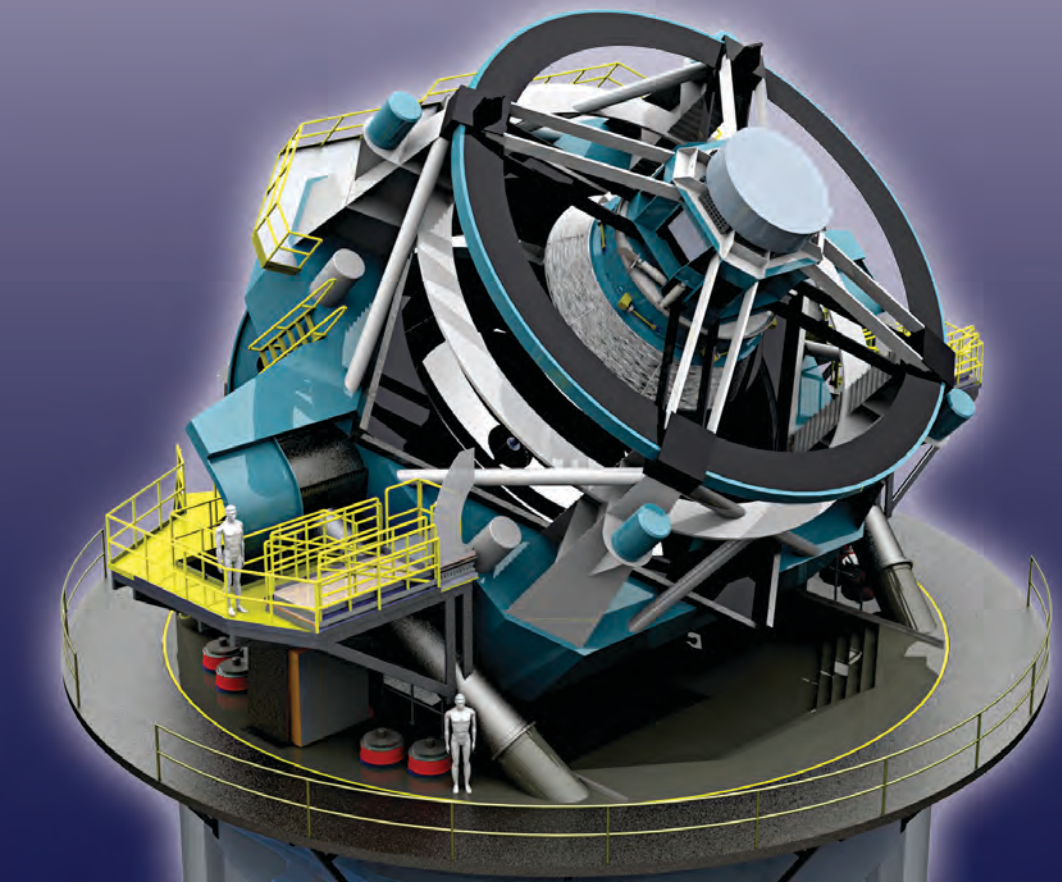
Galactic Science with the LSST

Beth Willman
Haverford College



Thanks to: Dana Casetti, Kevin Covey, Marla Geha, Zeljko Ivezic, Lynne Jones, Jason Kalirai, Nitya K, Dave Monet, Keivan Stassun

Two Science Collaborations

Imaging billions of southern hemisphere stars with wide-field, deep, multi-color, time-series photometry will revolutionize our understanding of stellar populations.

Stellar Populations
56 members

co-chairs:

Kevin Covey (Cornell)

Knut Olsen (NOAO)

These stellar populations will be the foundation of multi-dimensional maps of the Milky Way (MW) galaxy and its neighbors.

