Southern Sky Survey and the Milky Way Halo

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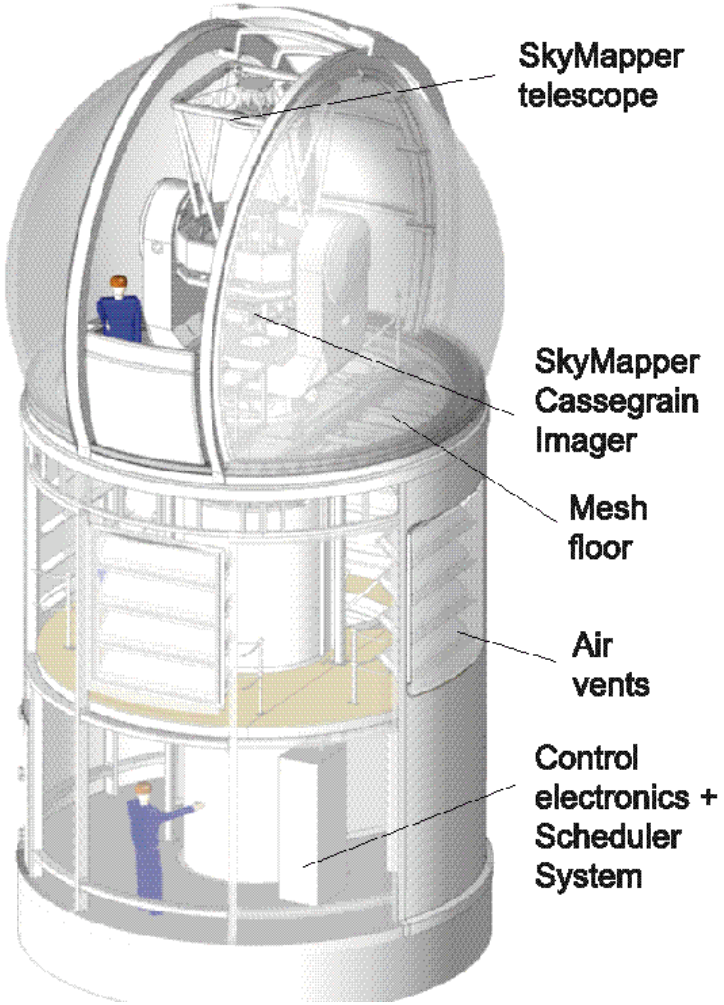
SkyMapper

- 1.35m telescope with a 5.7 sq. degree field of view
- located at Siding Spring Observatory, NSW
- To conduct the Southern Sky Survey:
  - Five year
  - Multi-colour (6 filters)
  - Multi-epoch (6 exposures, each filter)
  - 2π steradians
  - Limiting mag. g~23
- First light October 2007



The Rapid Imaging Survey Era

Name	Aperture (m)	FOV (sq deg)	Filter Set	Areal Coverage	Hemi sphere	First Light
SDSS	2.5	Drift scan	ugriz	π of 3/2π	N	Operating
CFHT MegaCam	3.6	1	ugriz	<1000	N	Operating
SkyMapper	1.35	5.7	uvgriz	2 π	S	2007
PanStarrs	1.8 (+3x)	7	grizY	3 π	N	2008
VISTA	4	1.65	zYJHK	2 π	S	2008
VST	2.6	1	ugriz	~5000	S	2008
Discovery Chn	4	2	?	?	N	2009?
Dark Energy	4	2	?	5000	S	2009?
LSST	8.4	10	ugrizY	3 π	S	2013

- We aim to fill the gap in the coverage of the Southern sky, matched to SDSS but with significant improvements:
  - sky + temporal coverage; sensitivity to stellar parameters (BUT no concurrent spectroscopy...)

