JINA Observations, Now and in the Near Future

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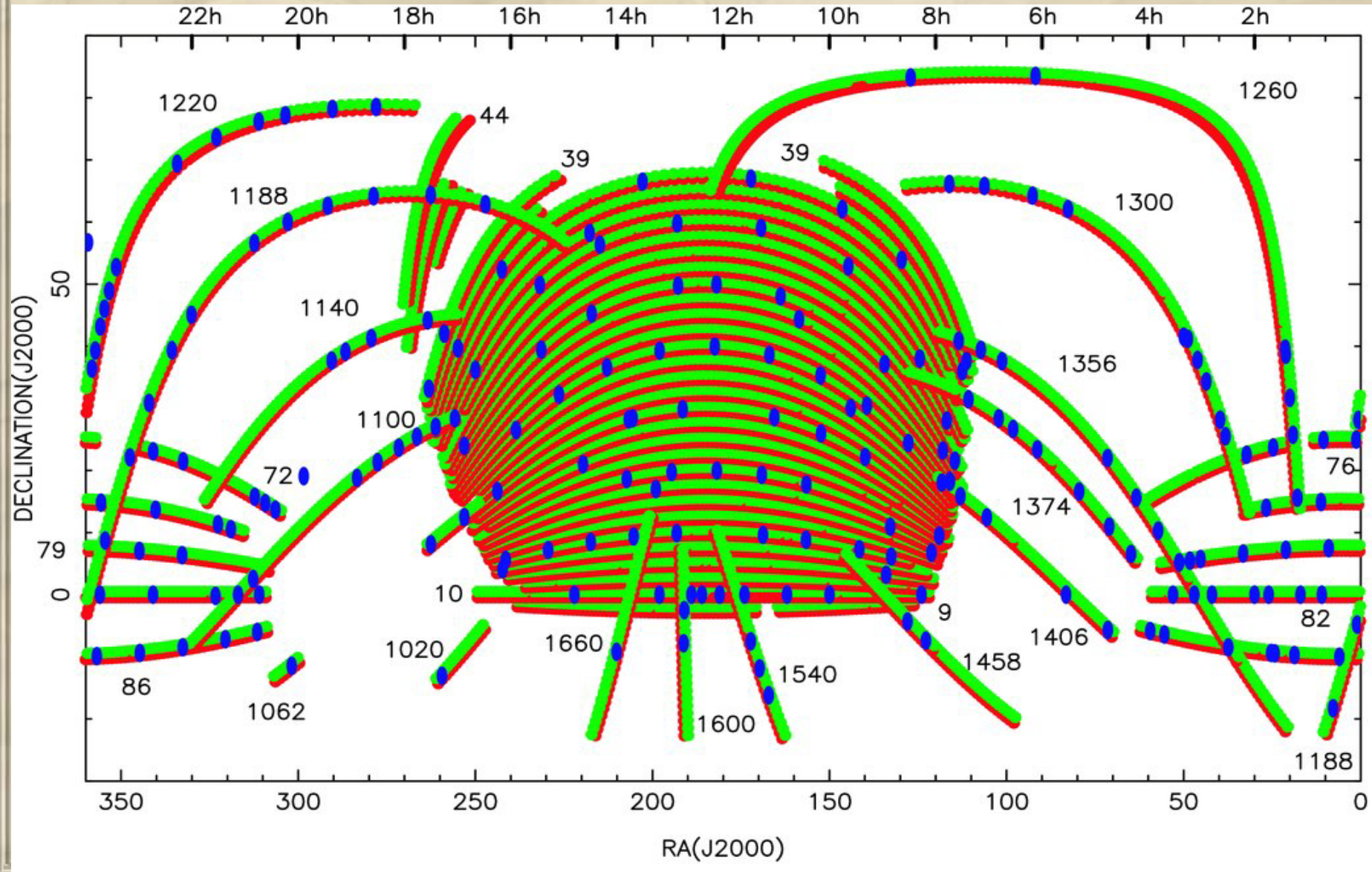
Examples

- SDSS-I, II, and III 1999-2014
- RAVE 2003-2012
- LAMOST 2010-2015
- SkyMapper 2010-2015
- HERMES 2012-2017
- LSST 2014-2024
- Gaia 2014-2024

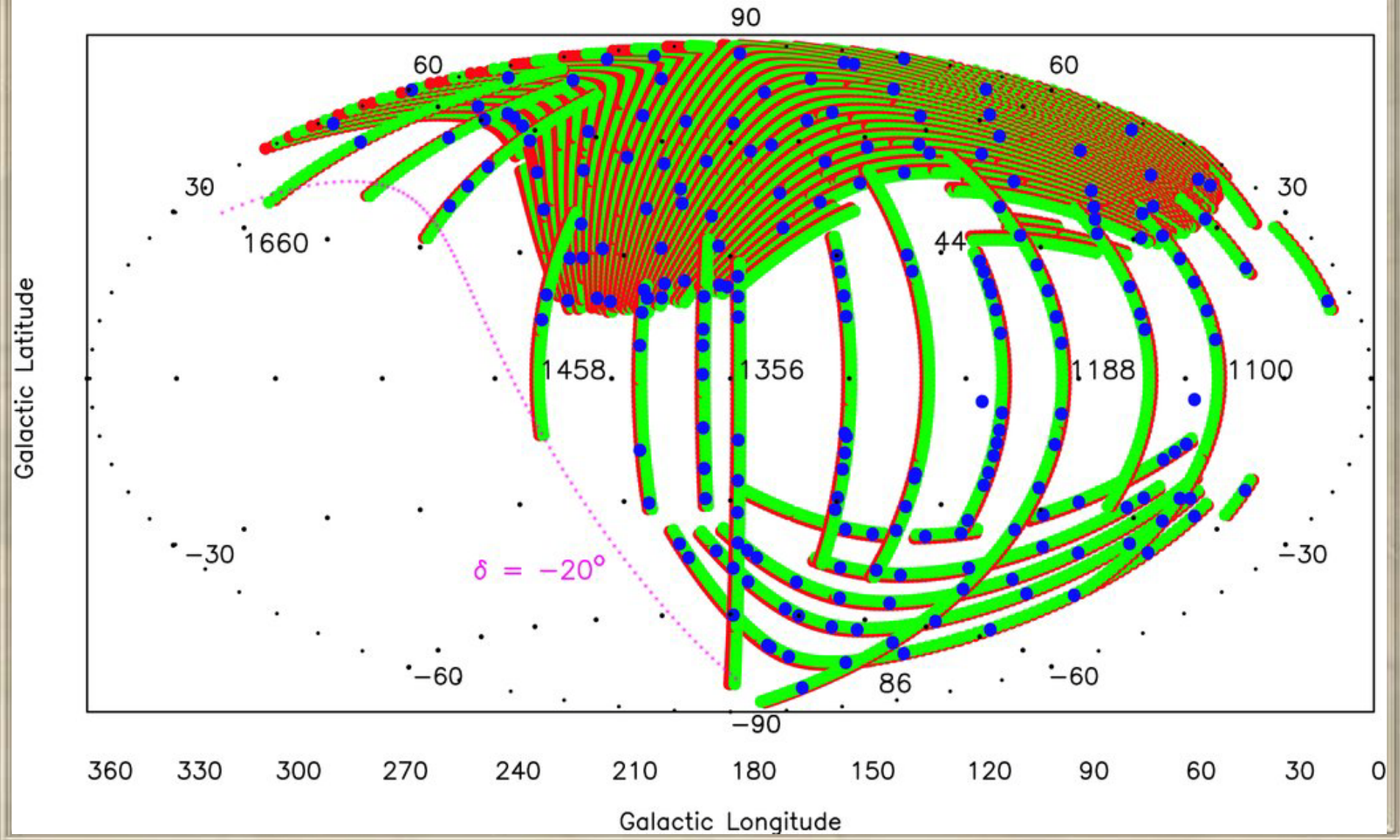
SDSS/SEGUE-1/SEGUE-2

- SDSS -- obtained broad-band *ugriz* photometry for over 300,000,000 objects, many of them stars
- SDSS -- also obtained medium-res (R ~ 2000) spectroscopy for some 100,000 stars (mostly WD, CV, BHB, FTO, G dwarfs, M dwarfs, and calibration stars)
- SEGUE-1 -- targeted BHB, FTO, G dwarfs, MP stars, K giants (about 250,000)
- SEGUE-2 -- had similar targets but, refined selection algorithm, push to include more outer-halo tracers (150,000)
- In Total – About 500,000 stellar spectra, roughly 400,000 of which have available atmospheric params (Teff, log g, [Fe/H]) from the SSPP

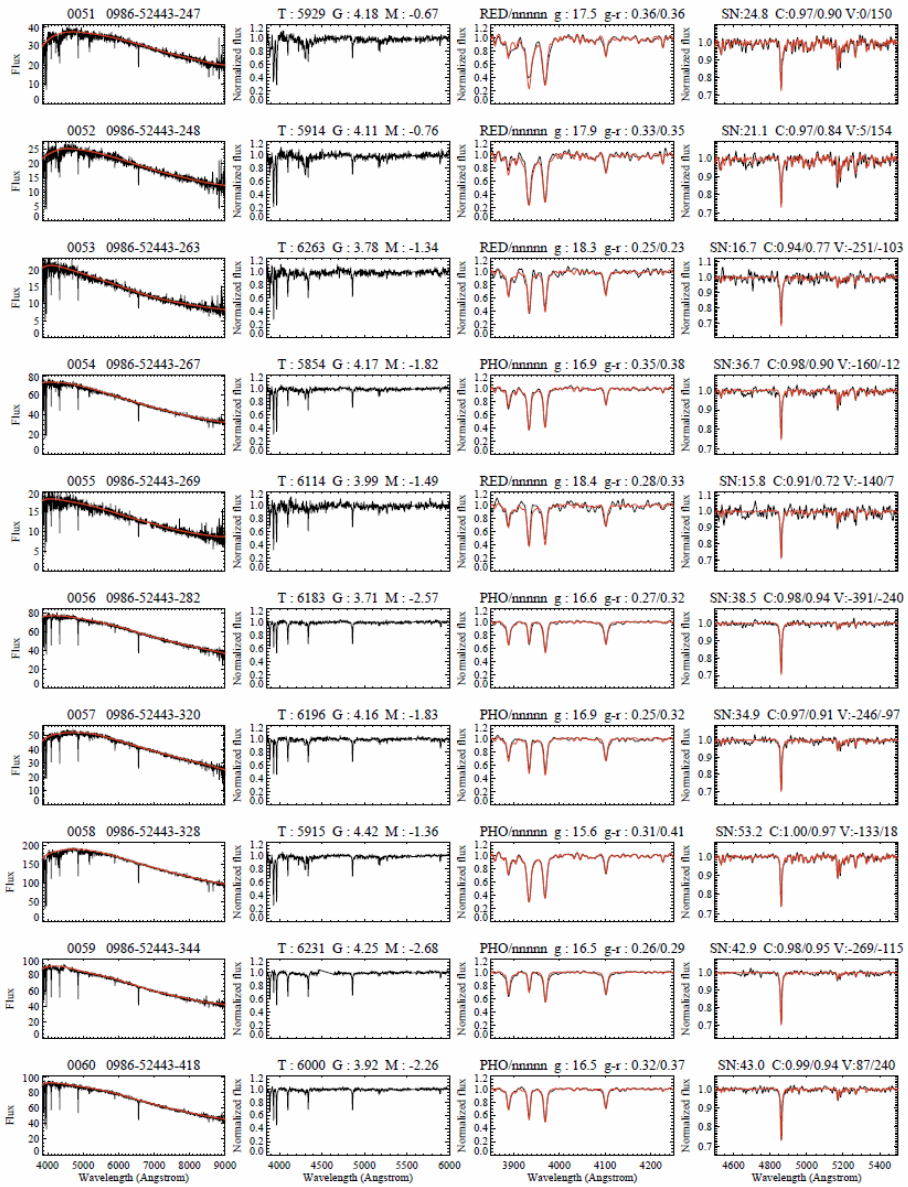
The SDSS/SEGUE Footprint (RA/DEC)

