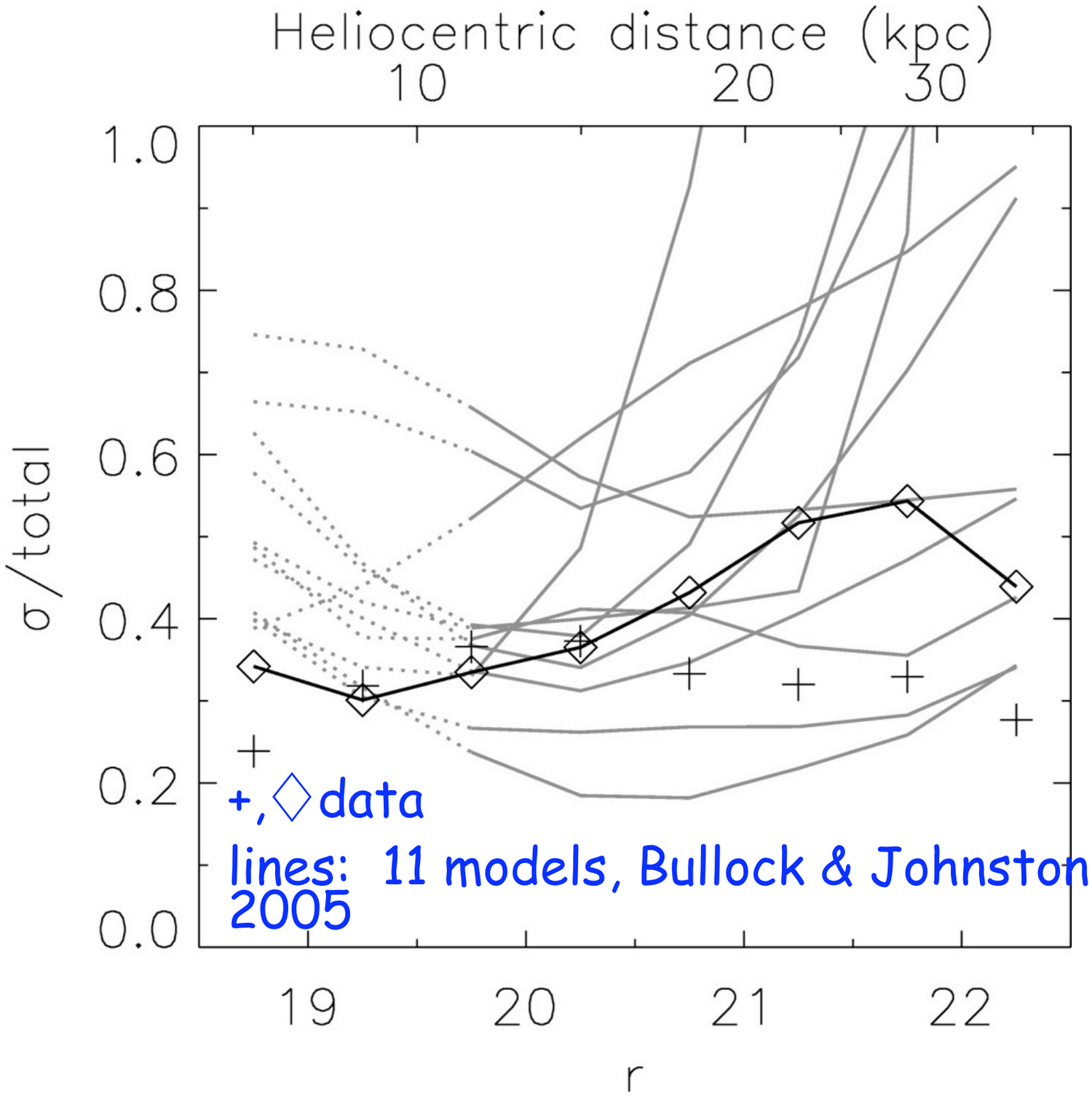
Beyond the Field of Streams

Bell et al. 2008
SDSS photometric substructure vs. halo models

Good agreement for recently accreted substructure at d > 20 kpc

Also:
Correlated [Fe/H] and kinematics in outer vs. inner halo stars: Carollo et al. 2007