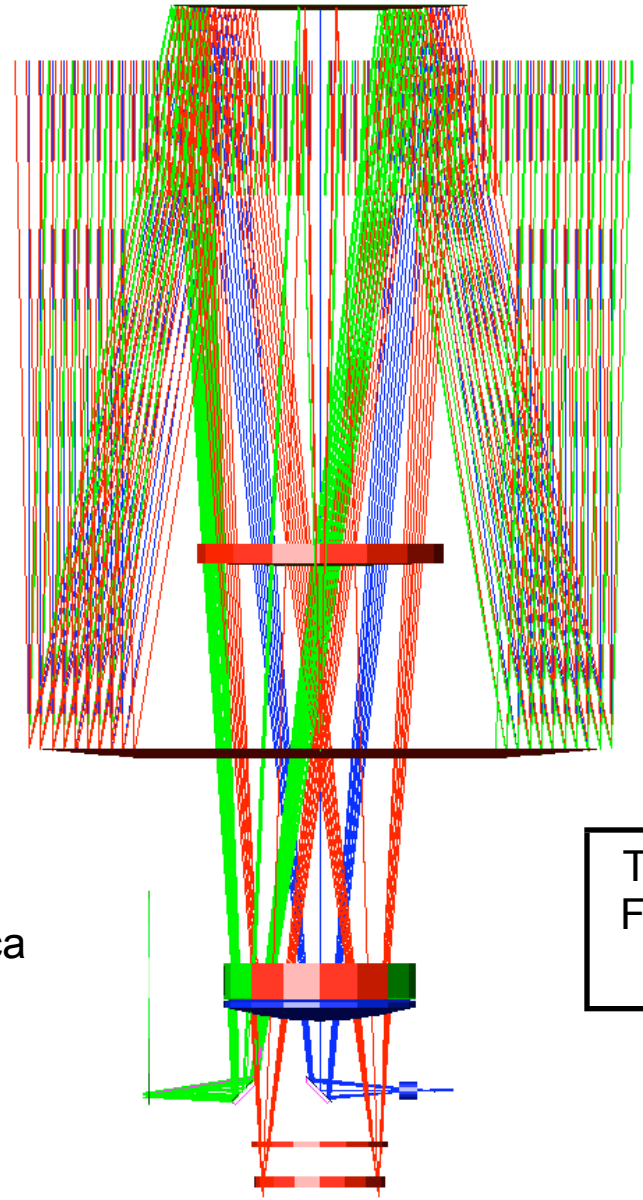
Telescope Optics

0.69m secondary

0.6m fused silica asphere

1.35m primary

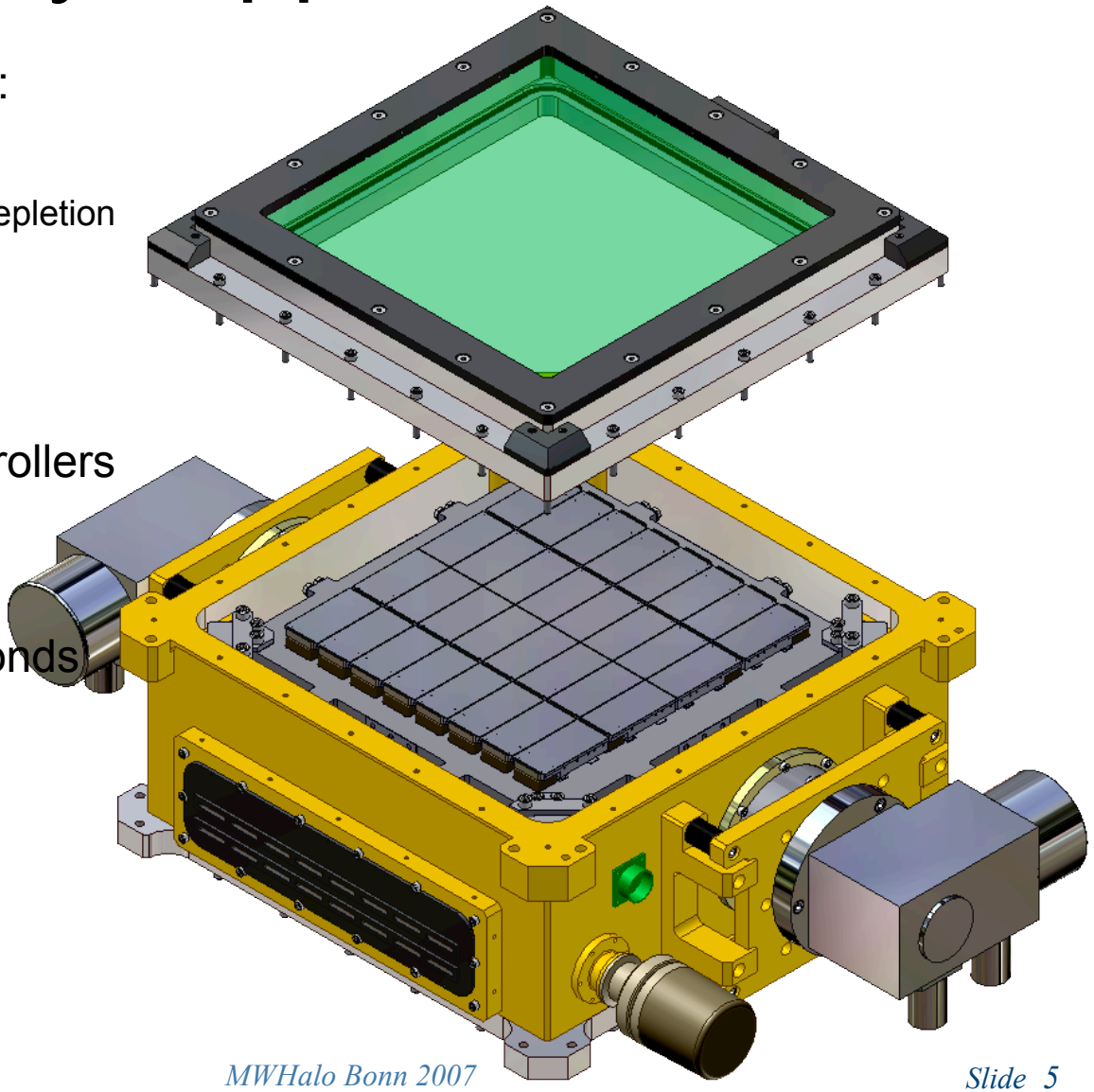
2 x 0.45m fused silica spherics

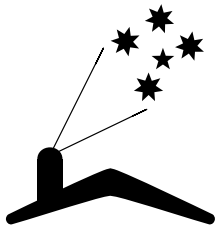


Telescope – Focal length & f/ ratio.	16224.75mm f/4.78

The SkyMapper CCDs

- 32 E2V CCD44-82 devices:
  2048x4096 15 micron pixel CCDs
  - Broadband coated
  - 40 micron (thick) deep depletion devices
  - Reduced fringing, inc. red response
- 16384x16384 0.5” pixels
- Using new Pan Starrs controllers (http://www.stargrasp.org/)
- Readout in ~12seconds
- Readnoise ~5e- @ 12 seconds