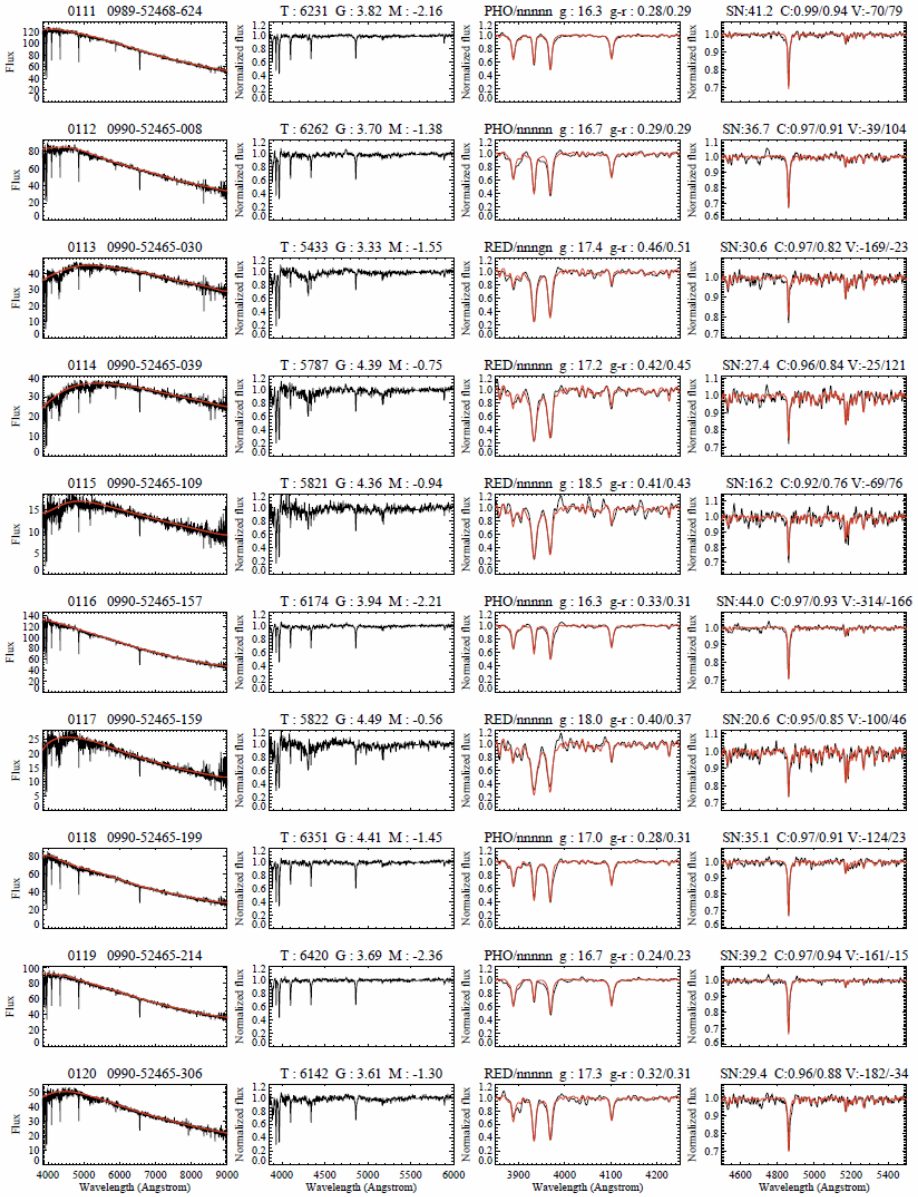


The SDSS/SEGUE Footprint (l, b)



Sample Spectra



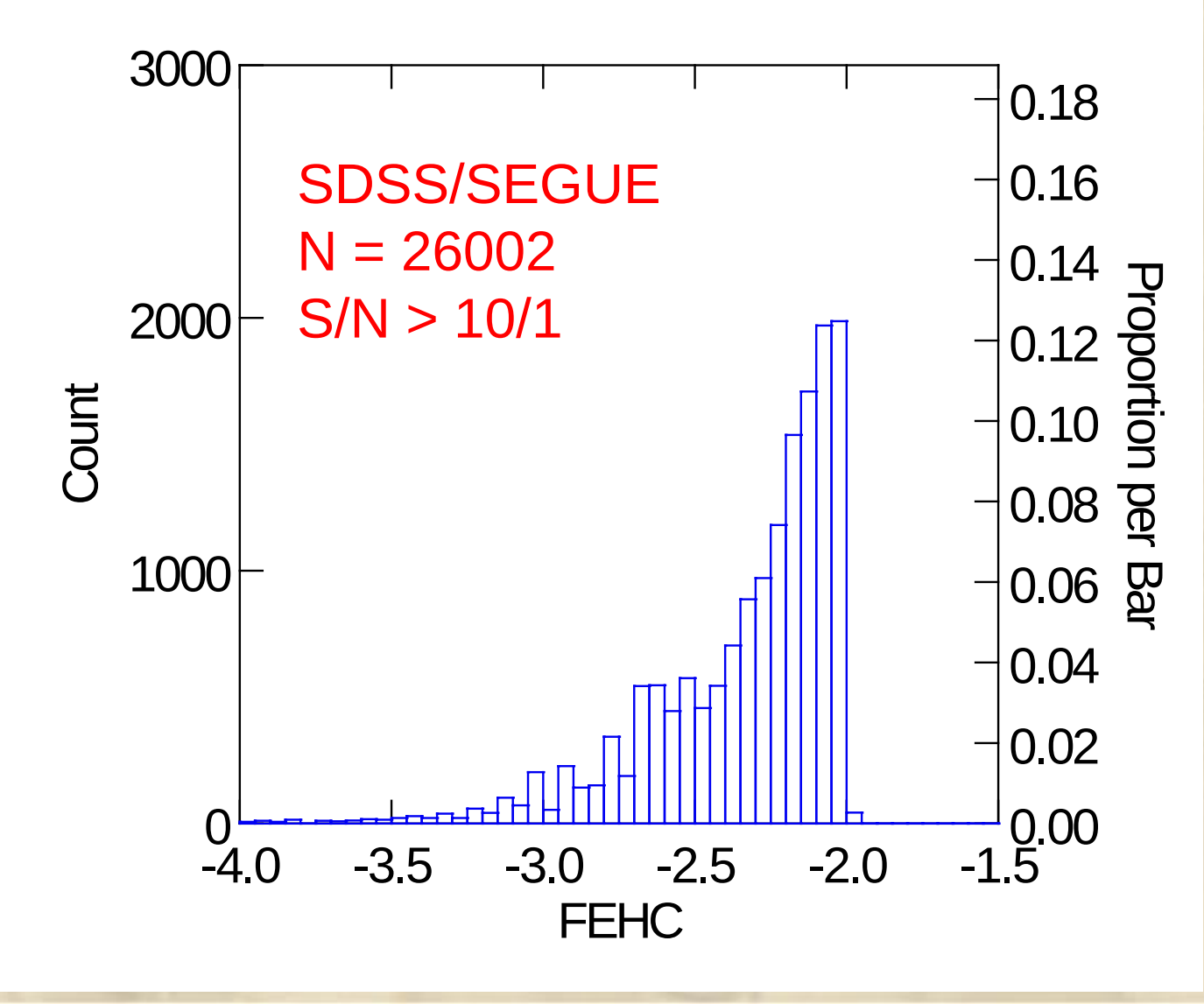


Known MP Stars – Pre and Post SDSS/SEGUE-1/SEGUE-2

Name	Metallicity	Pre	Post
• Metal-Poor	[Fe/H] < -1.0	15,000	150,000+
• Very Metal-Poor	[Fe/H] < -2.0	3,000	30,000+
• Extremely Metal-Poor	[Fe/H] < -3.0	400	1000+
• Ultra Metal-Poor	[Fe/H] < -4.0	5	5
• Hyper Metal-Poor	[Fe/H] < -5.0	2	2
• Mega Metal-Poor	[Fe/H] < -6.0	0	0