Milky Way and Local Volume Structure
34 members

co-chairs:

Marla Geha (Yale)

Beth Willman (Haverford College)

Fundamental Stellar Parameters with Eclipsing Binaries

LSST Galactic Science: Case 1

Fundamental Stellar Parameters with Eclipsing Binaries

Combination of:

Half of sky and six filters (ugrizy)

- **time domain:** entire visible sky every 3 nights for 10 years
- **deep:** 5σ limits

	u	*g*	*r*	*i*	*z*	*y*
single	23.9	25.0	24.7	24.0	23.3	22.1
co-add	26.3	27.5	27.7	27.0	26.2	24.9

Case 1: Eclipsing Binaries

LSST will observe:

16 million EBs to r ~ 22 with S/N > 10 per data point

1.6 million EBs with photometric precision sufficient for detailed modeling

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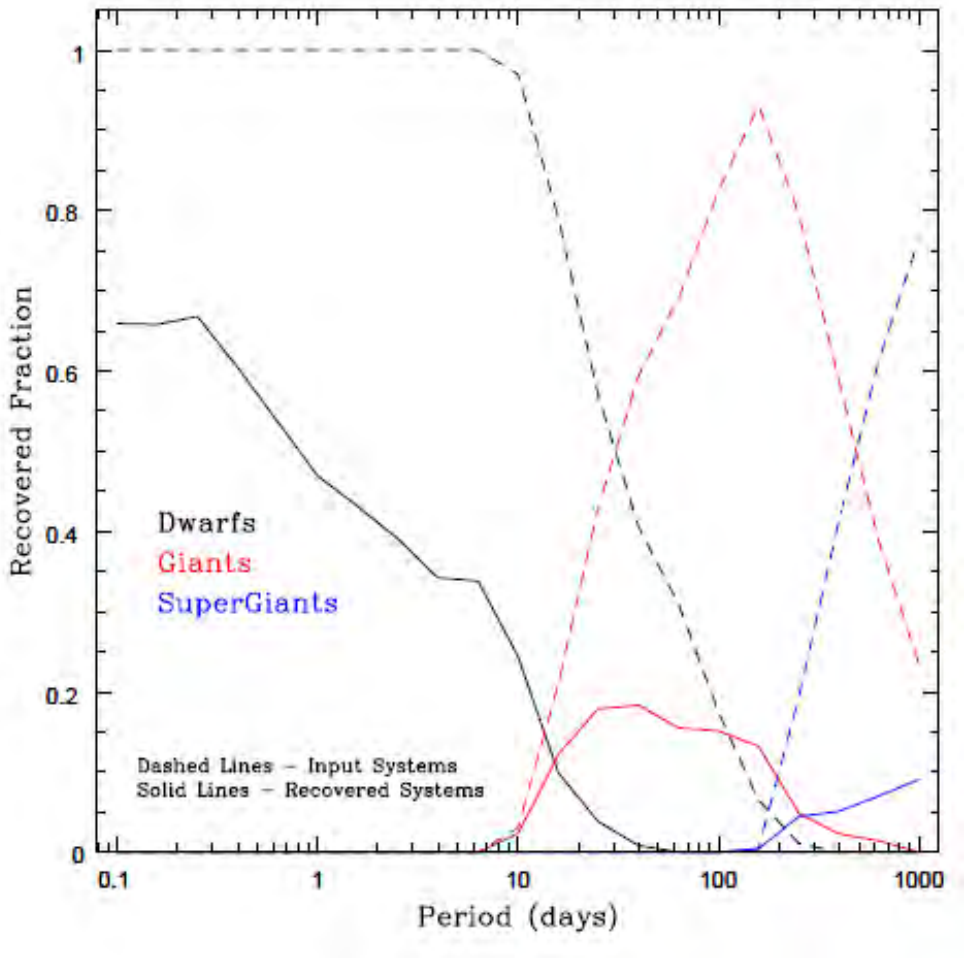

10,000 simulated EBs sampled with LSST cadence and sensitivity. Prsa, Pepper, & Stassun (in preparation)

LSST Galactic Science: Case 2

10 billion main sequence stars

Spatial-([Fe/H]) map of the Milky Way and beyond

High fidelity maps of tangential velocity field to at least 10 kpc (at 10 km s^{-1} precision) and as far as 25 kpc (at 60 km s^{-1} precision).