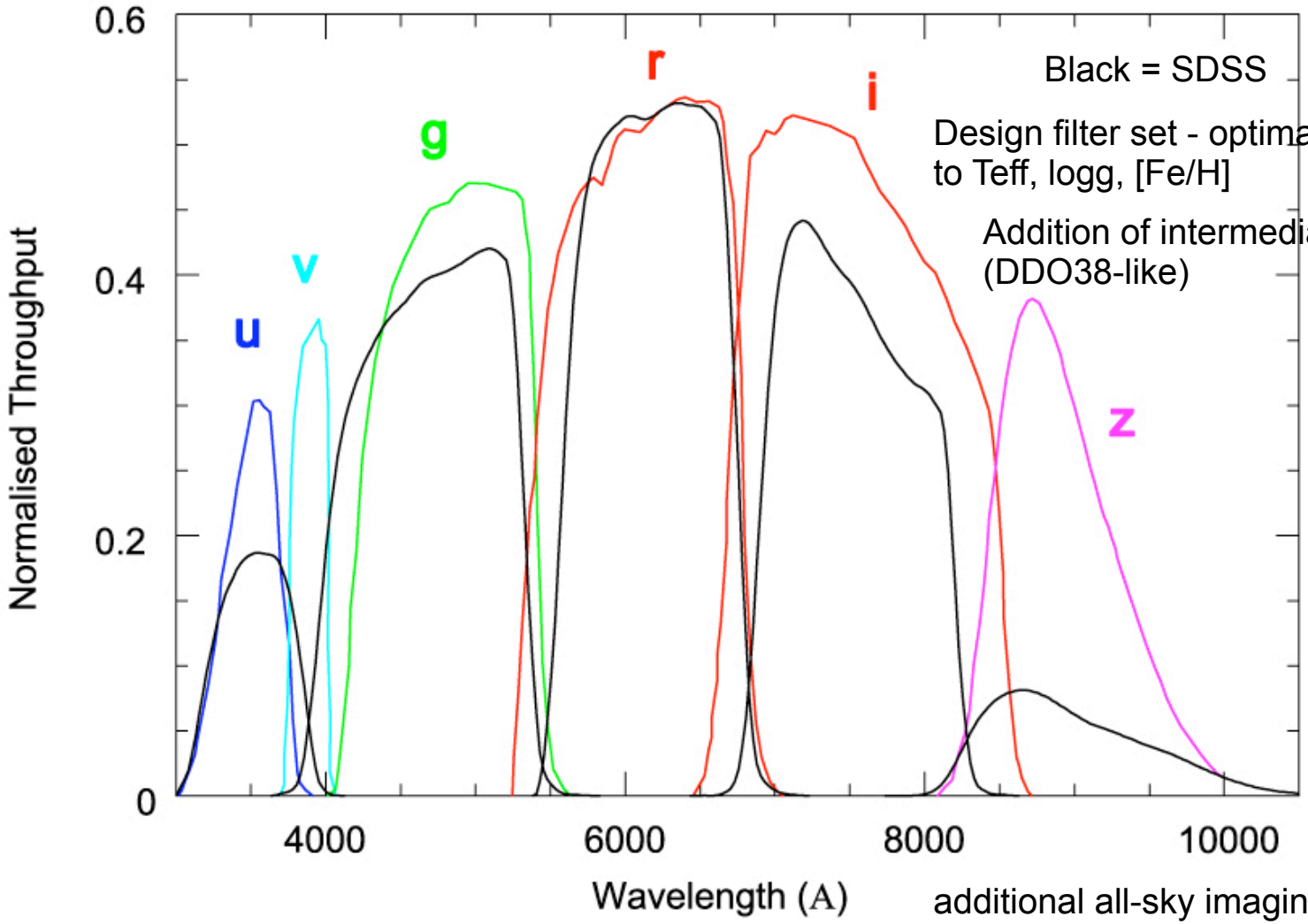
The Southern Sky Survey

- 2π coverage: 4096 fields observed in six filters, six times per filter
- Cadence: hours, days, weeks, months, years
- star/galaxy photometry to 3% globally (g<18)
- astrometry to 50 milliarcsec (absolute)
  - 36 images of each object over 5 years

    ⇒ proper motions to ±2 mas/yr. (i.e. σvtan=25km/s at 2.5kpc)

    ⇒ parallax ±5 mas (i.e. 20pc σd=10%) [David Monet priv. comm.]
- survey complete in 5 years

SkyMapper Filter Set



Design filter set - optimal sensitivity to Teff, logg, [Fe/H]

Addition of intermediate *v* filter (DDO38-like)

additional all-sky imaging in DDO51 (MgH) & Hα

Expected Survey Limits

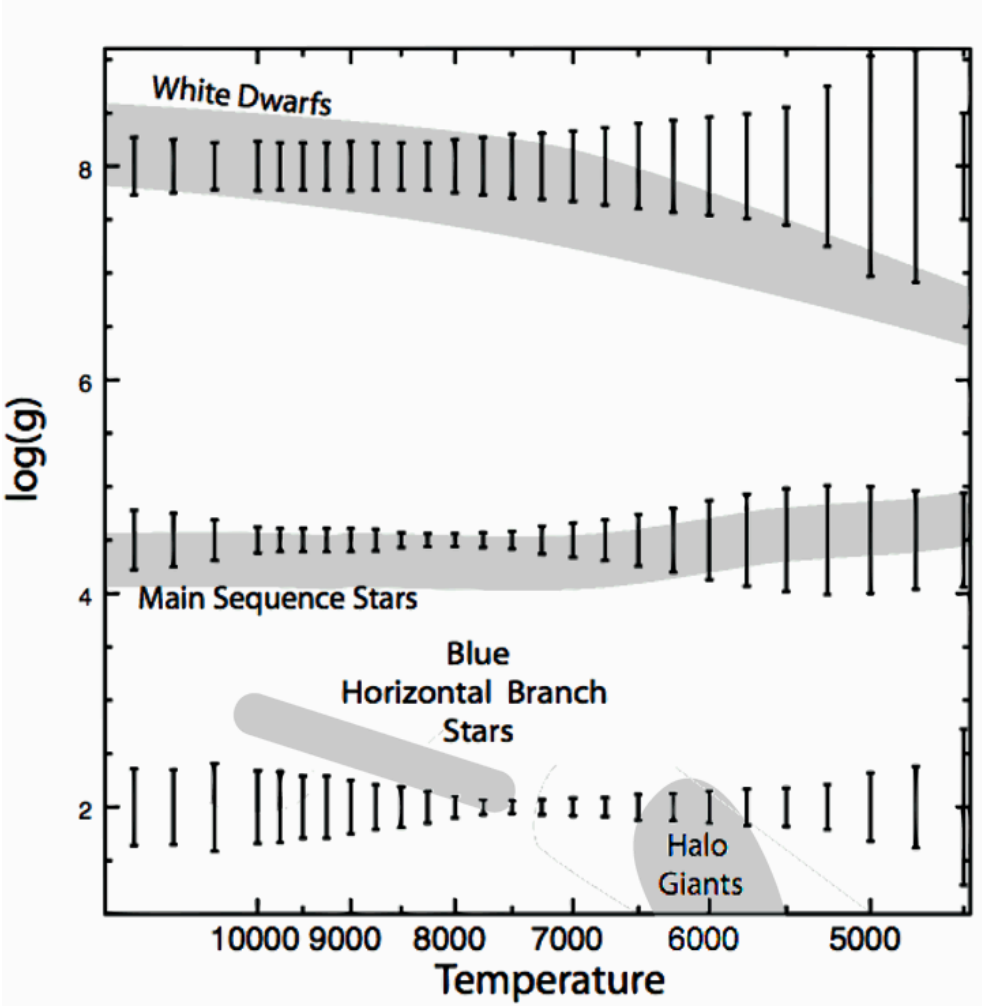
	u	*v*	*g*	*r*	*i*	*z*
1 epoch	21.5	21.3	21.9	21.6	21.0	20.6
6 epochs	22.9	22.7	22.9	22.6	22.0	21.5
Sloan Digital Sky Survey comparison	22.0	n/a	22.2	22.2	21.3	20.5