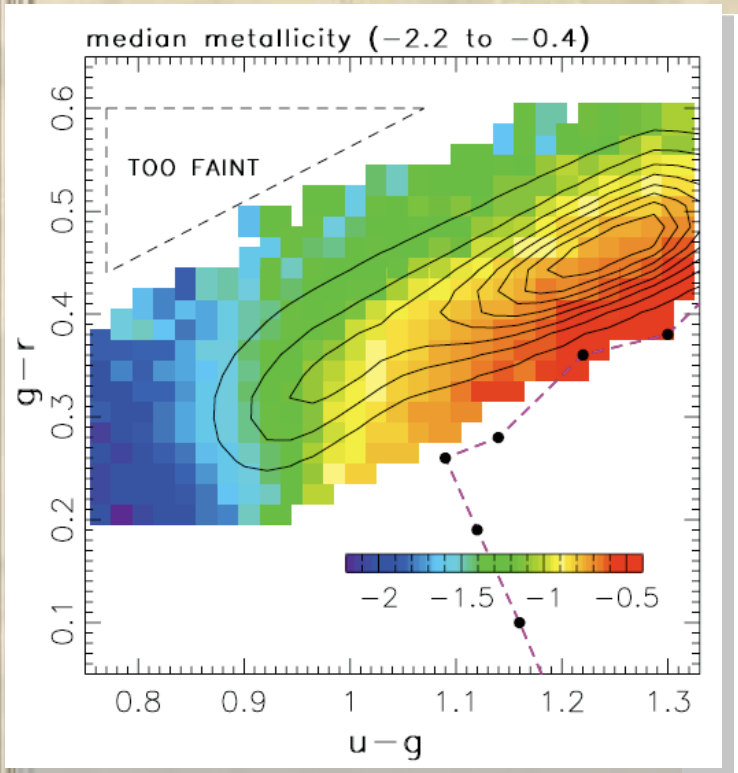
N.B. -- Only includes stars with S/N > 10/1, 4500 < Teff < 7000

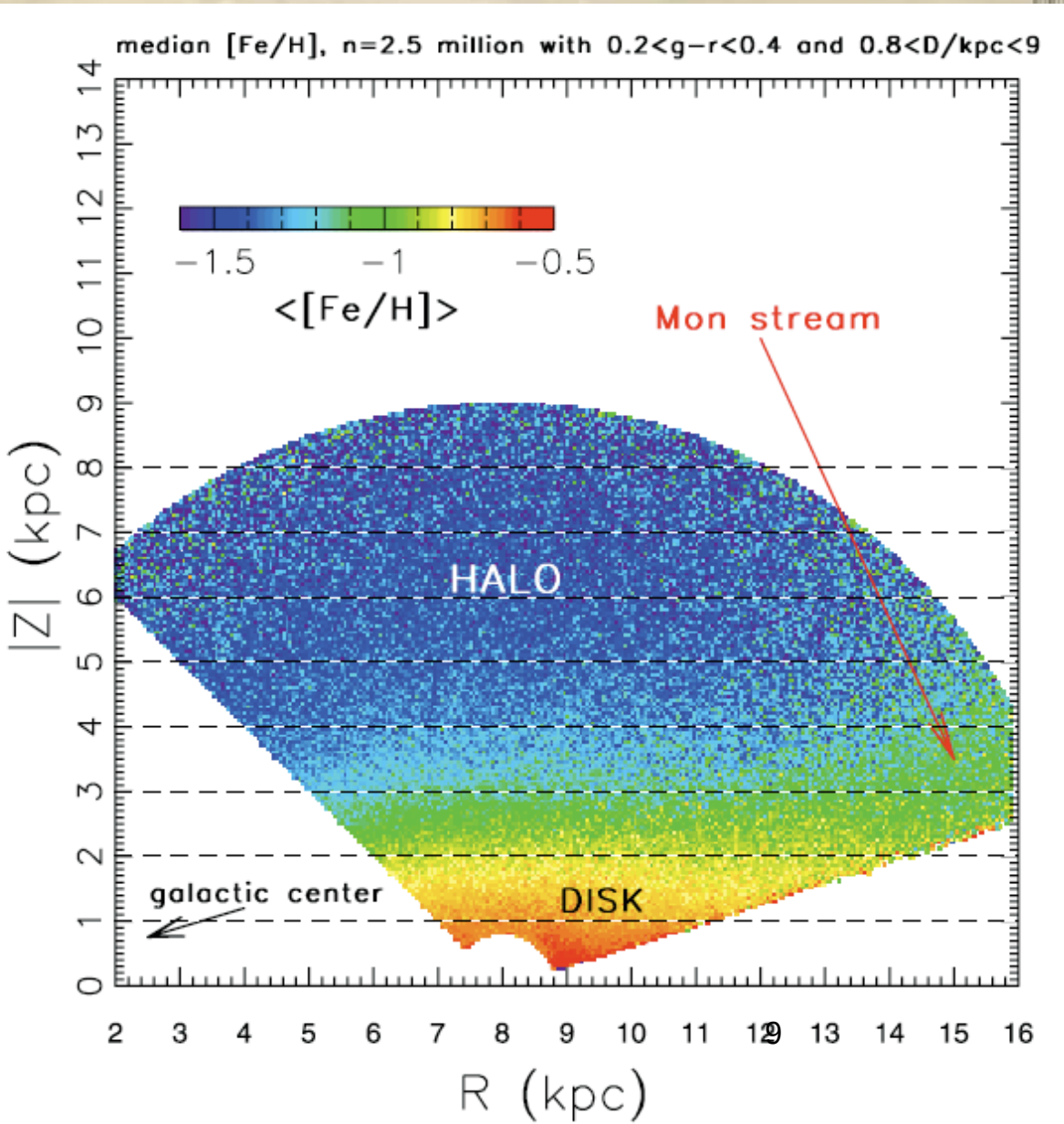
Latest and Greatest from SDSS/SEGUE



Photometric Metallicity from *ugr*

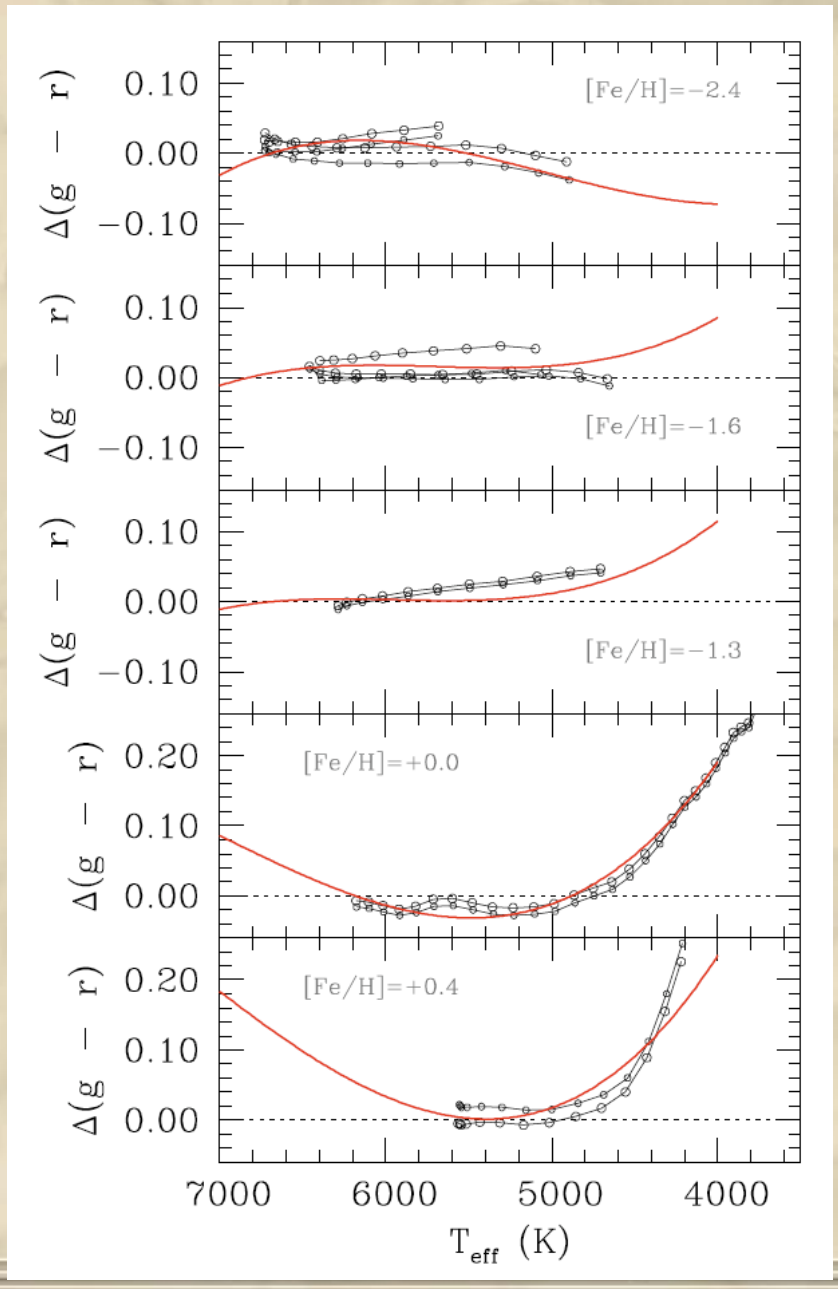
Ivezić et al. 2008





Revised color-T_{eff}-[Fe/H] Corrections

Preliminary



Improvements over the initial analysis in An et al. (2009):

- **Refined color-T_{eff} corrections**

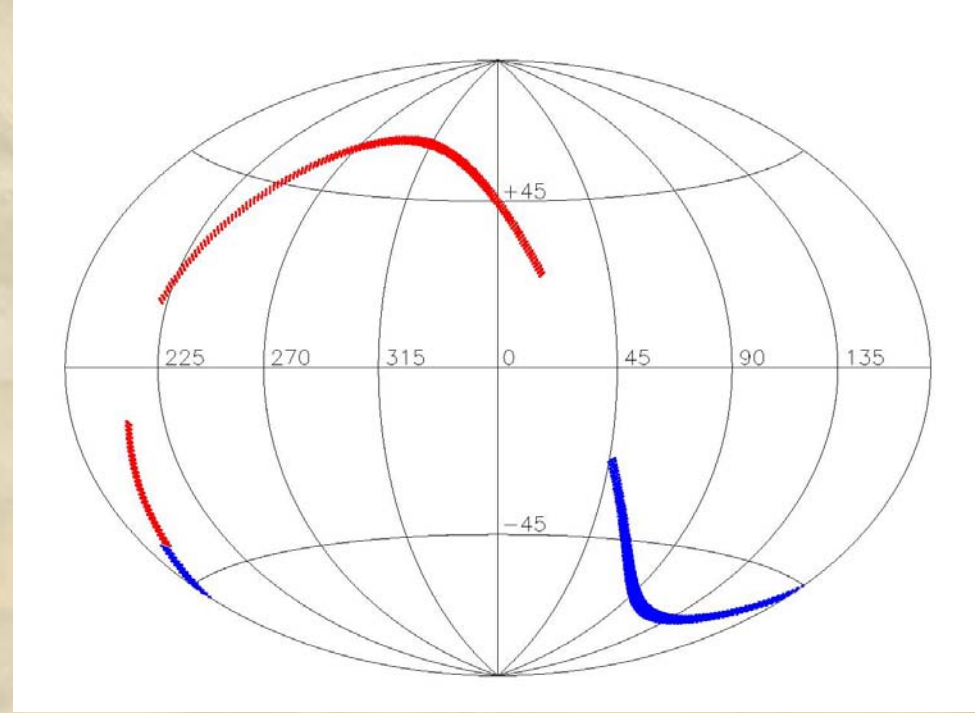
$$\Delta u-g, \Delta g-r, \Delta g-i, \Delta g-z\ (T_{\rm eff}, [Fe/H]) = c_0 + c_1 T_{\rm eff} + c_2 {T_{\rm eff}}^2 + c_3 {T_{\rm eff}}^3 + c_4 [Fe/H] + c_5 [Fe/H]^2 + c_6 [Fe/H]^3 + c_7 [Fe/H] T_{\rm eff} + c_8 [Fe/H] {T_{\rm eff}}^2 + c_9 [Fe/H]^2 T_{\rm eff}$$