Case 2: 3D Spatial-[Fe/H]-v_{tan} Maps

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- **precision photometry:**
  0.01 mag precision in *u* yields [Fe/H] to 0.1 dex
- **precision astrometry:**
  0.2 mas/yr at r = 21
  1.0 mas/yr at r = 24

Case 2: 3D Spatial-[Fe/H]-v_{tan} Maps

Many stellar tracers of structure, hierarchical formation, and star formation history of the Milky Way, e.g.

low-mass stars and brown dwarfs (e.g. detect L0 to 2 kpc and parallaxes to 200? pc, detect T0 to 100 pc)

F- and G- main-sequence turnoff stars

RR Lyrae stars (> 400 kpc)

bright red giant branch stars (6 Mpc)

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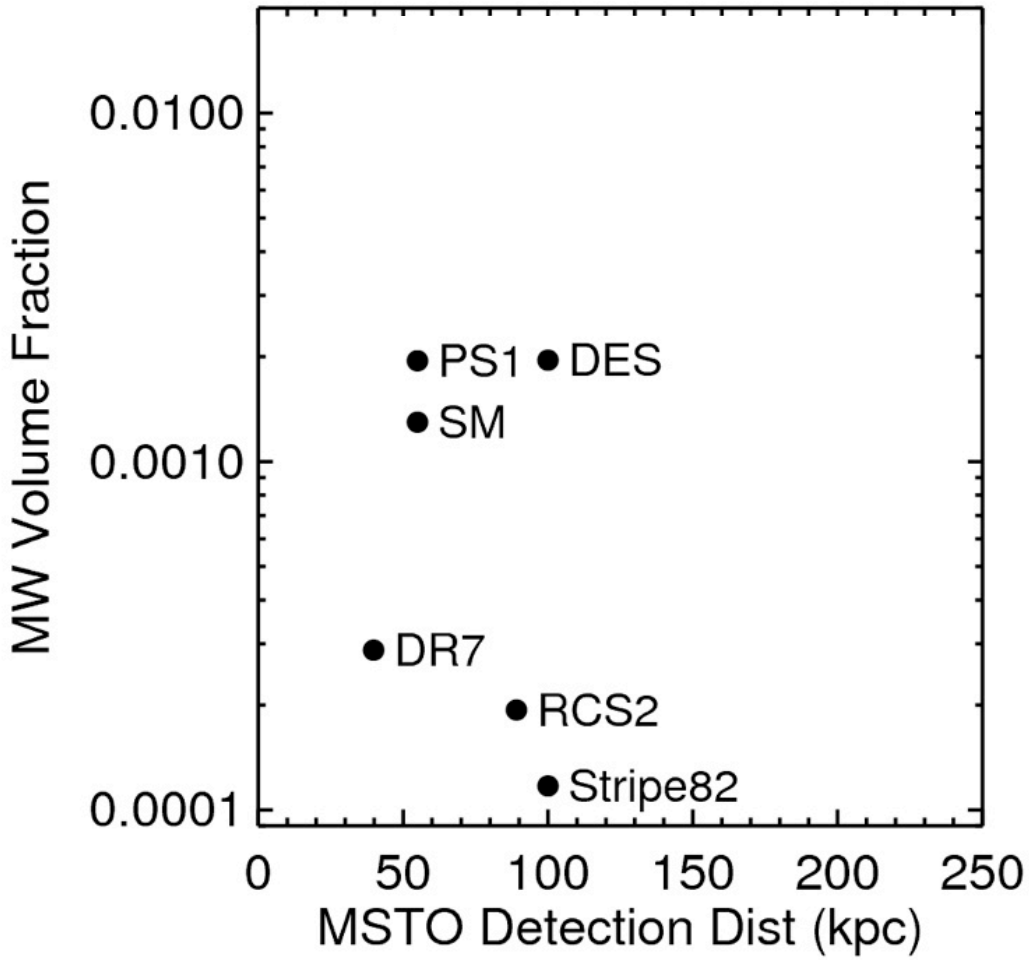