AB mag. for signal-to-noise = 5 from 110s exposures

Key Science

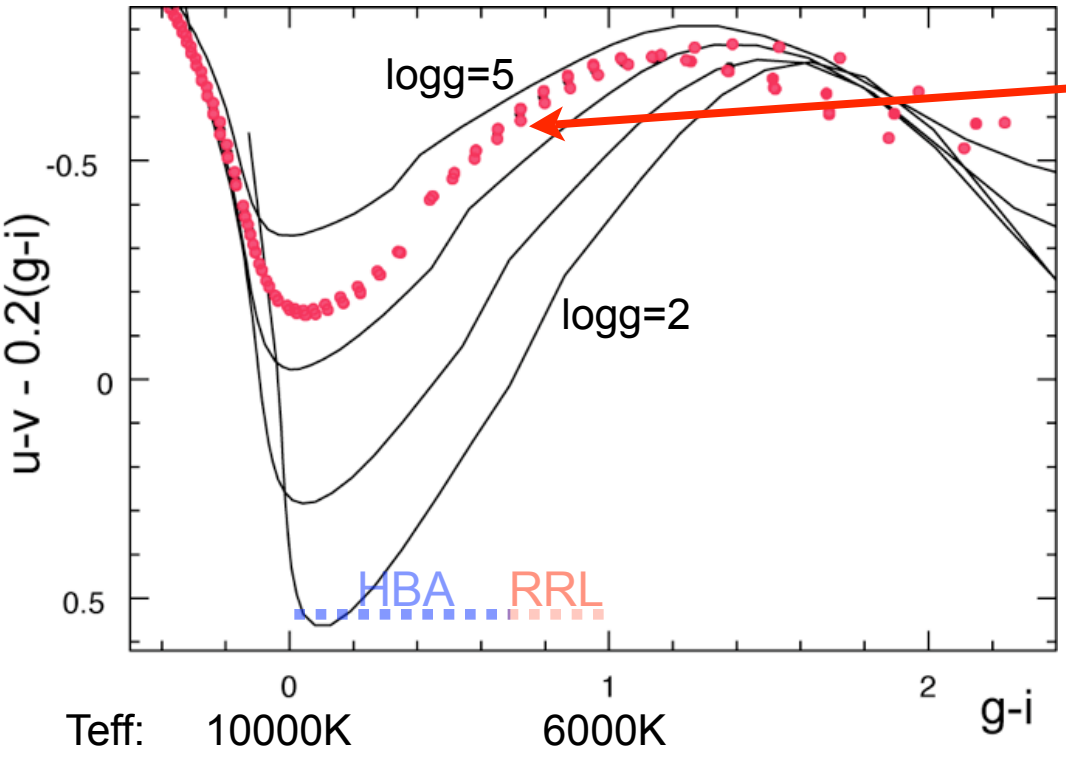
- What is the distribution of large Solar-System objects beyond Neptune?
- What is the history of the youngest stars in the Solar neighbourhood?
- How far does the dark matter halo of our galaxy extend and what is its shape?
- Gravity and metallicity for on order of 100 million stars ⇒ the assembly and chemical enrichment history of the bulge, thin/thick disk and halo?
- Extremely metal poor stars
- dSph satellites of the MW
- Nearby SNe and GRBs
- bright z>6 QSOs