Spatial density and overdensities: Jurić et al. 2008



Beyond the Field of Streams

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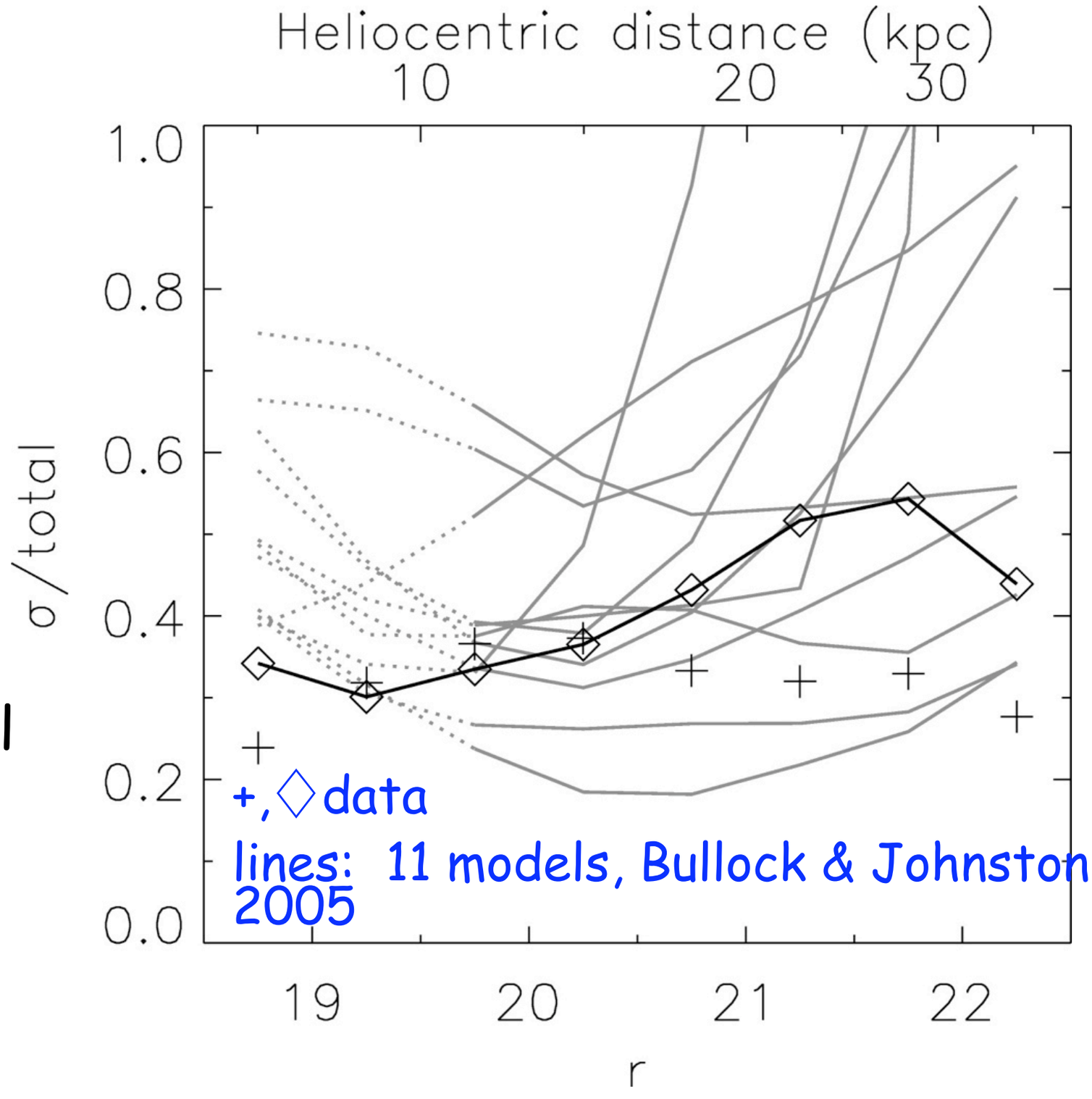
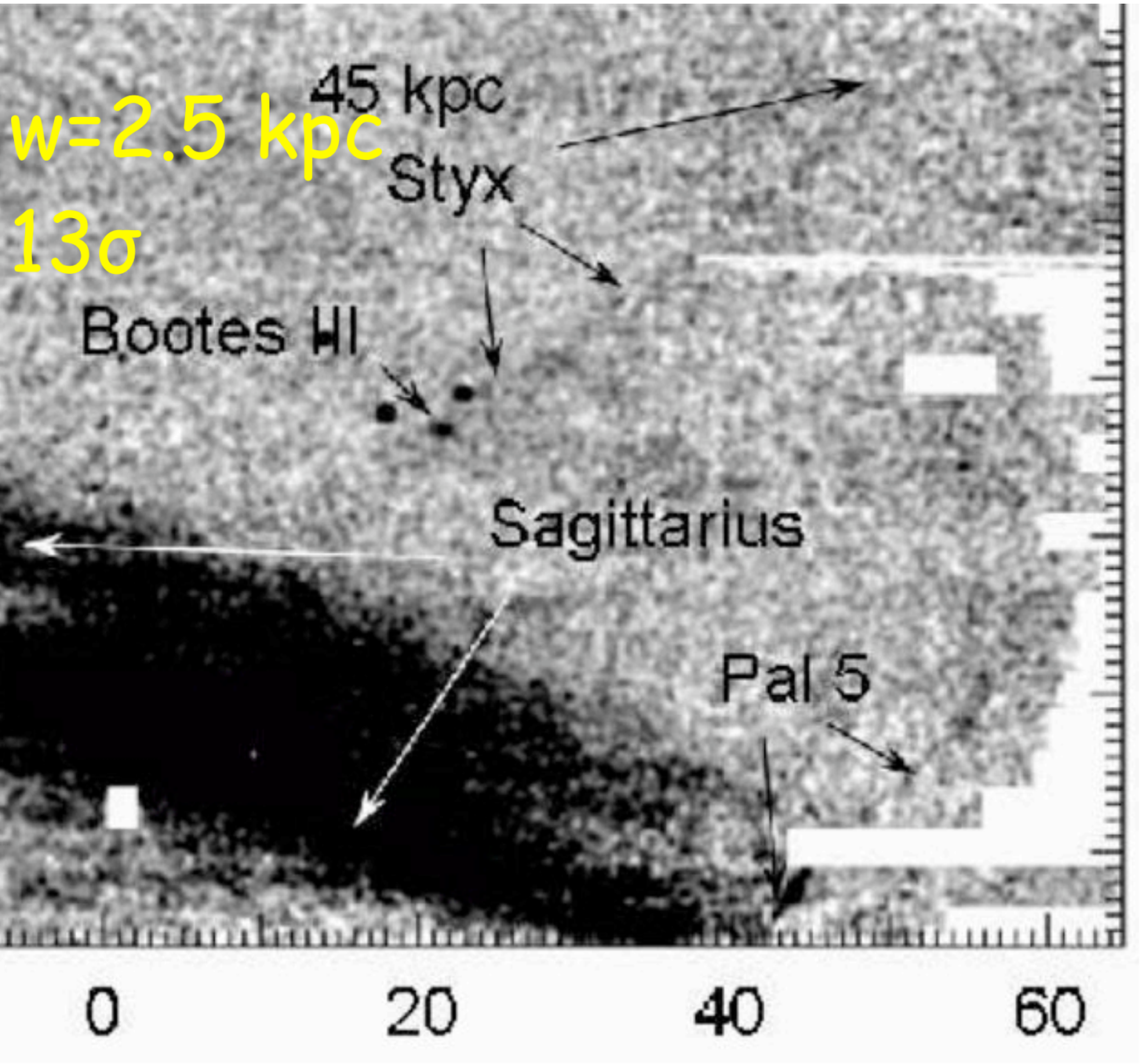
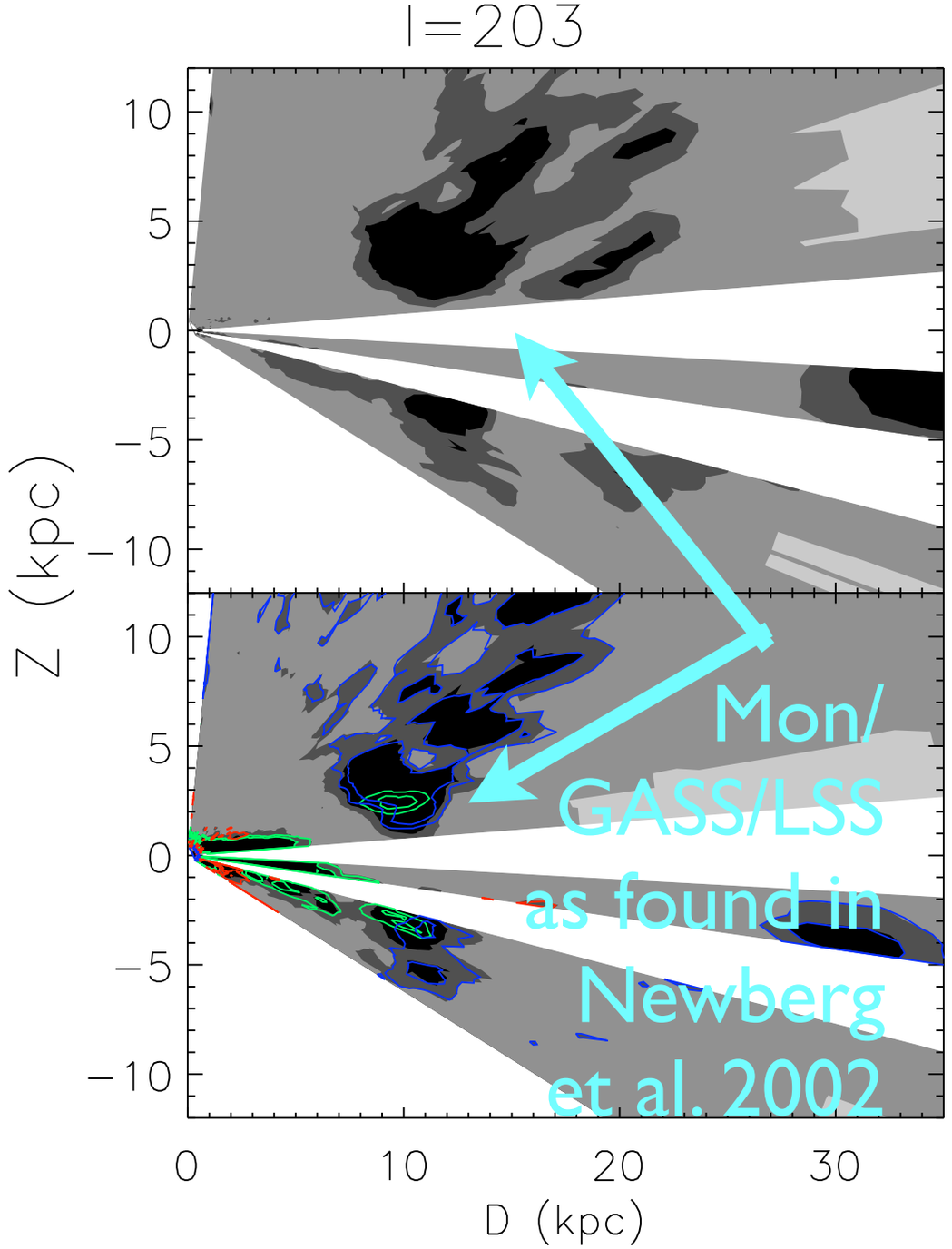
Also:
Disentangling the Virgo overdensity, the Sgr. tidal stream and the solar neighborhood: Newberg et al. 2007