- **Inclusion of all *ugriz* bandpass information whenever available**
- **Parameter search in [stellar mass, [Fe/H], stellar age] space.**

SDSS Stripe 82

- Multiply imaged during SDSS-II for the Supernova Survey
- Best (yet) ground-based ugriz photometry available
- Errors in all bands

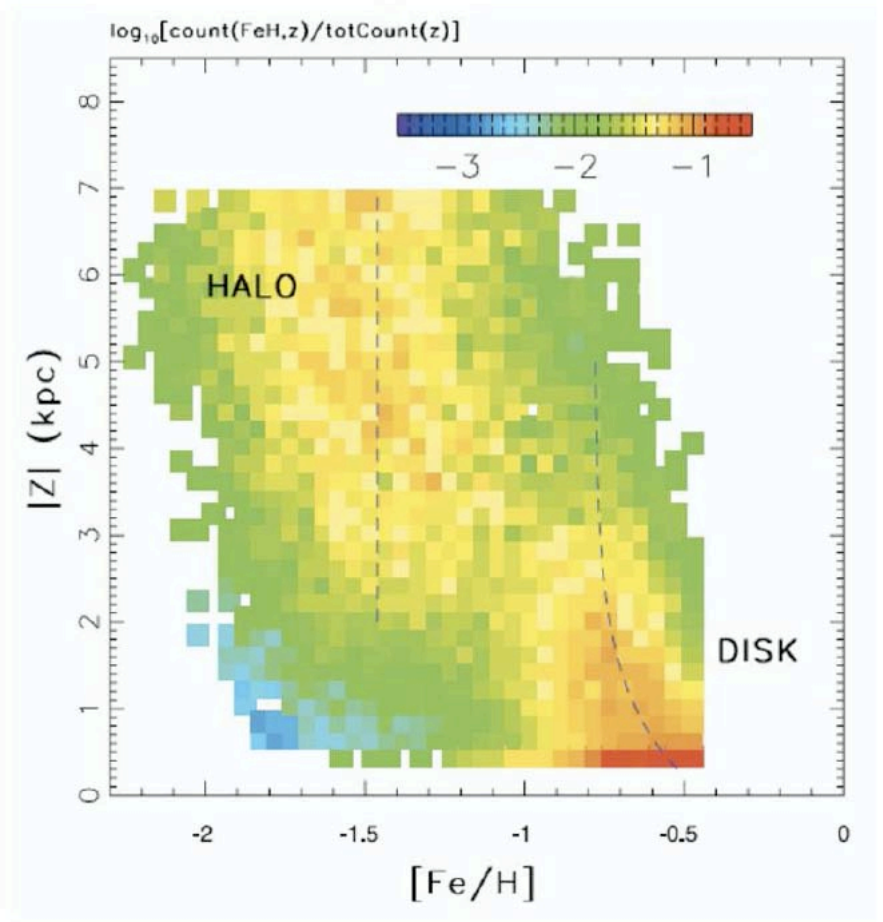
  < 0.01 mags

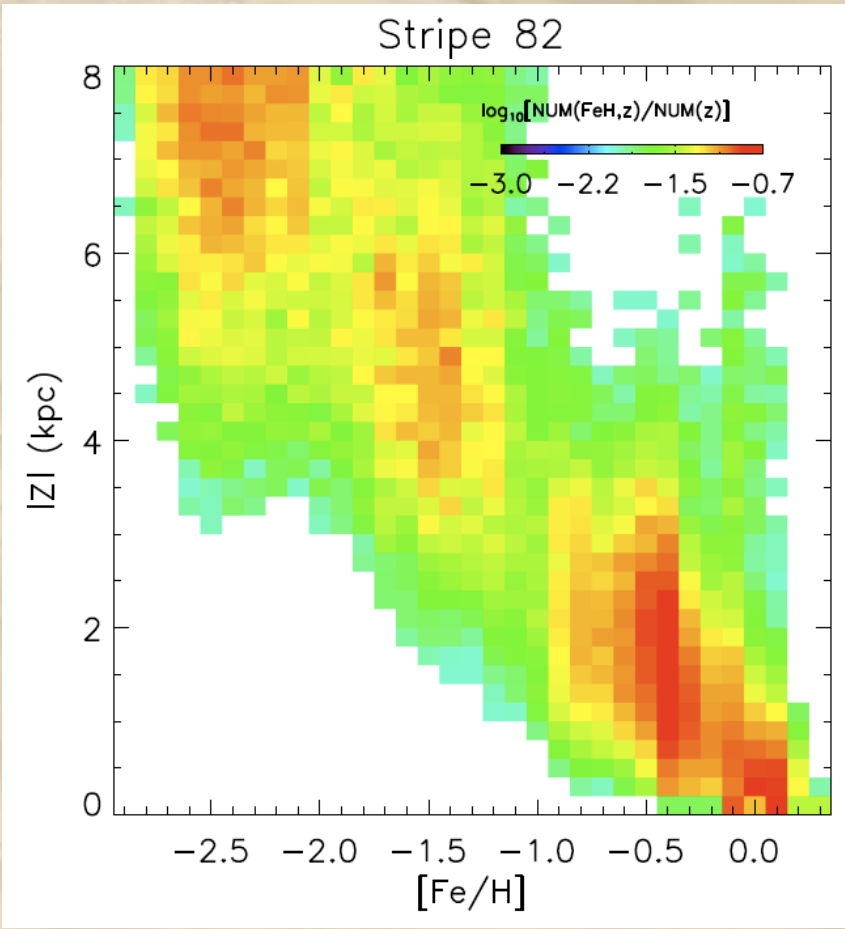


Stripe 82 in BLUE

Metallicity Distribution

Preliminary





Ivezic et al. (2008)