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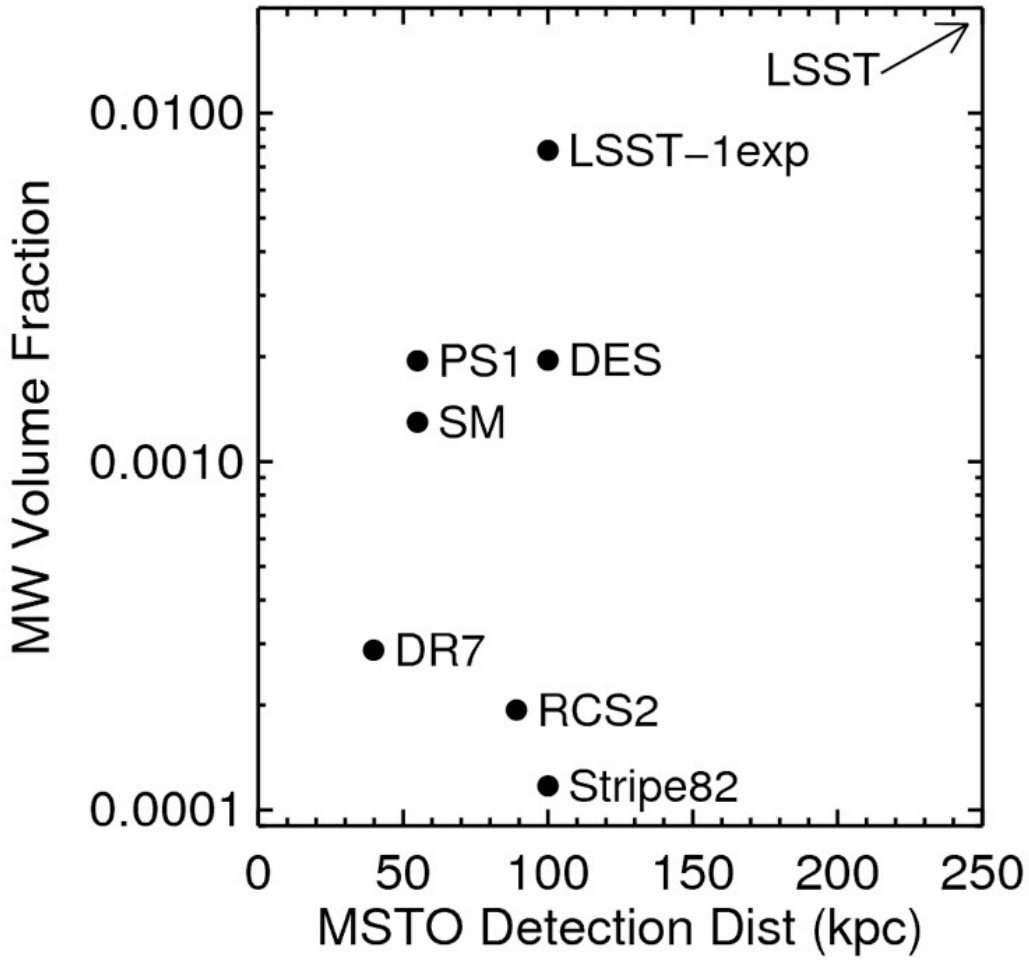

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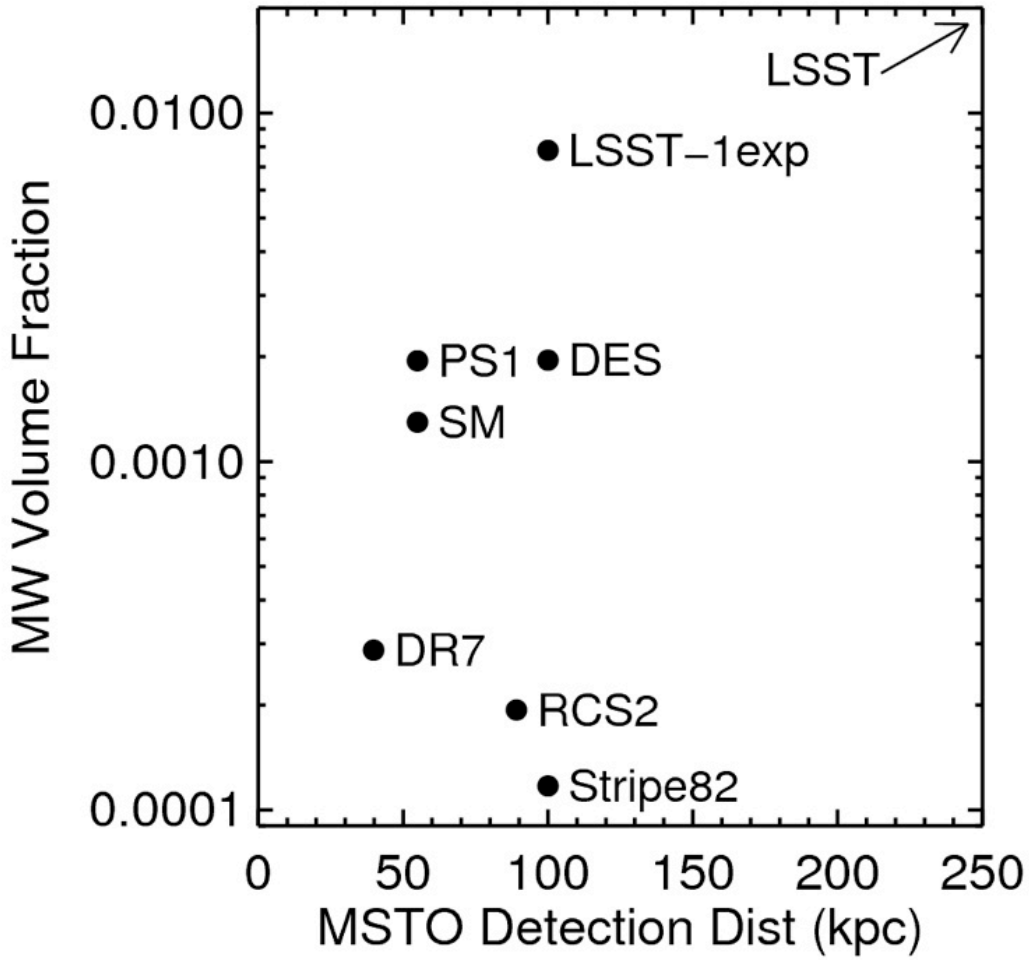