New Streams and New Data



Grillmair et al. 2008



de Jong et al. 2008

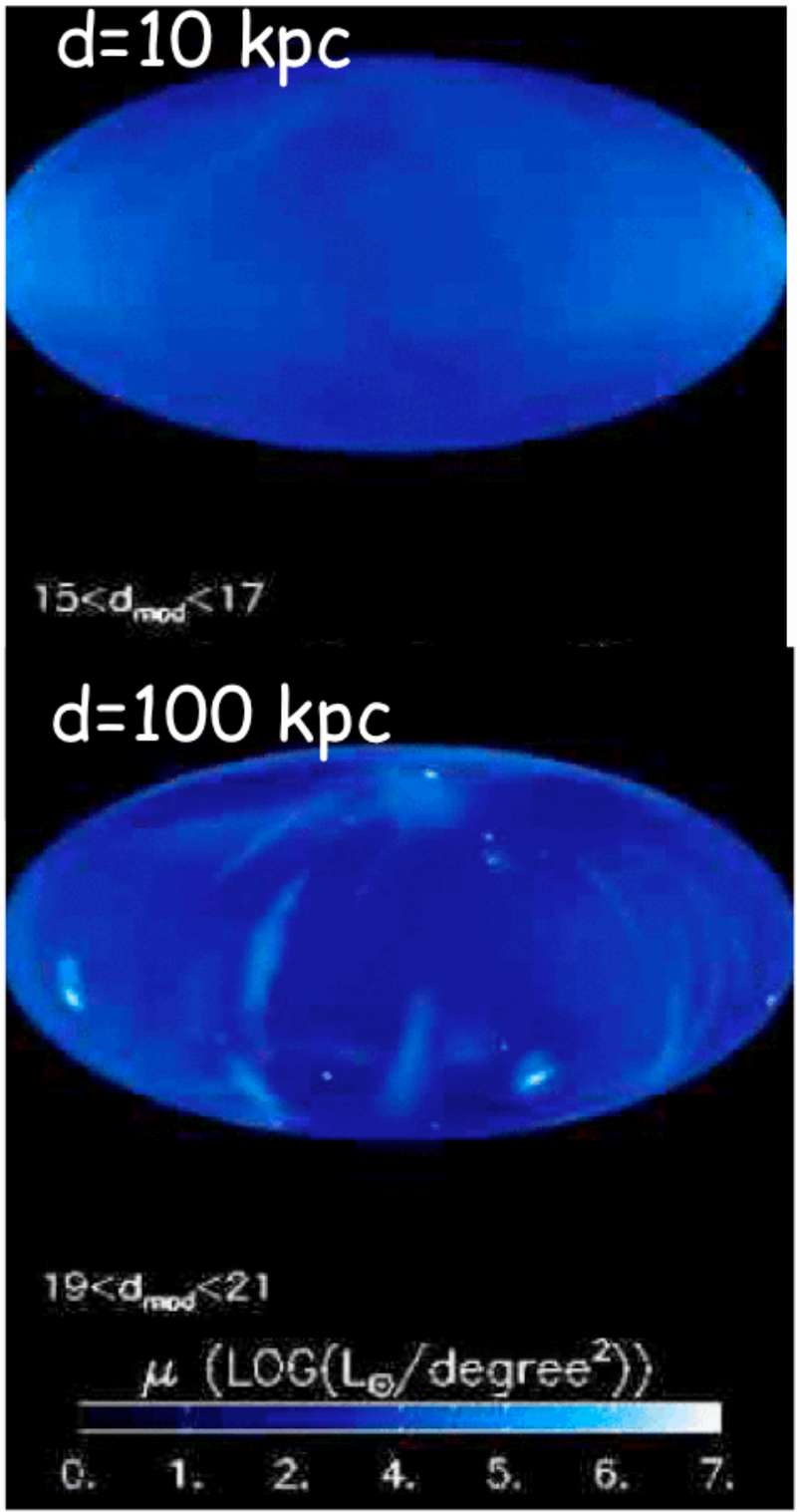
Radial Velocity Substructure in the Inner Halo