SkyMapper Filter Set
optimised for stellar astrophysics



1-sigma uncertainty in logg as a function of logg, T_{eff}

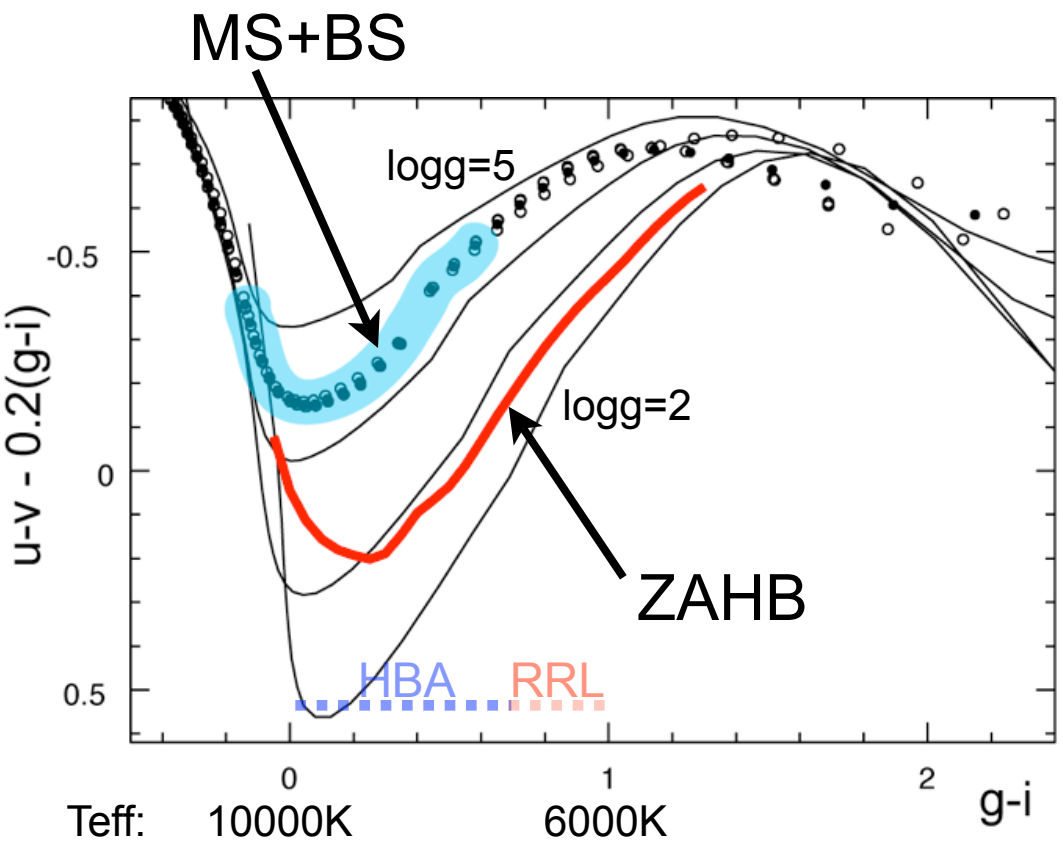
Blue Horizontal Branch Stars

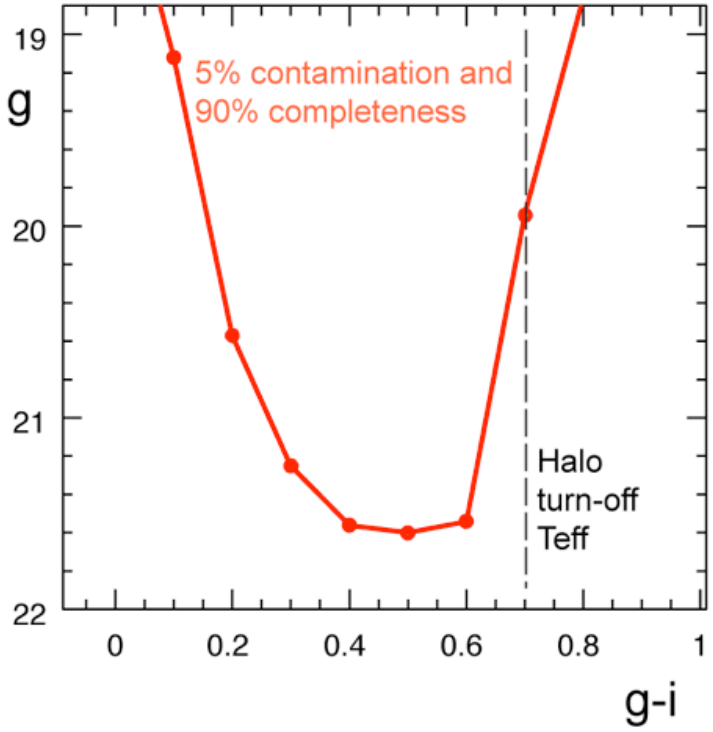


u-v: surface gravity sensitive

u-v measures H^- continuum opacity which increases with log*g*

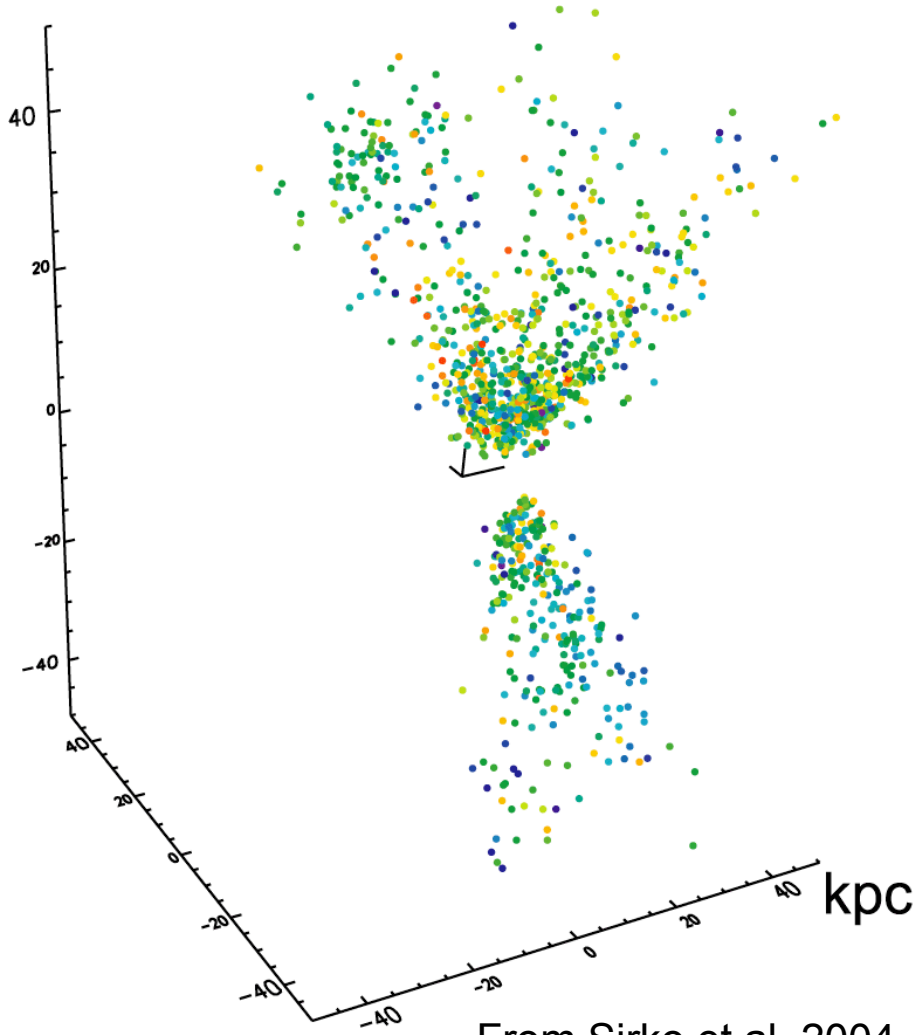
Blue Horizontal Branch Stars





takes us out to distances >100kpc with low contamination

Blue Horizontal Branch Stars



From Sirko et al. 2004
AJ, 127, 914

The SDSS view

Use a set of colour and spectroscopic indices to isolate BHBs

Extend to 60kpc

The SkyMapper View

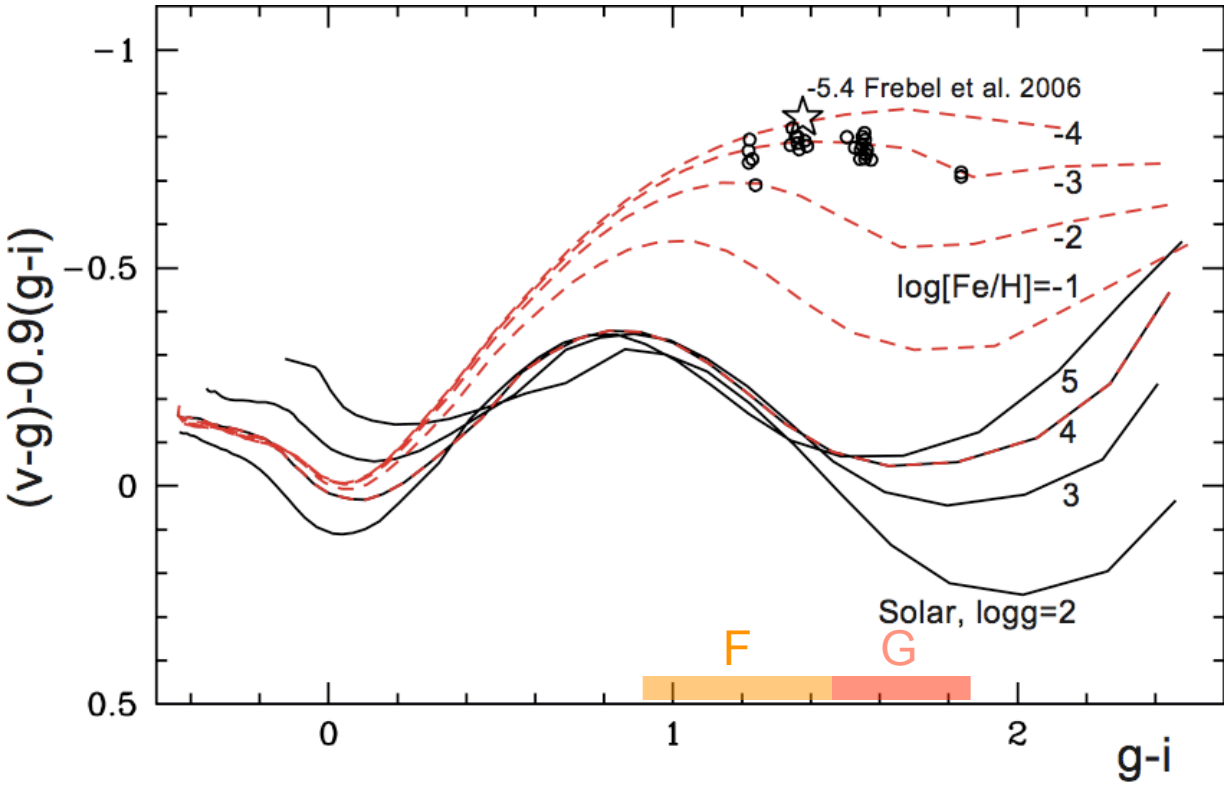
Photometric BHB selection to 130kpc with 5% contamination