MSTO stars detectable to 300 kpc
Census of ultra-faint dwarfs to virial radius

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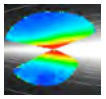

inset: SDSS map to d_{limit} = 10 kpc

Old, metal-poor MSTO stars detected **to 300 kpc.**

Photometric [Fe/H] as precise as 0.1 - 0.2 dex for **200 million stars to 100 kpc.**

Tangential velocity field **to >10 kpc (at 10 km s^{-1} precision)** and as far as 25 kpc (at 60 km s^{-1} precision).

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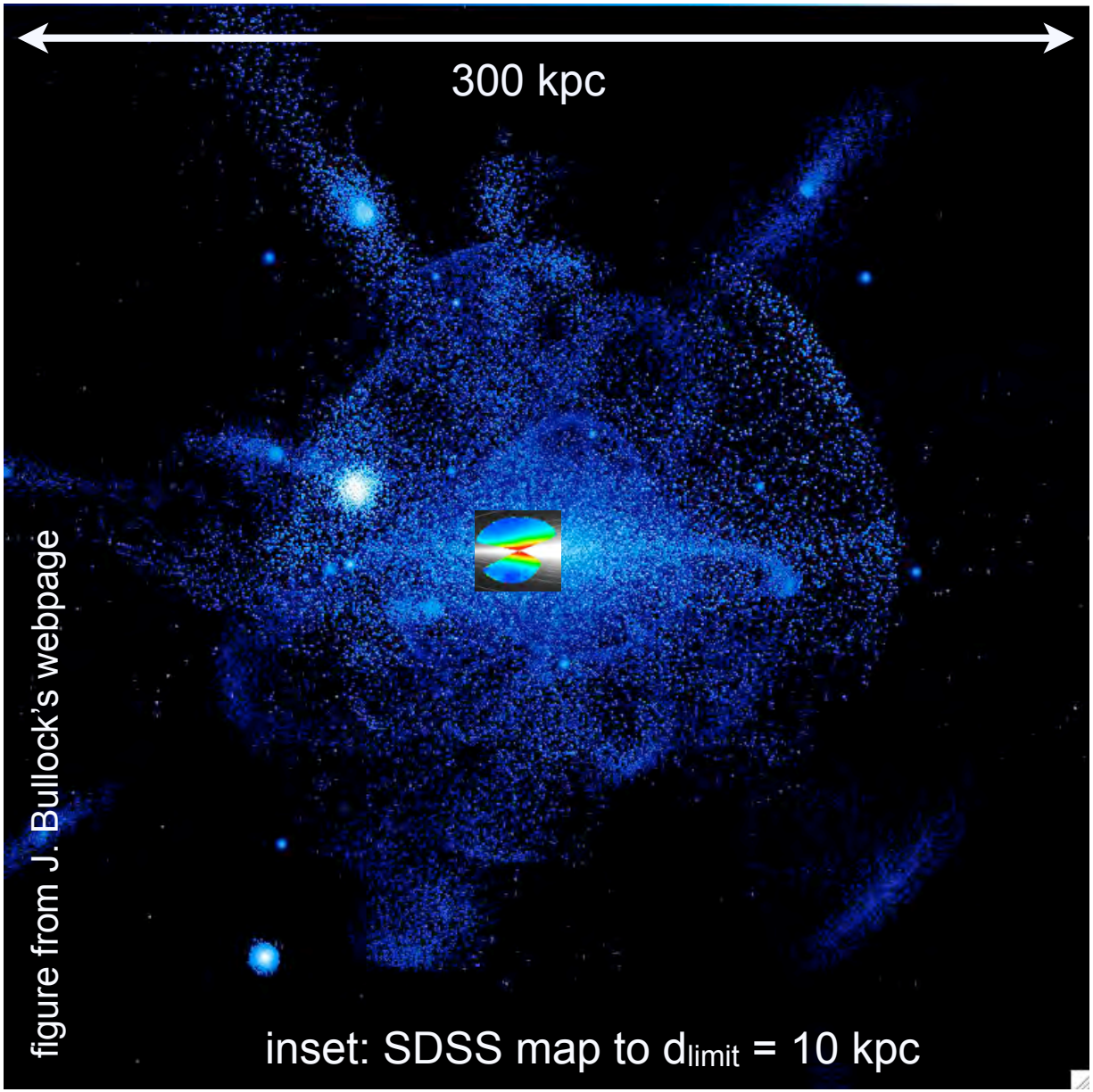