expect lower fraction, lower density substructure in nearby halo

- fewer, more massive satelites at earlier time

- more opportunity for phase mixing, relaxation

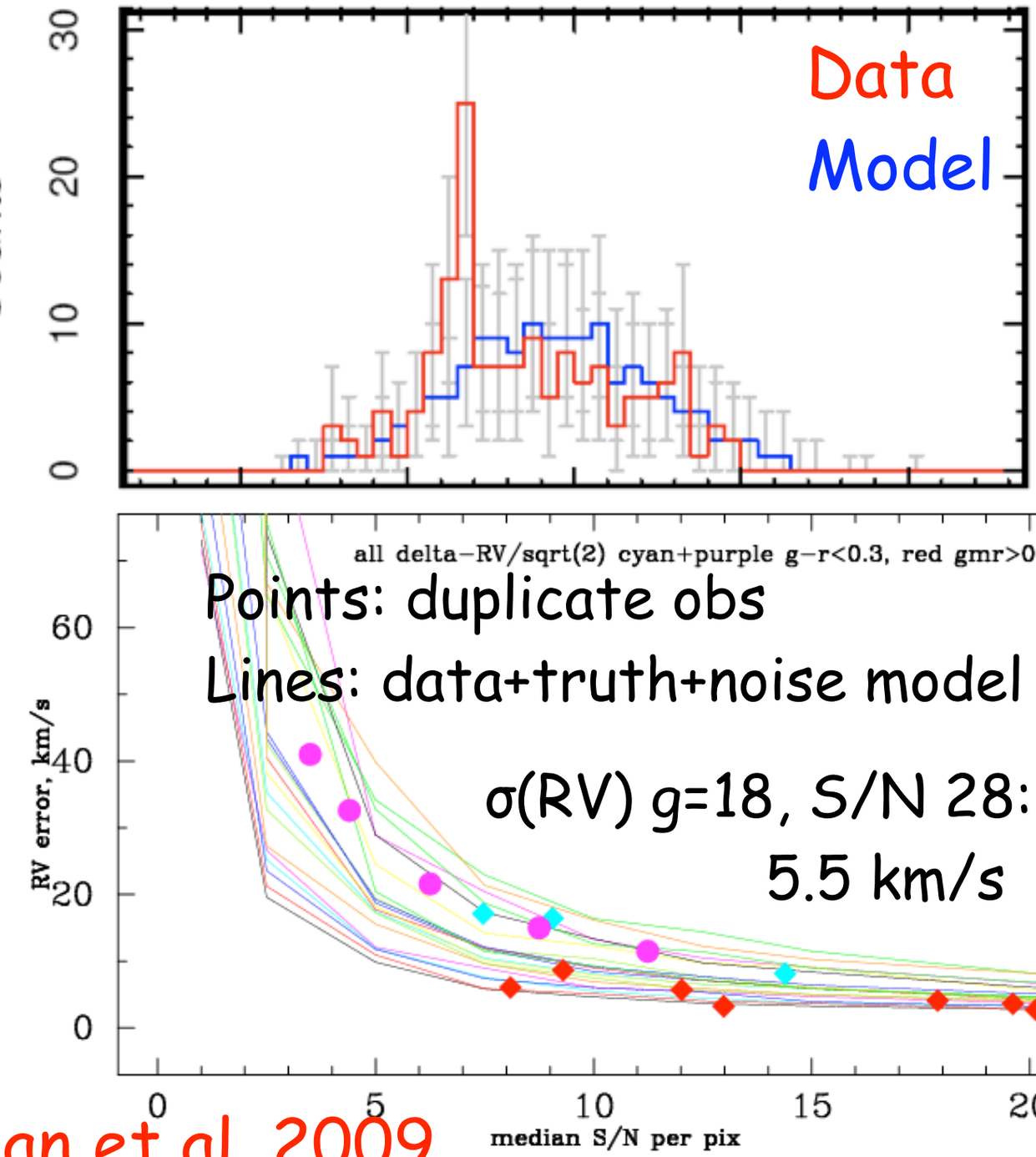
need to model DM→stars to compare simulations