+ RRLs obtained from time series

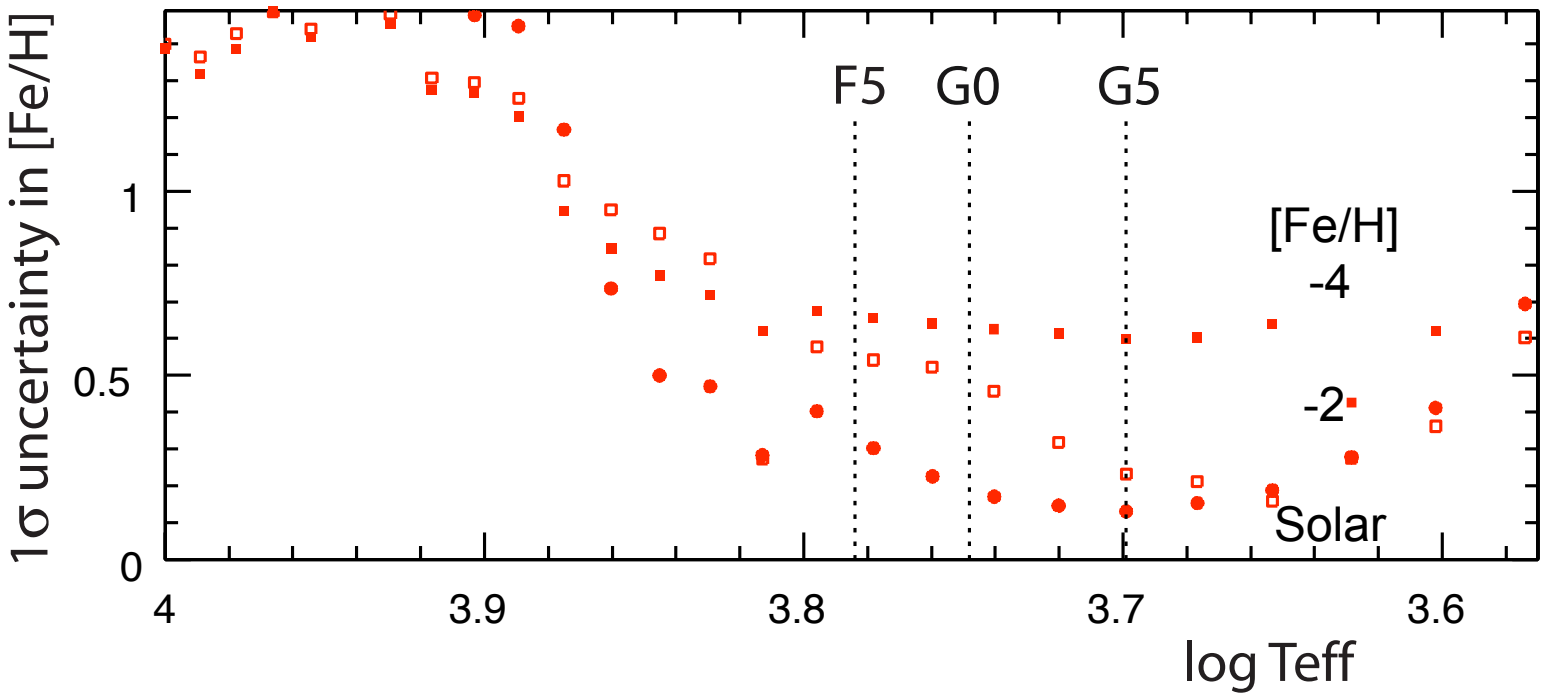
Extremely Metal-poor Stars in the Halo

- Goal: find the first stars to have formed in the Universe: tell us about the assembly and chemical enrichment of the Galaxy
- v-g is dependent on the level of metal line blanketing in the blue continuum

✓ not perturbed dramatically by C-enhancement, chromospheric emission as affects objective-prism surveys