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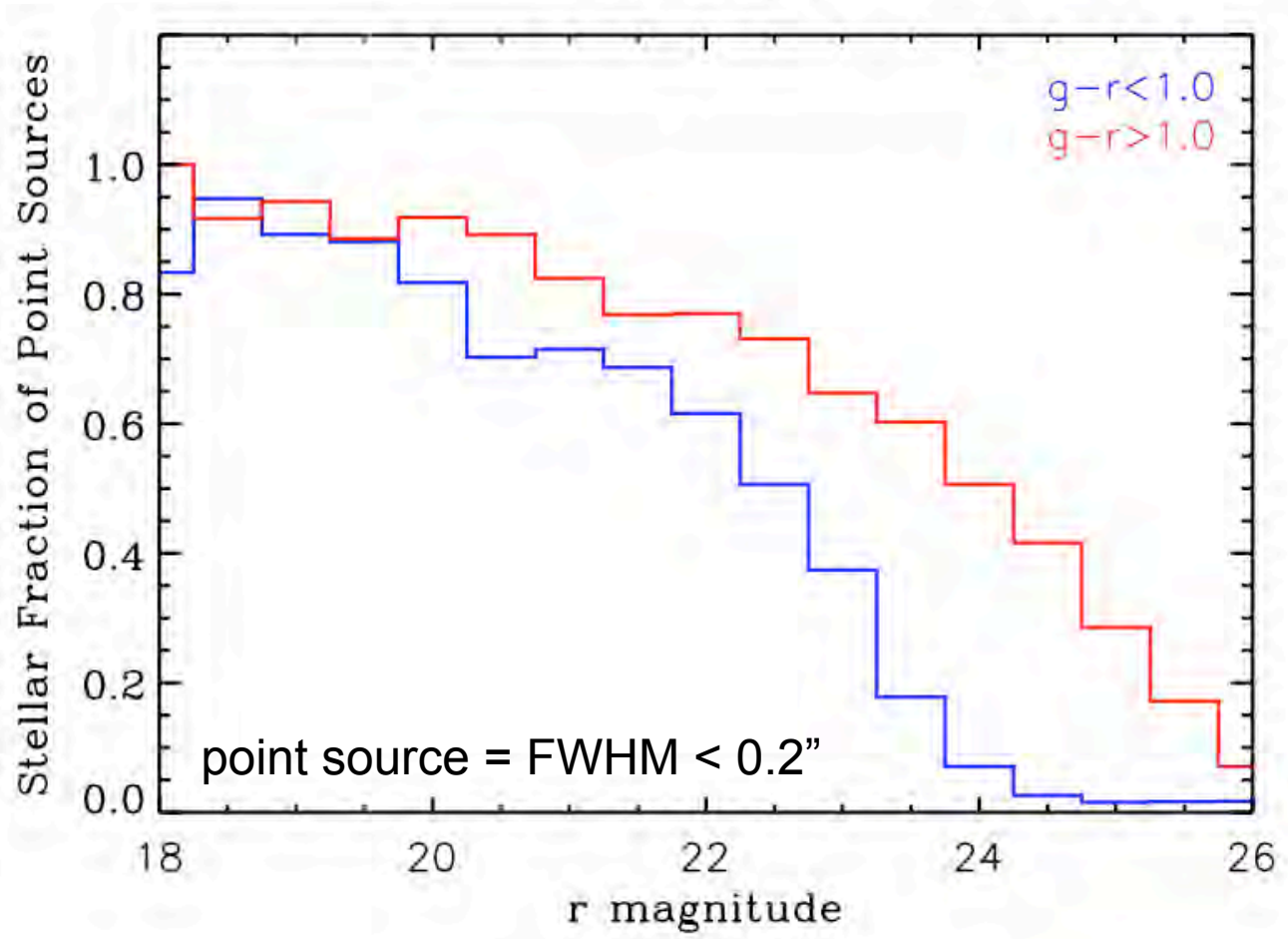
Current Work: Stars vs. Galaxies