Johnston et al. 2008

Radial Velocity Substructure in the Inner Halo

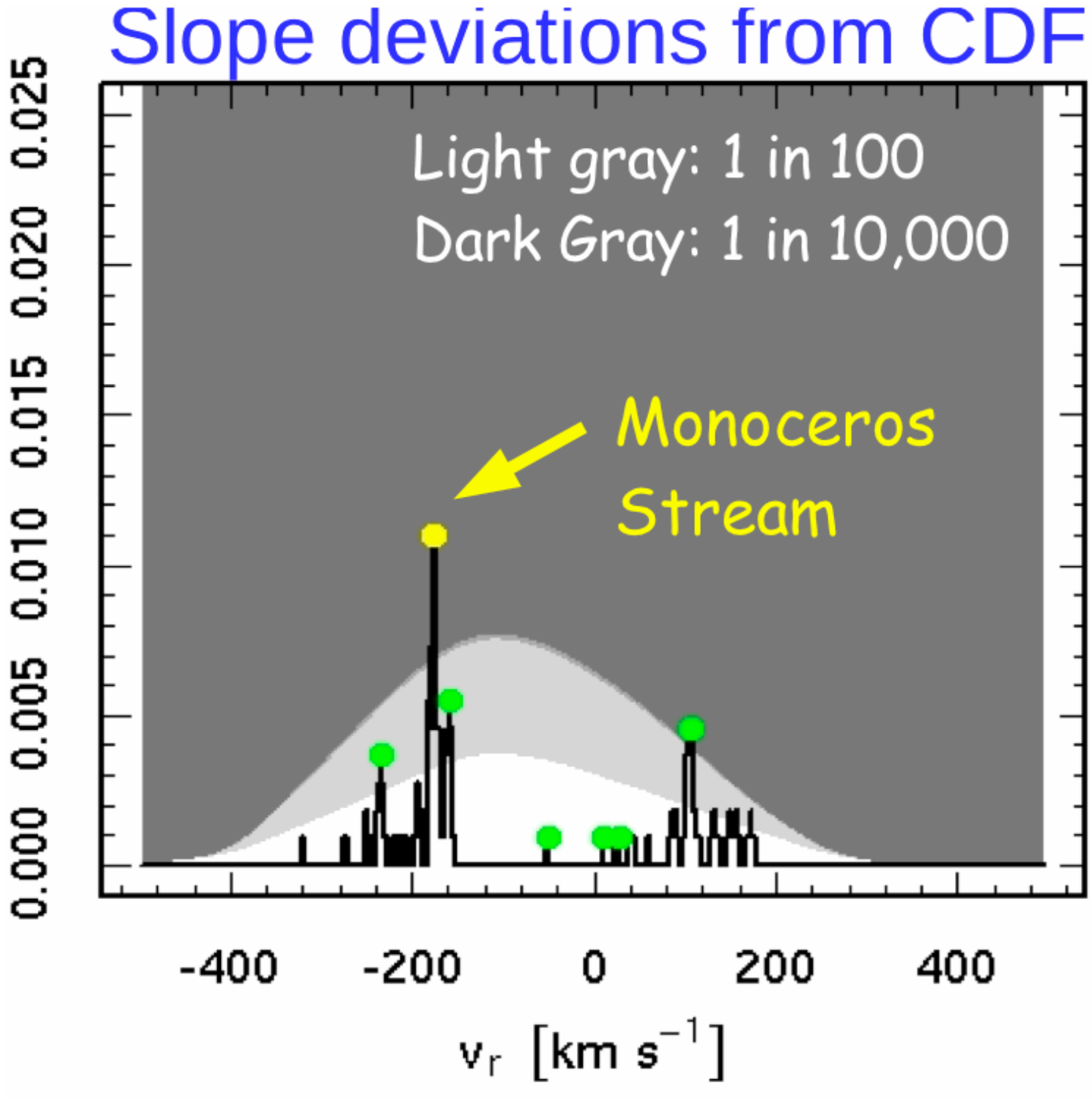
- search SEGUE RVs of UVX MSTO stars: max. #s + distance
- 10 kpc < r_{GC} < 17.5 kpc |z| > 4 kpc
- 50-150 per LoS
- 125 field LoS (DR7)
- model observations of smooth halo



Schlaufman et al. 2009

Radial Velocity Substructure in the Inner Halo

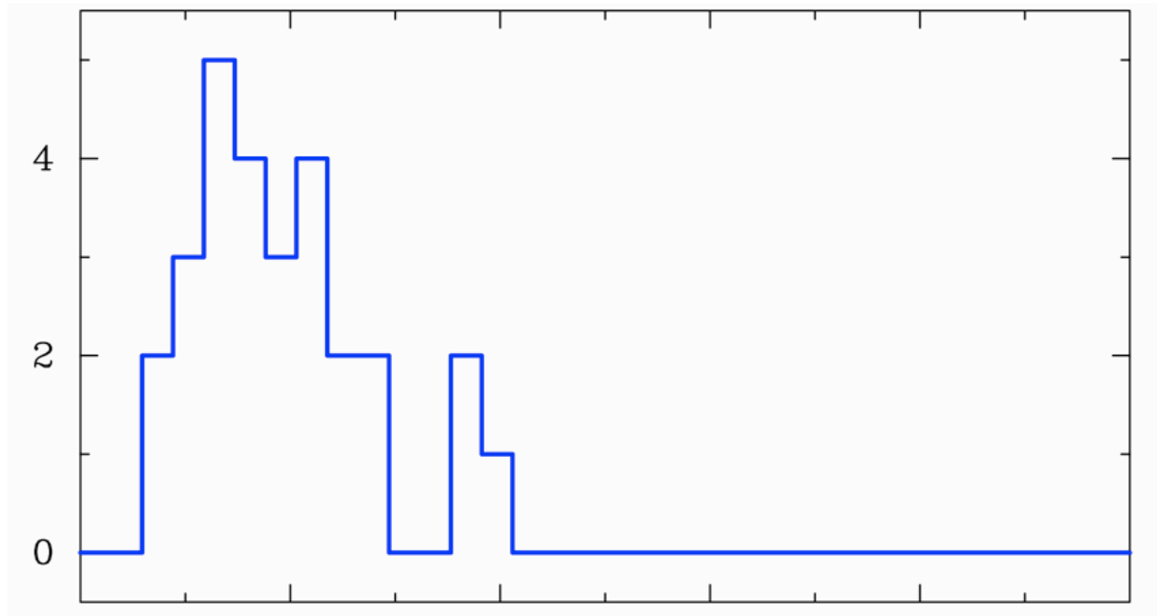
- Find statistically significant deviations
- model completeness, false positive rate
- sensitive to cold substructure - distinct peak in RV distribution
- 11 new detections on 125 lines of sight ("most secure" list)