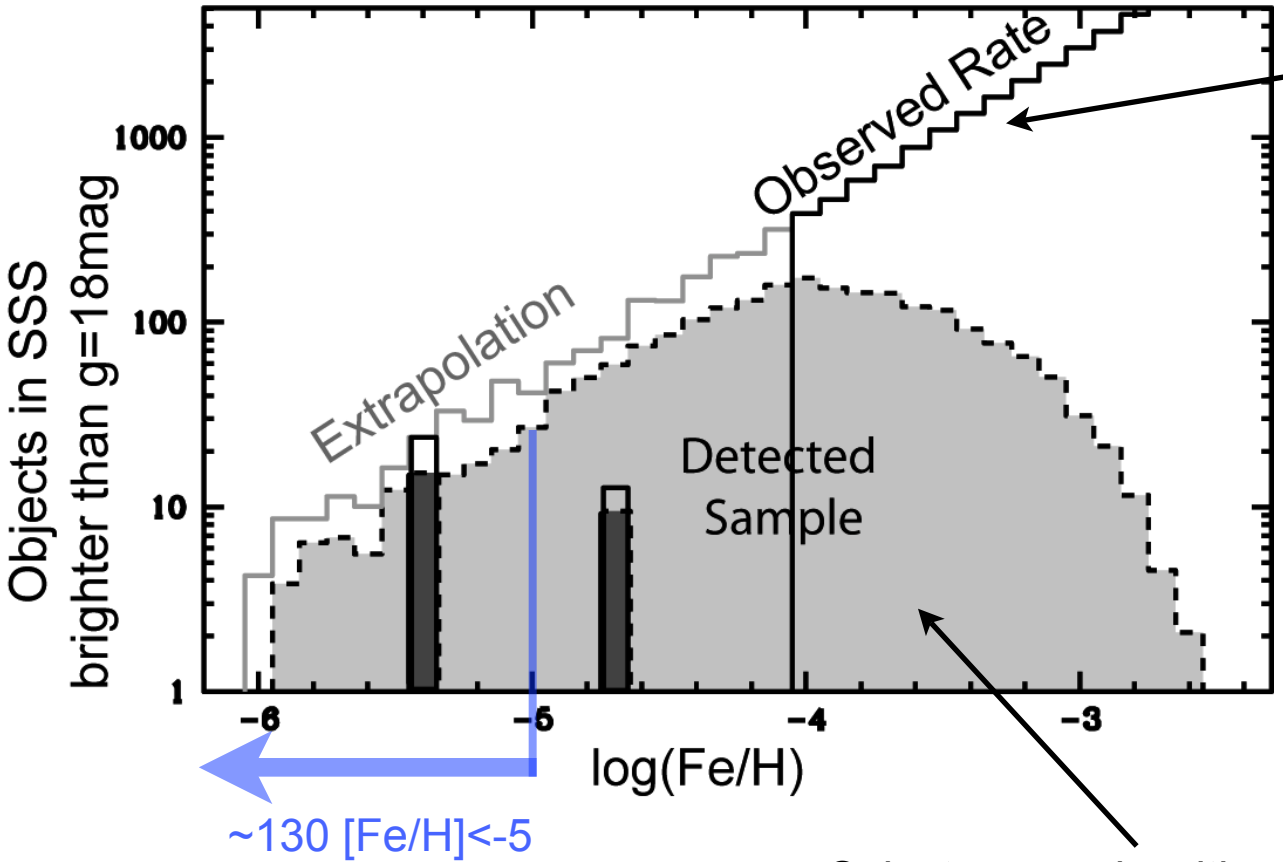


Extremely Metal-poor Stars in the Halo



Better still in 5-dimensional colour space.
From the 5-d colour space: [Fe/H]=-4 ⇒ ±0.7dex

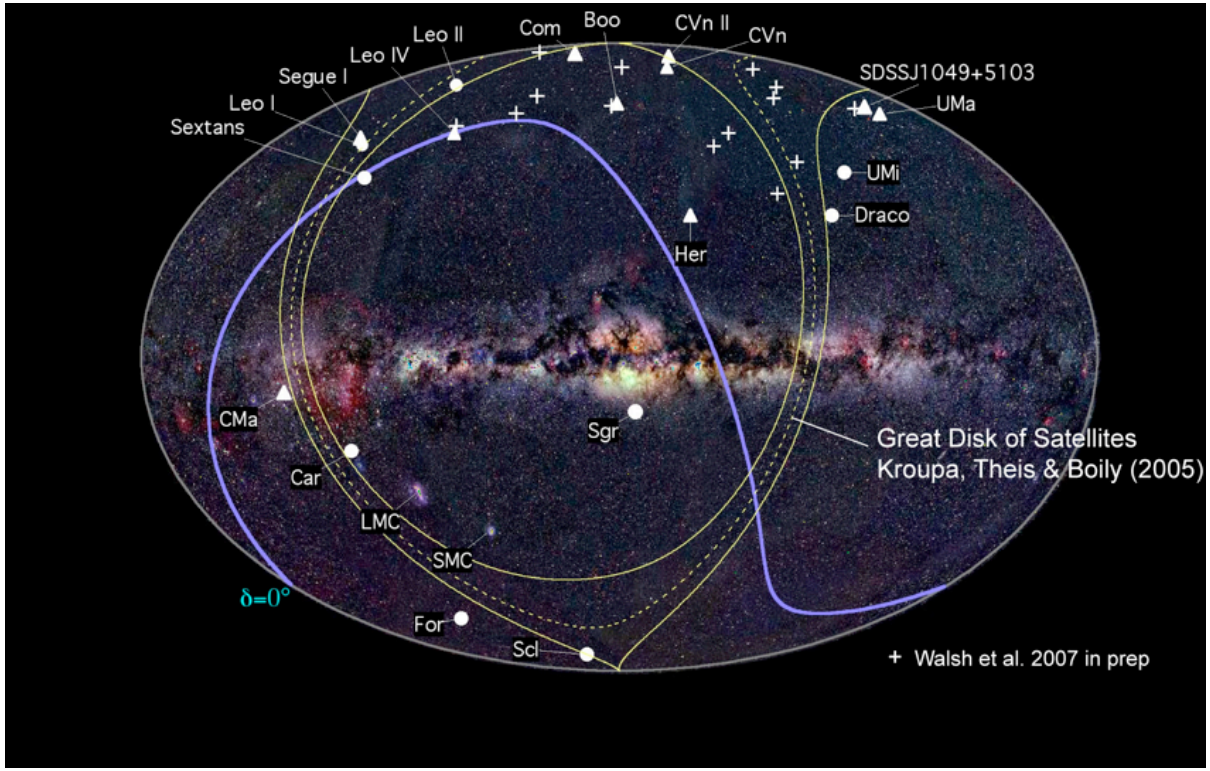
Extremely Metal-poor Stars in the Halo



Scale HES numbers for increased area, depth

Select a sample with photometrically derived [Fe/H]<-4 and g<18 returns this sample of spectroscopic [Fe/H]