At faint magnitudes, most point sources are galaxies

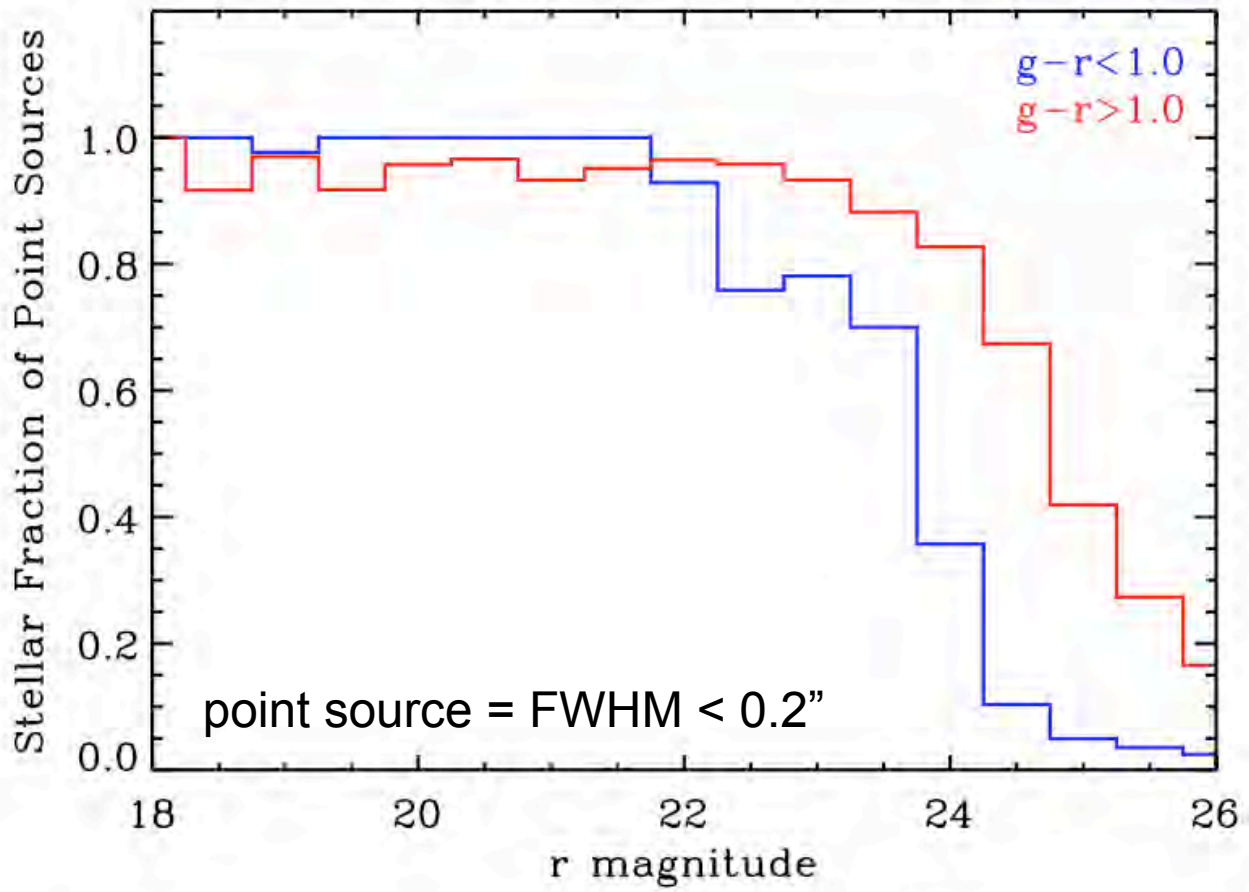


Data from COSMOS
catalog of Ilbert et al (2009)