u g r i z

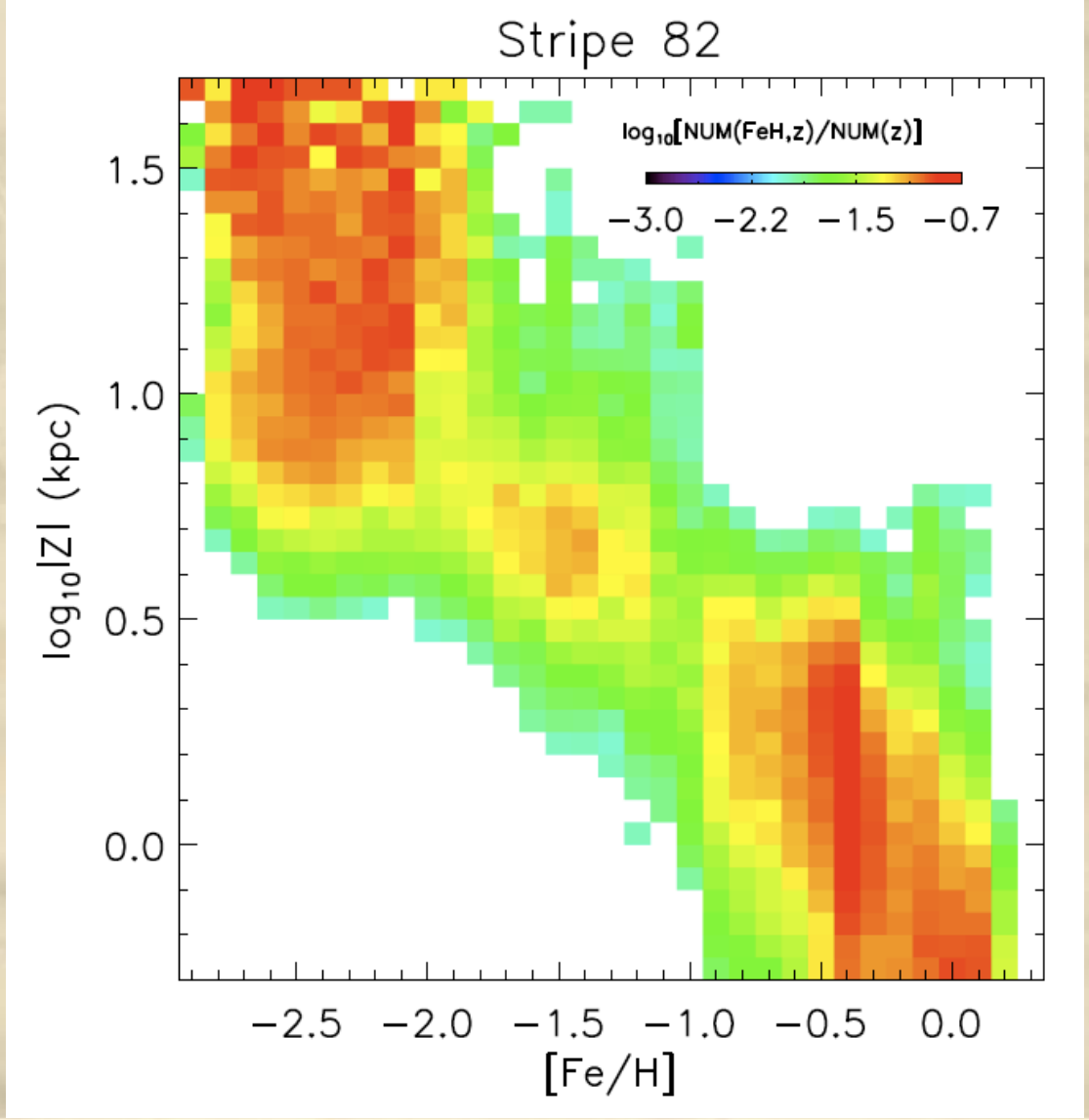
***Recalibrated* isochrones**

u g r i z

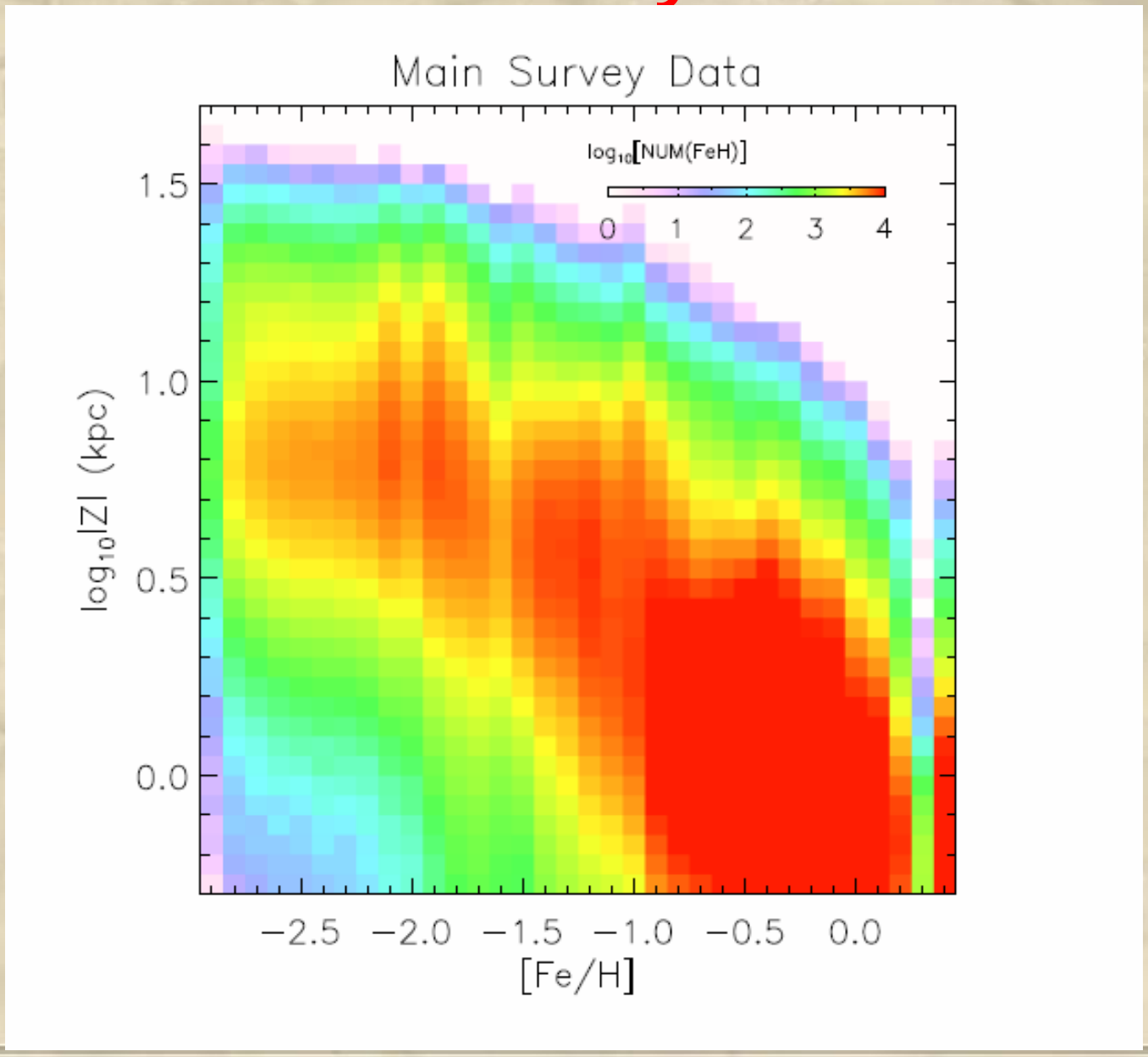
Metallicity Distribution to 30 kpc

Preliminary

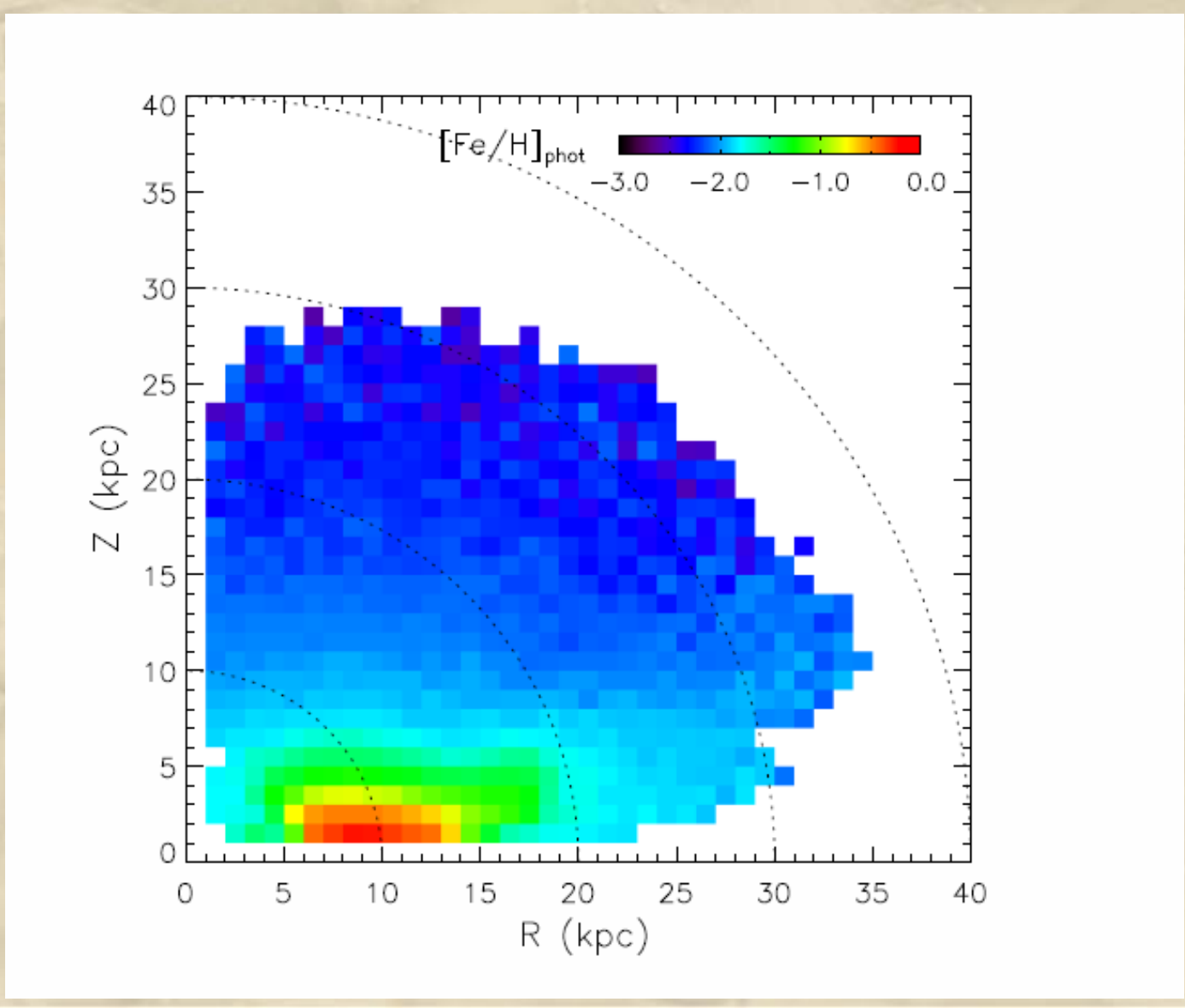
u g r i z



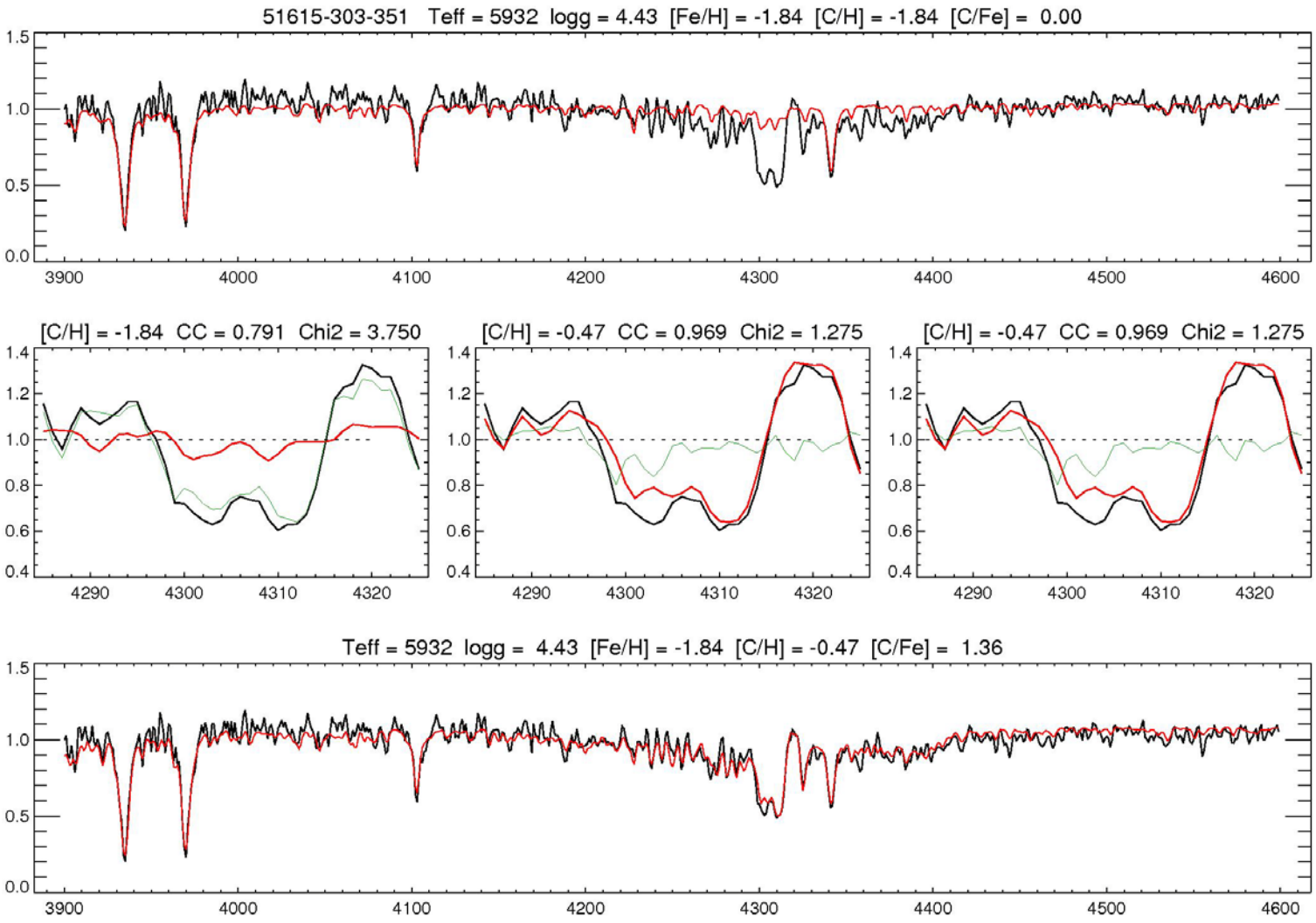
Full Survey Data

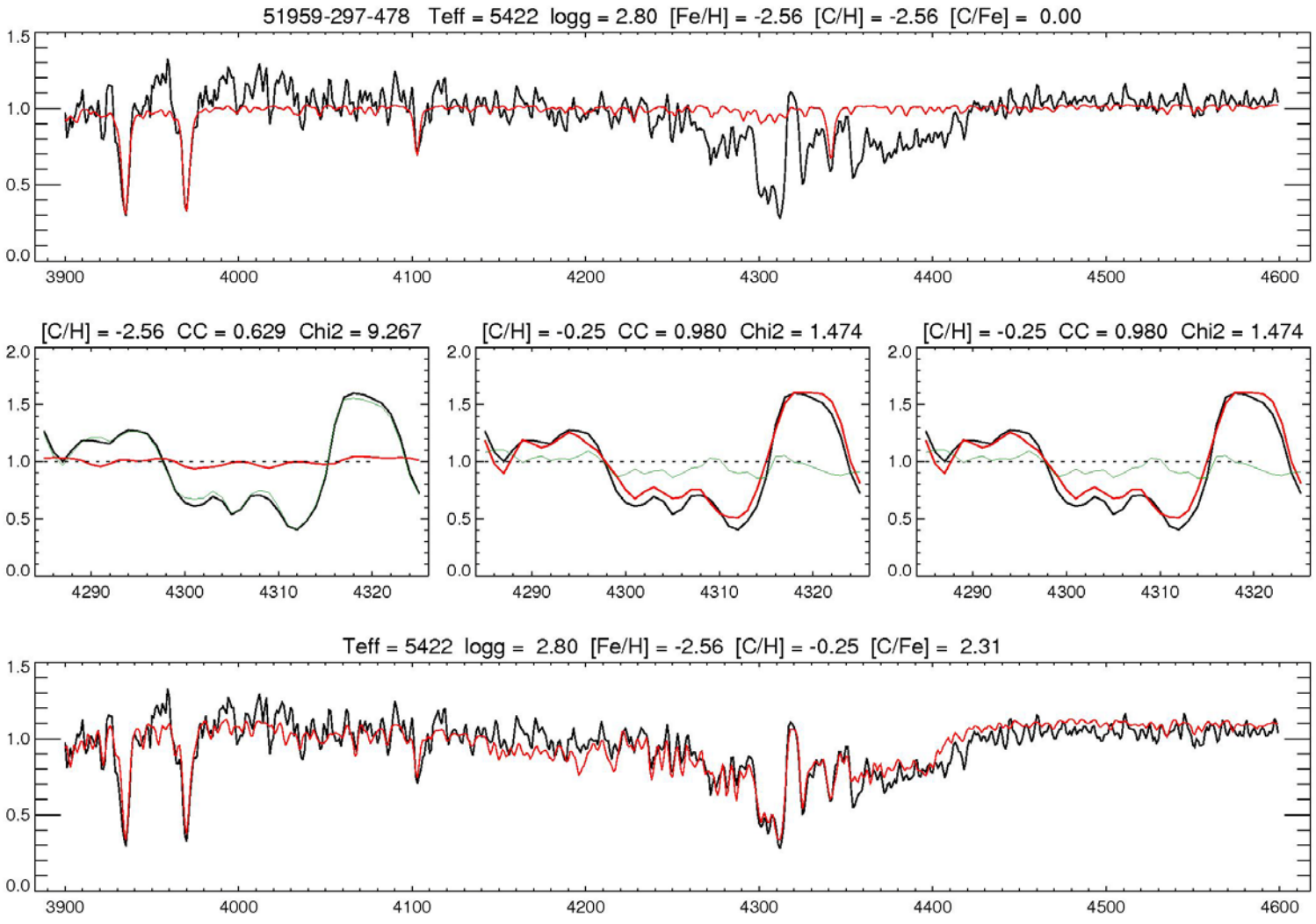


Currently Best Metallicity Map



[C/Fe] for SDSS/SEGUE Stars




51959-297-478 Teff = 5422 logg = 2.80 [Fe/H] = -2.56 [C/H] = -2.56 [C/Fe] = 0.00
[C/H] = -2.56 CC = 0.629 Chi2 = 9.267
[C/H] = -0.25 CC = 0.980 Chi2 = 1.474
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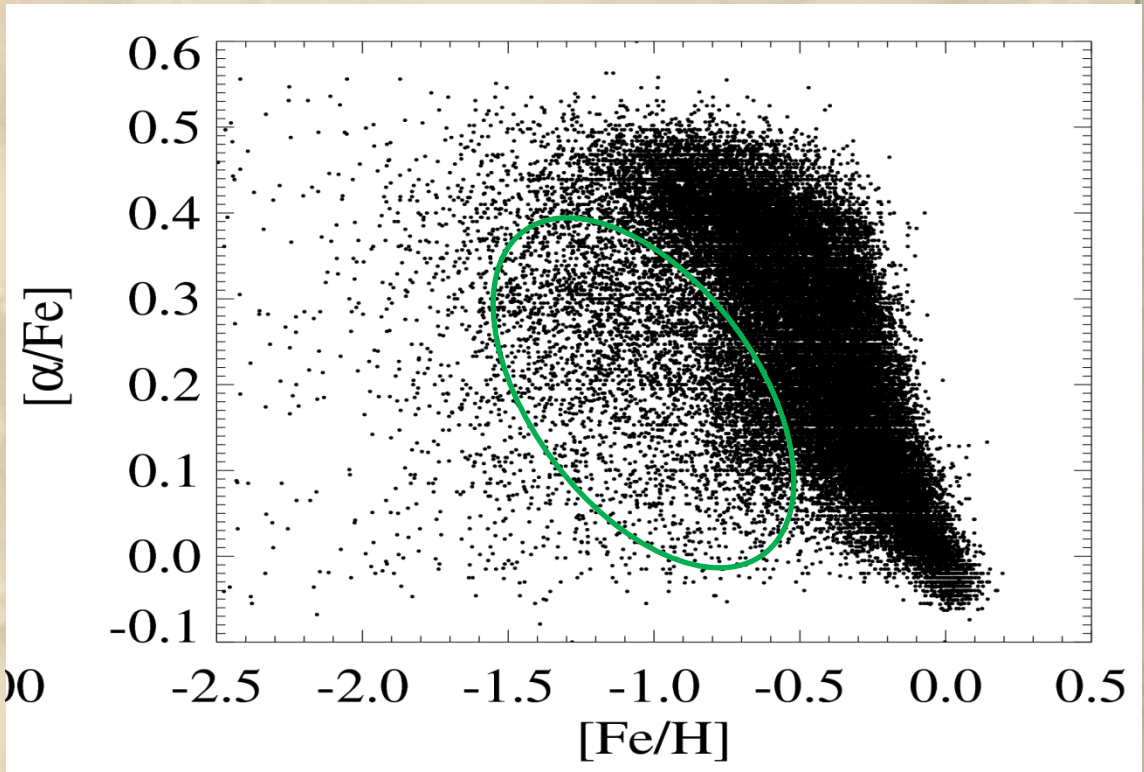
Teff = 5422 logg = 2.80 [Fe/H] = -2.56 [C/H] = -0.25 [C/Fe] = 2.31

[α/Fe] for SDSS/SEGUE Stars

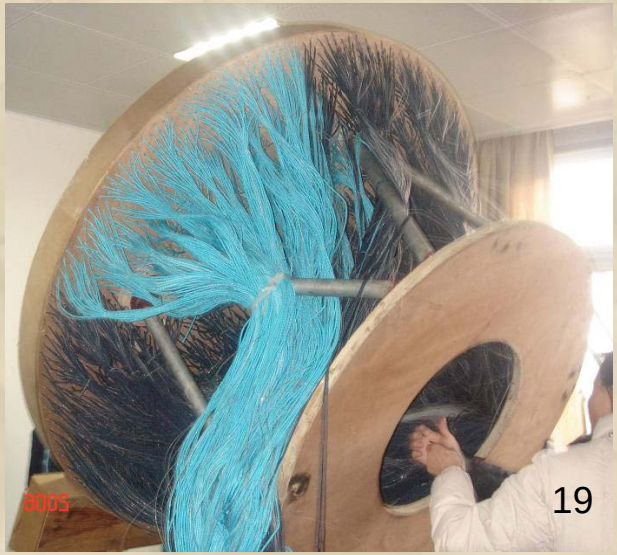
- [α/Fe] ratios are critical probes of the environment in which metal-poor stars were born (masses of parent sub-halos)
- [α/Fe] ratios are critical probes of the accretion history of the Galaxy (Johnston et al. 2008)
- Can estimate to < 0.1 dex for stars in SDSS/SEGUE with S/N > 20/1 (Lee et al. 2010, in prep)



Roughly 45,000 F/G dwarfs, S/N > 20/1

LAMOST

- Large Sky Area Multi-Object Fibre Spectroscopic Telescope
- A meridian reflecting Schmidt telescope
- Large aperture (4 meter) with a wide field of view (5 degrees)
- Located at Xinglong Observing Station in northern China (2 hours from Beijing)
- Up to 4000 fibers for spectroscopy
- Low to medium resolution spectroscopic survey
- First light Fall 2008
- Can obtain medium-res data for ~5 million stars over a 2-3 year period