Dwarf Galaxy Satellites of the MW

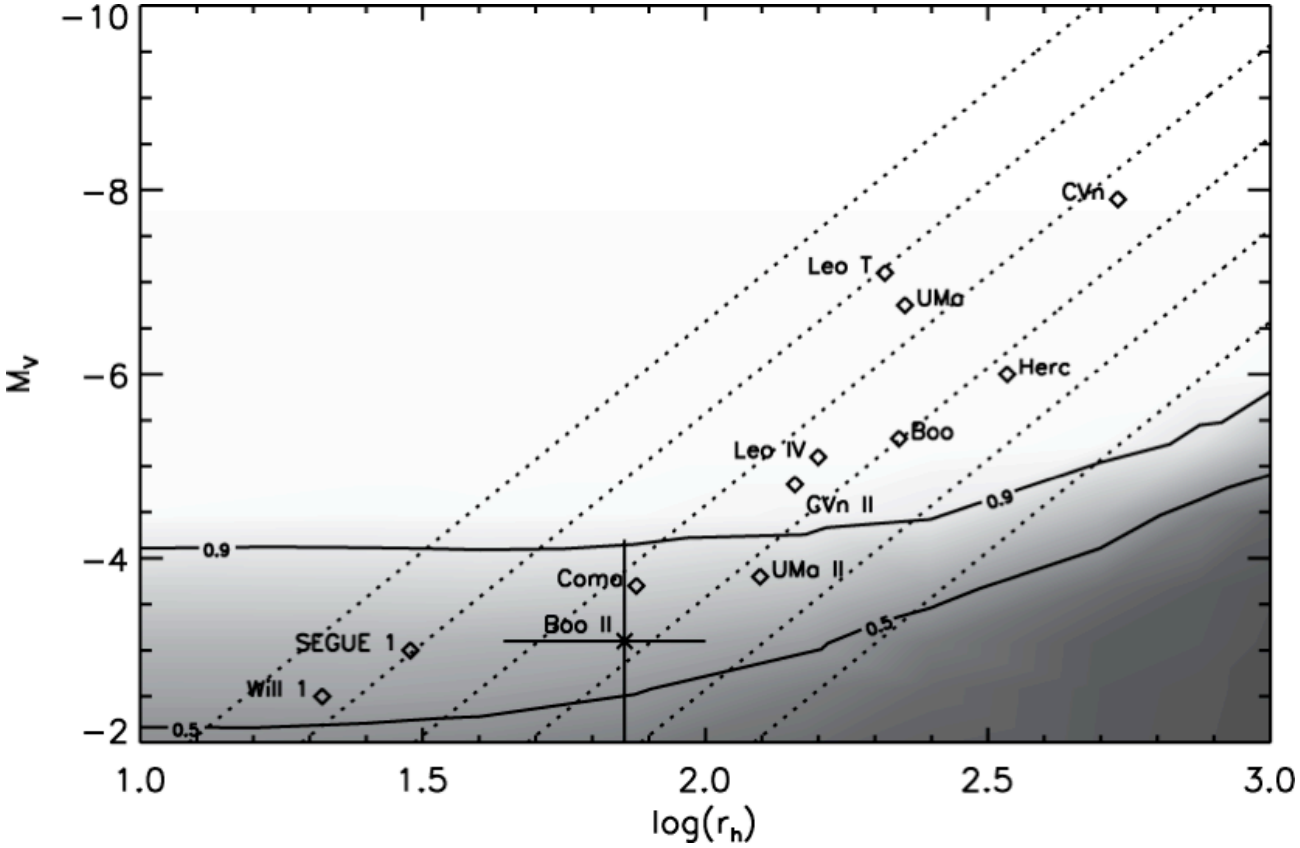


The Stromlo Missing Satellite Program
PI: Helmut Jerjen

SDSS has almost doubled the number of known MW satellites

Walsh et al. (2007 in prep.) present 14 more candidates!

Dwarf Galaxy Satellites of the MW



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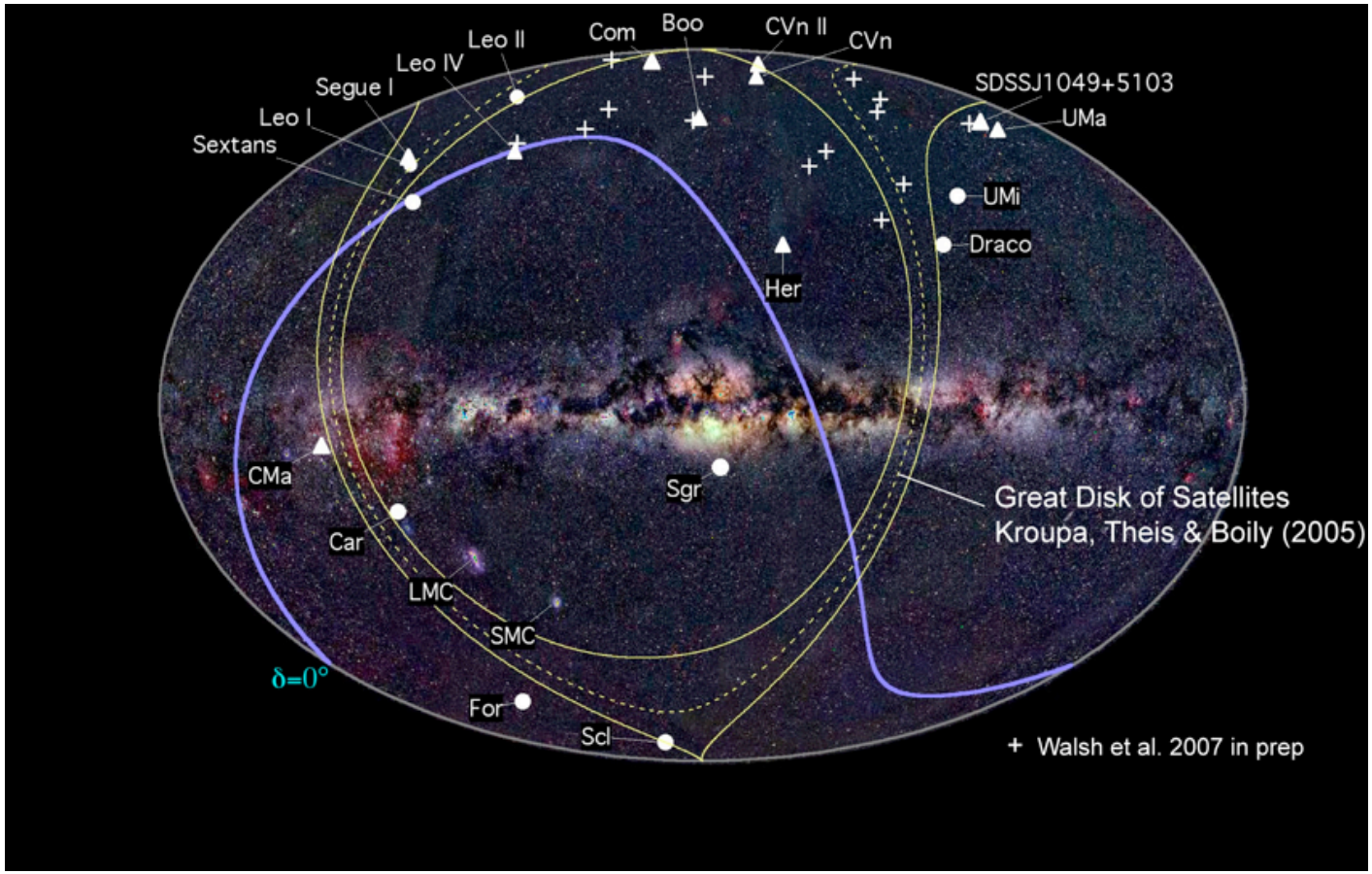
We can expect similar limits from the Southern Sky Survey

from Walsh et al. 2007 astro-ph/07051378 - discovery of Boo II dSph

Dwarf Galaxy Satellites of the MW



- The frequency of new dSph ⇒ many more to be found
- Will the Great Disk stand? More interesting discussion!

Summary

- SkyMapper and the Southern Sky Survey - a valuable resource for the southern sky
- with a filter set specifically designed for stellar astrophysics
- Provide accurate photometry and astrometry for 8 to 23rd magnitudes in multiple epochs
- First light in October this year
- Can be used for countless science programs - ask us, get involved

http://www.mso.anu.edu.au/skymapper

astro-ph:0702511 Project Overview