work in progress by Fadely, Hogg & Willman

Current Work: Stars vs. Galaxies

A simple *ugriz* spectral template χ^2 calculation helps, but...



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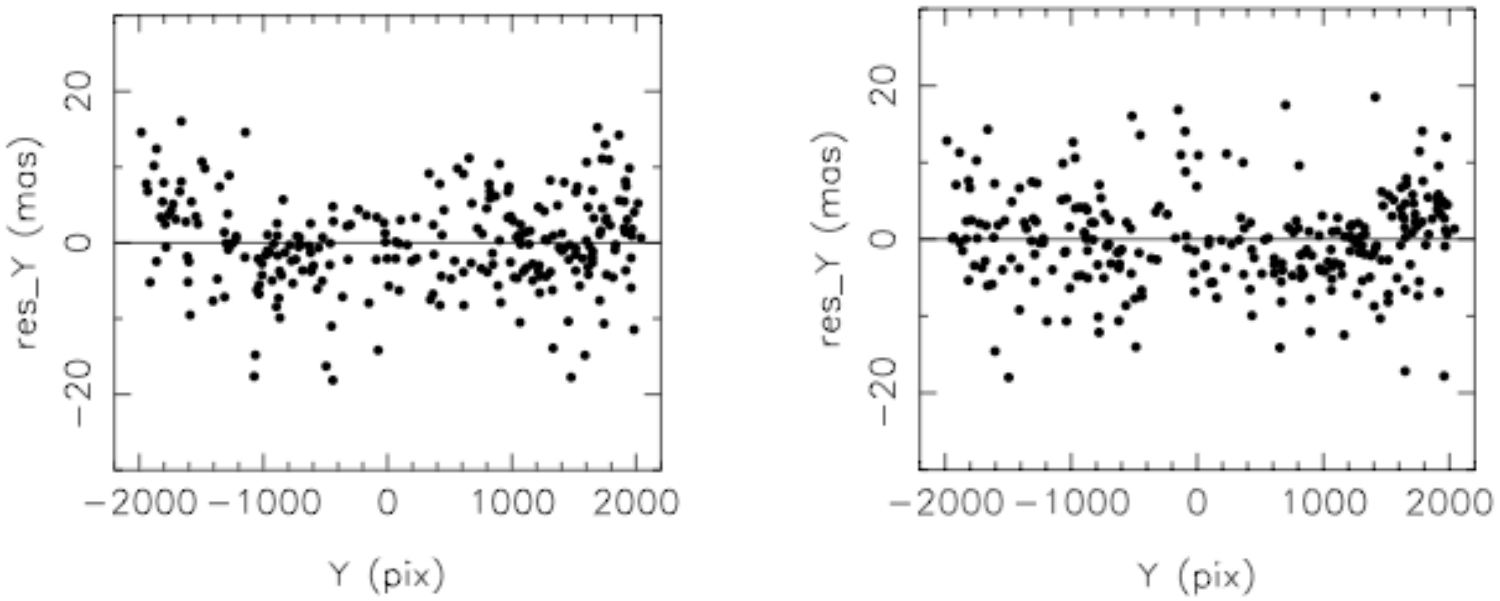
Current Work: Short Exposure Astrometry



Series of observations on Subaru, MMT/Megacam

Investigate atmospheric effects on short exposures

work in progress by Dana Casetti, Terry Girard, Nitya Kallivayalil (Yale)

Summary

• Time domain, deep+precise photometry, precise astrometry *uniquely combine* to enable definitive measures of fundamental stellar parameters and a multi-dimensional map of the Milky Way and beyond

• Wide range of work in progress by many collaboration members - geared to LSST but making resolved stellar science better *now* (e.g. using Operations/Image simulations to develop algorithms, separating stars and galaxies, short exposure astrometry)

• Lots more to do!