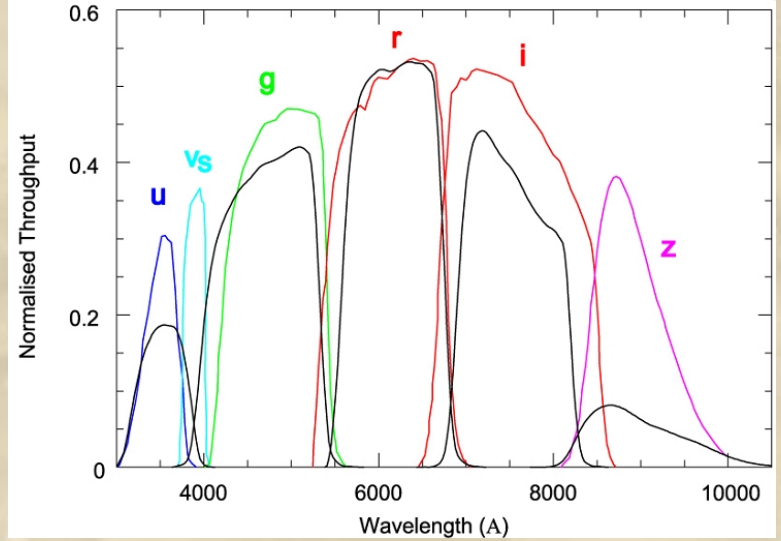
SkyMapper

- The SkyMapper Telescope is a 1.3m telescope with an 8-sq degree field of view
- Has an integrated16kx16k CCD mosaic with 0.5" pixels covering 5.7 square degrees
- Located at Siding Spring Observatory
- Fully automated
- Will conduct a multi-color, multi-epoch survey of the southern hemisphere known as the Southern Sky Survey.
- First Light 2009 / Now in commissioning

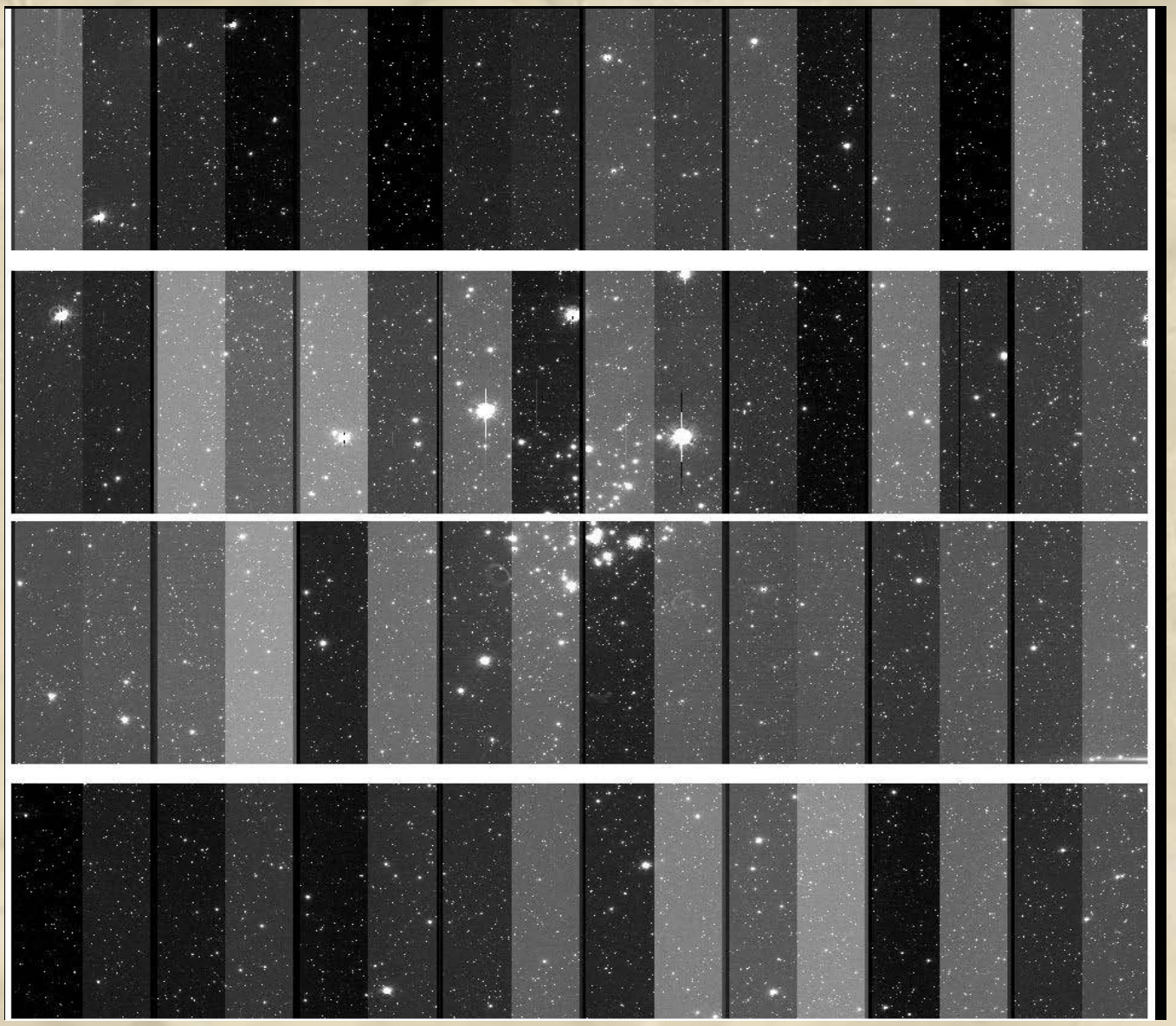
By choosing filter that optimize the data return for stellar astrophysics, SkyMapper will be able to measure surface gravities and metallicities for 100,000,000 stars

Identification of 100,000 stars with [Fe/H] < -2.0, 10,000 < -3.0, hundreds of stars < -4, tens of stars < -5.0

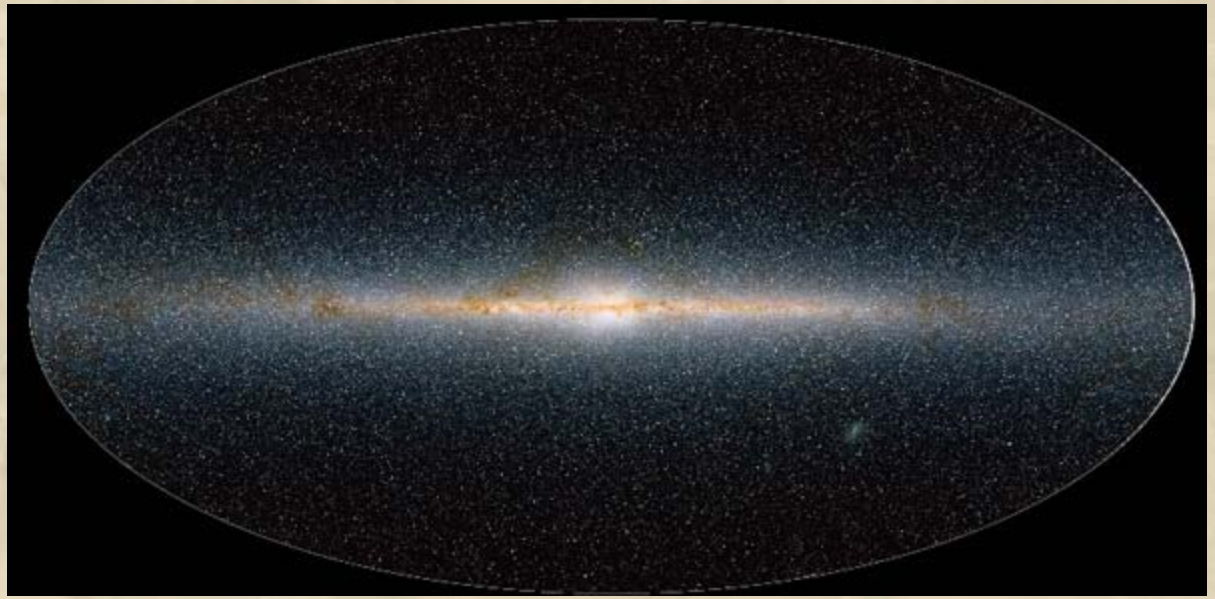
JINA-supported personnel have developed techniques that will be implemented by SkyMapper



First Data from SkyMapper



SDSS – APOGEE



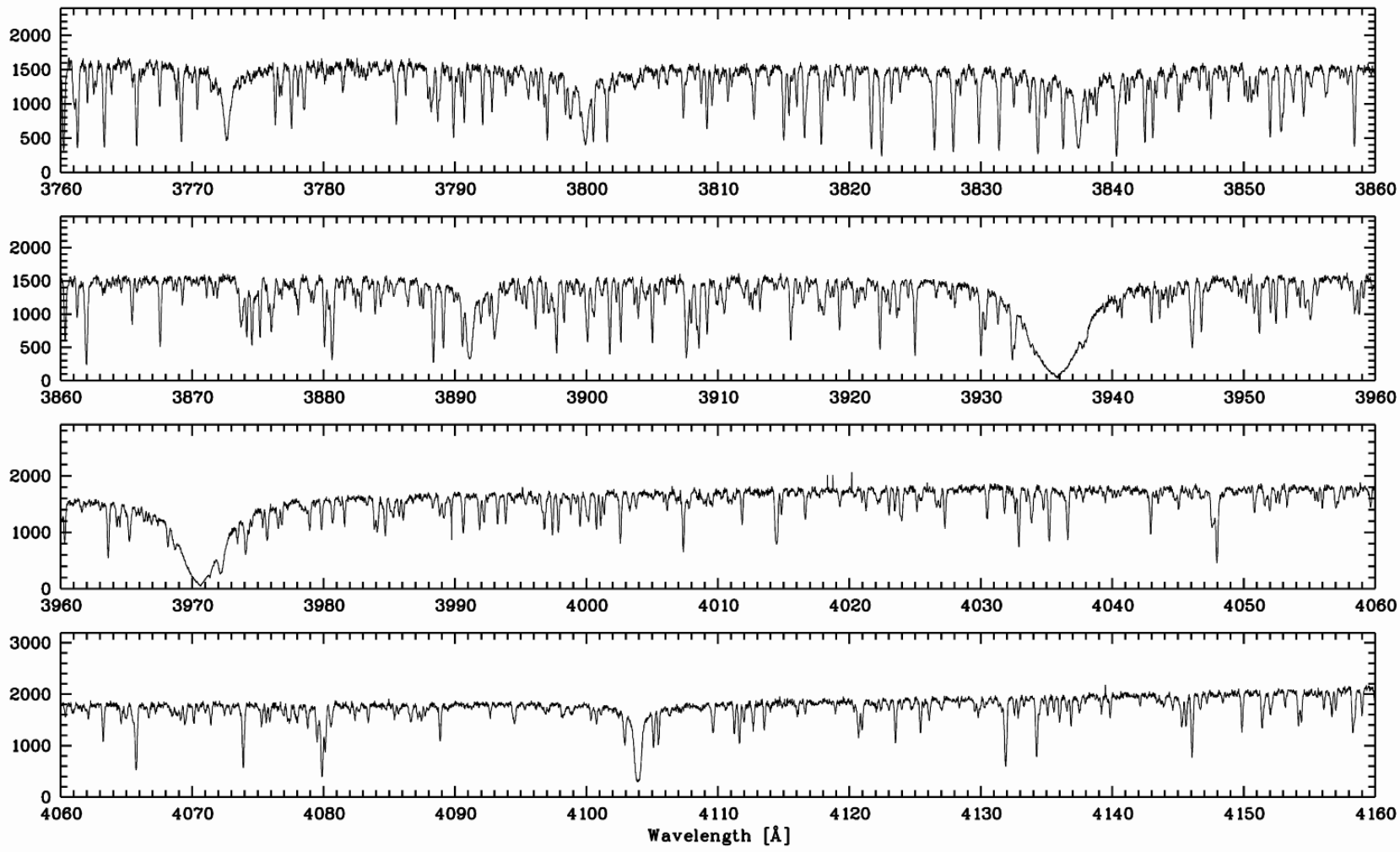
- Apache Point Observatory Galactic Evolution Experiment
- Bright time observations on ARC 2.5m telescope, beginning fall 2011
- APOGEE will produce the first systematic survey of the 3-D distribution functions of the abundances of 15 chemical elements that are key for the understanding of the star formation and chemical evolution of the Galaxy.
- This will be achieved by use of a new 300-fiber cryogenic high-resolution near-IR spectrograph that will provide access to regions of high extinction in the Galactic inner disk and bulge.