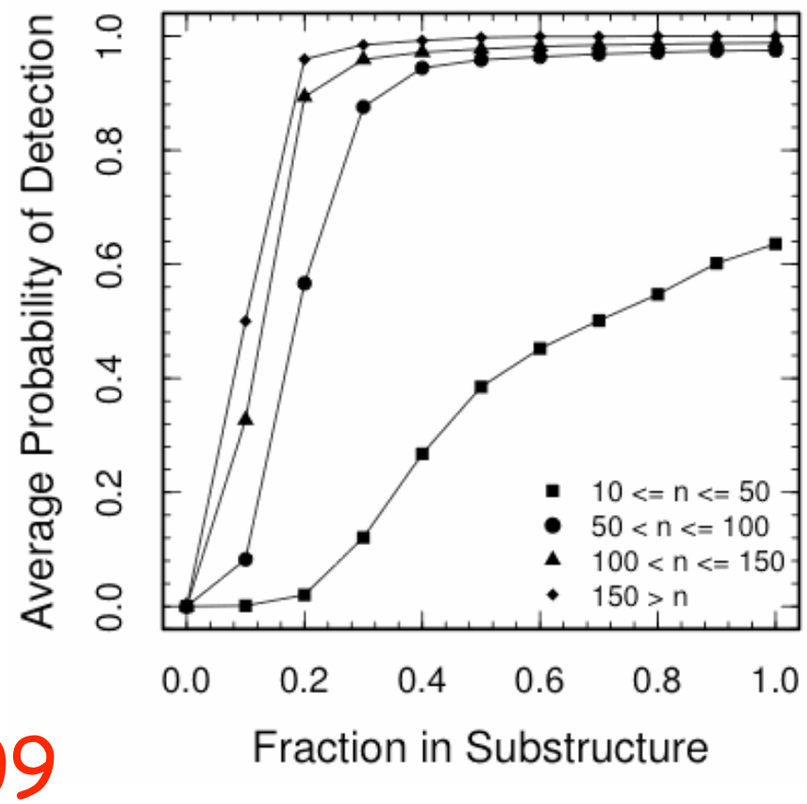


Schlaufman et al. 2009

Radial Velocity Substructure in the Inner Halo

- Selection unbiased w.r.t velocity → fair sample of 10 kpc < r < 17.5 kpc shell
- ~1/3 of detections are f = 0.1 overdensities, 10-30% complete
- Noticeable fraction of inner halo in cold substructure
- Counting individual streams is not so easy with pencil beams
- Could apply to simulations: M, t, σ, etc. of progenitors





Schlaufman et al. 2009

Looking Forward

- SEGUE-2: 2x the SEGUE area, 60% more stars at larger <d>
  - more area for sparse targets: BHBs
  - more chances at rare things: EMP, usdM, ...
  - more chances to find halo stars at 20+ (++..) kpc
- There are 1000's of stars deg^{-2} $g < 19$ warmer than M0: a magnitude-limited sample of MS stars @ large $\langle r_{GC} \rangle$ won't be practical for a long time
- Large spectroscopic surveys with kinematic and abundance data, drawn from Good photometric catalogs, are timely now and will continue to be in the future