HERMES

- High Resolution Multi-object Echelle Spectrograph
- Will obtain high-resolution (R = 30,000) spectra using a 400 fibre instrument on the Anglo-Australian Telescope, beginning in 2012
- Primary mission will be Galactic Archeology for several million stars, but other targets possible as well
- Combining the abundance signatures and phase space locations for millions of stars will provide an extraordinarily detailed insight into the formation and structure of the Milky Way

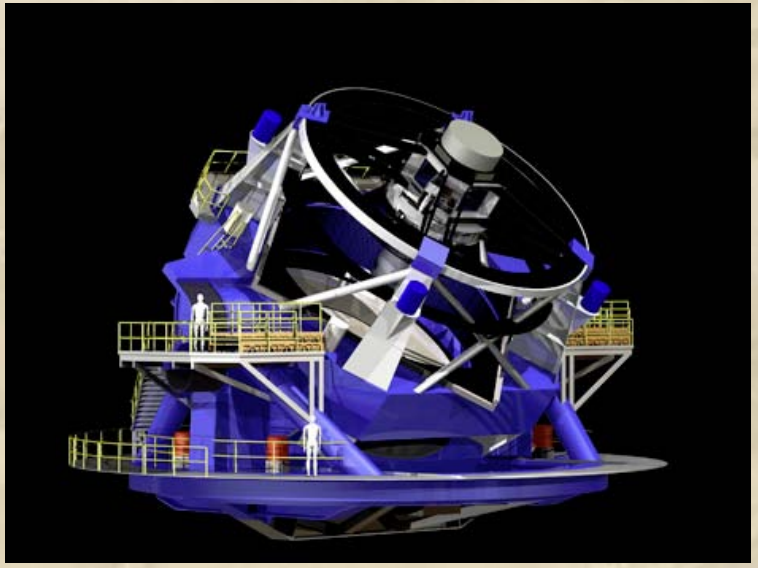
Example High-Resolution Spectrum

CS 31082-001: [Fe/H] = -2.9 HERES Blue Spectrum

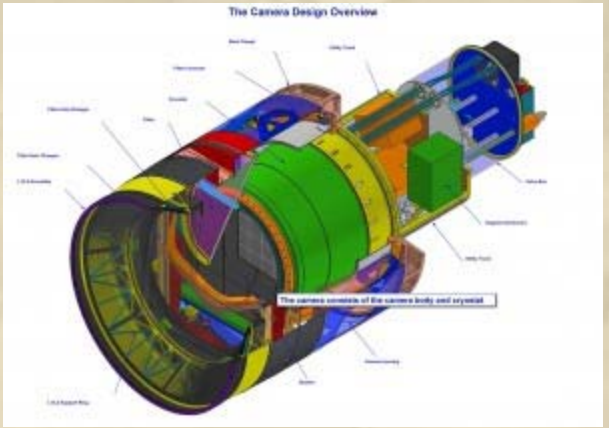


LSST

- Currently, the best large-area faint optical survey is SDSS: a digital color map of the sky r~ 22.5, 1-2 visits, 300 million objects
- LSST = d(SDSS)/dt: an 8.4m telescope to r~24.5 over a 9.6 deg^2 FOV over the entire southern hemisphere
- Images sky in two bands every three nights, 1000 visits over 10 years, beginning in 2015
- LSST = Super-SDSS: an optical/near-IR survey of the observable sky in multiple bands (ugrizy) to r > 27.5 (co-added), producing a catalog of 10 billion stars and 10 billion galaxies
- LSST: a digital color movie of the sky



Large Synoptic Survey Telescope



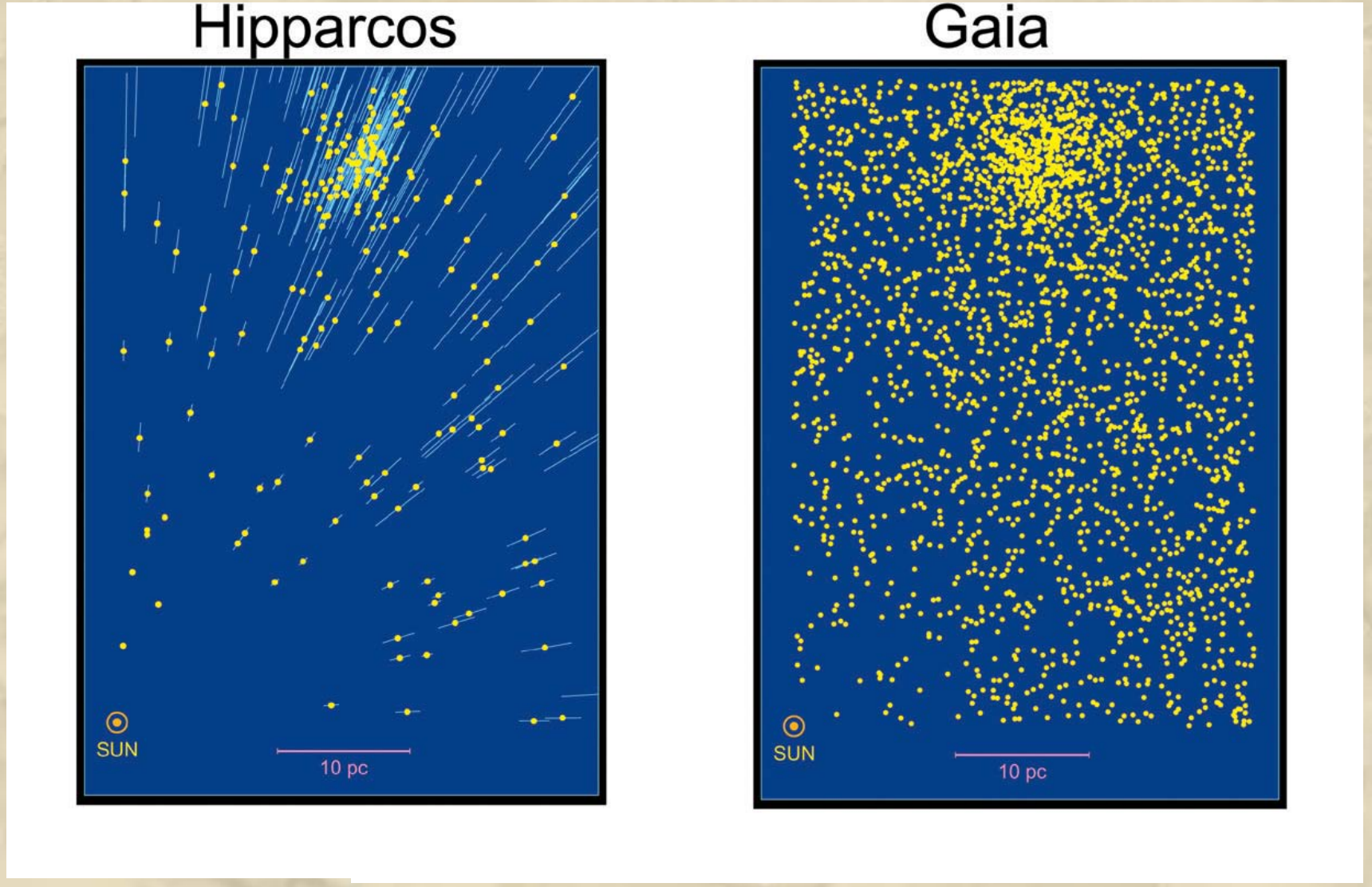
Gaia

- Gaia is a global space astrometry mission. Its goal is to make the largest, most precise three-dimensional map of our Galaxy by surveying an unprecedented number of stars - more than a billion

- It will monitor each of its target stars about 70 times over a five-year period, beginning in 2012, precisely charting their positions, distances, movements, and changes in brightness

- Plans to obtain radial velocities and abundance information for an essentially complete sample of stars down to 15th magnitude
- Astrometric information for much fainter samples

Parallax Distances to Hyades Cluster



Goals for JINA Observations

- Fully exploit wealth of data from SDSS/SEGUE ([C/Fe], [α/Fe]) to capitalize on understanding halo and disk systems
- Coordinate high-res follow-up of SDSS/SEGUE metal-poor stars
- Fully participate with LAMOST medium-res survey of stars in the Milky Way (including SSPP development)
- Participate in follow-up spectroscopy of SkyMapper metal-poor candidates
- Fully participate in APOGEE survey, as part of SDSS-III
- Initiate coordination with HERMES, LSST, Gaia for nuclear astrophysics research in the coming decade