

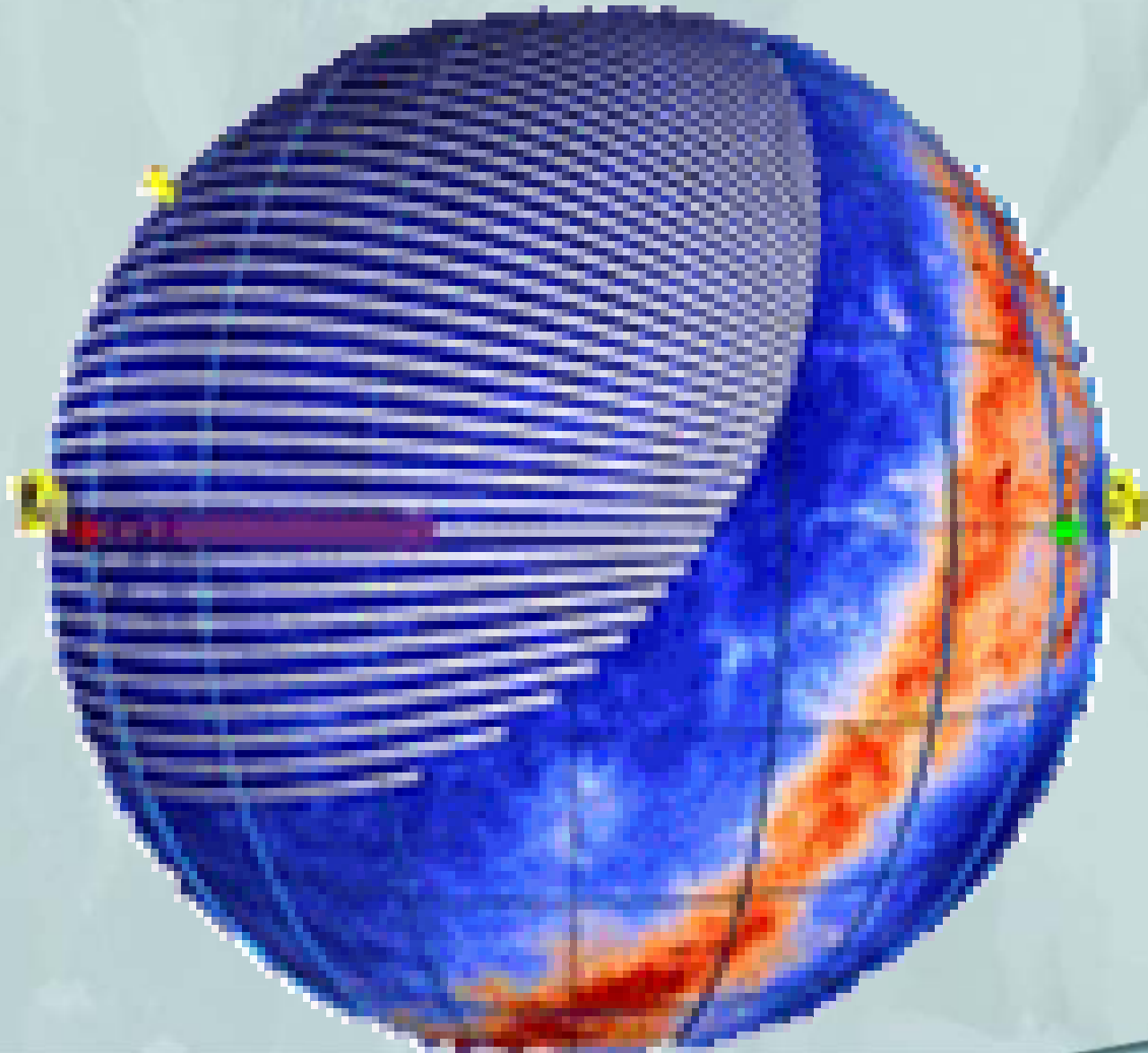
A Sloan Digital Sky Survey Extension

JINA Participation

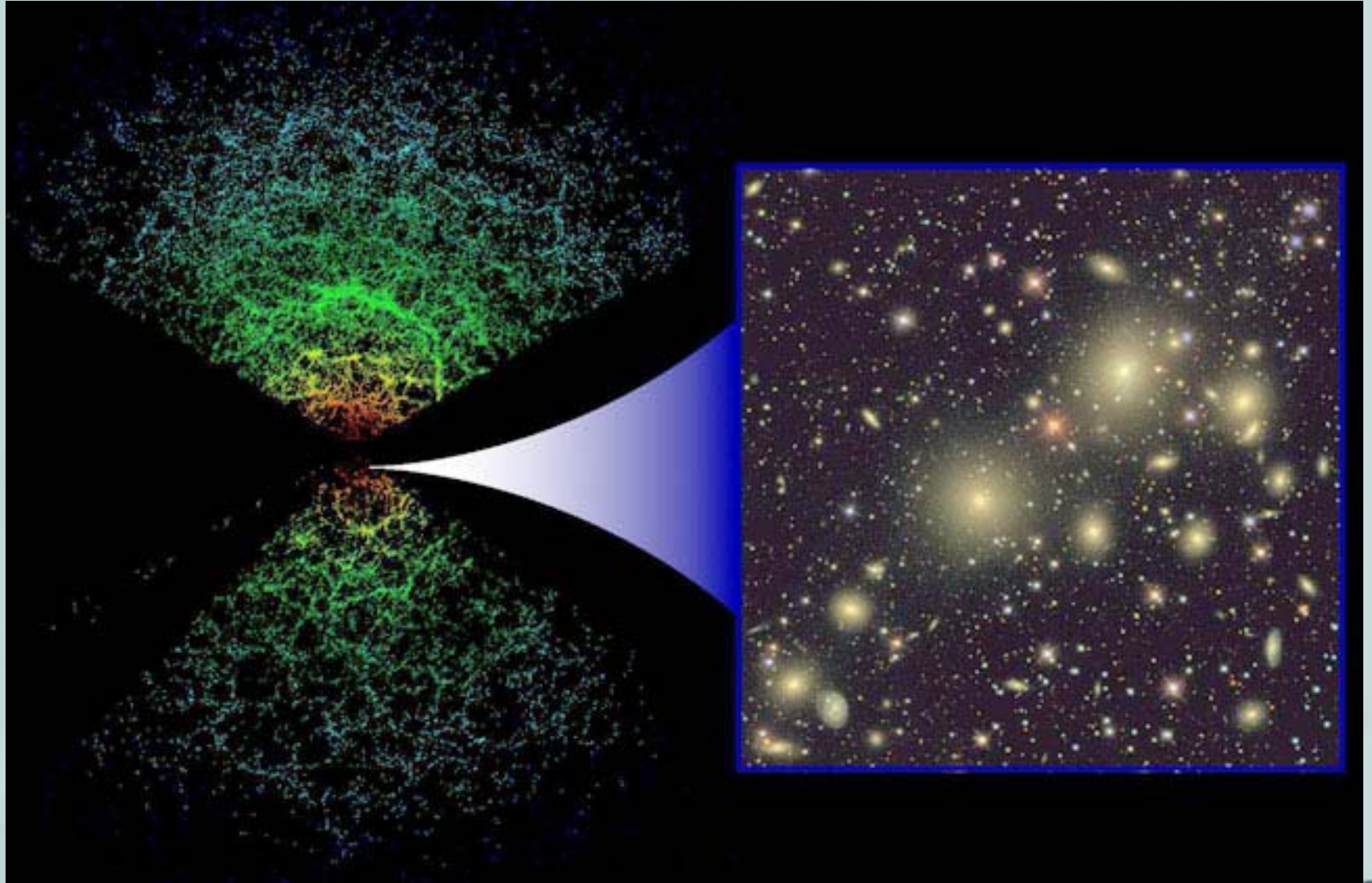
The Sloan Digital Sky Survey

- The most ambitious astronomy project ever undertaken
 - Obtain accurately calibrated imaging of **10,000** square degrees of (northern) sky, in five filters (*ugriz*)
 - Obtain moderate-resolution spectroscopy for
 - **1,000,000 galaxies**
 - **100,000 quasars**
- Has been fully operational since ~ Jan 1999
- Scheduled to complete (or nearly so) its primary imaging mission in July 2005
- In many ways, a precursor of similar surveys to follow

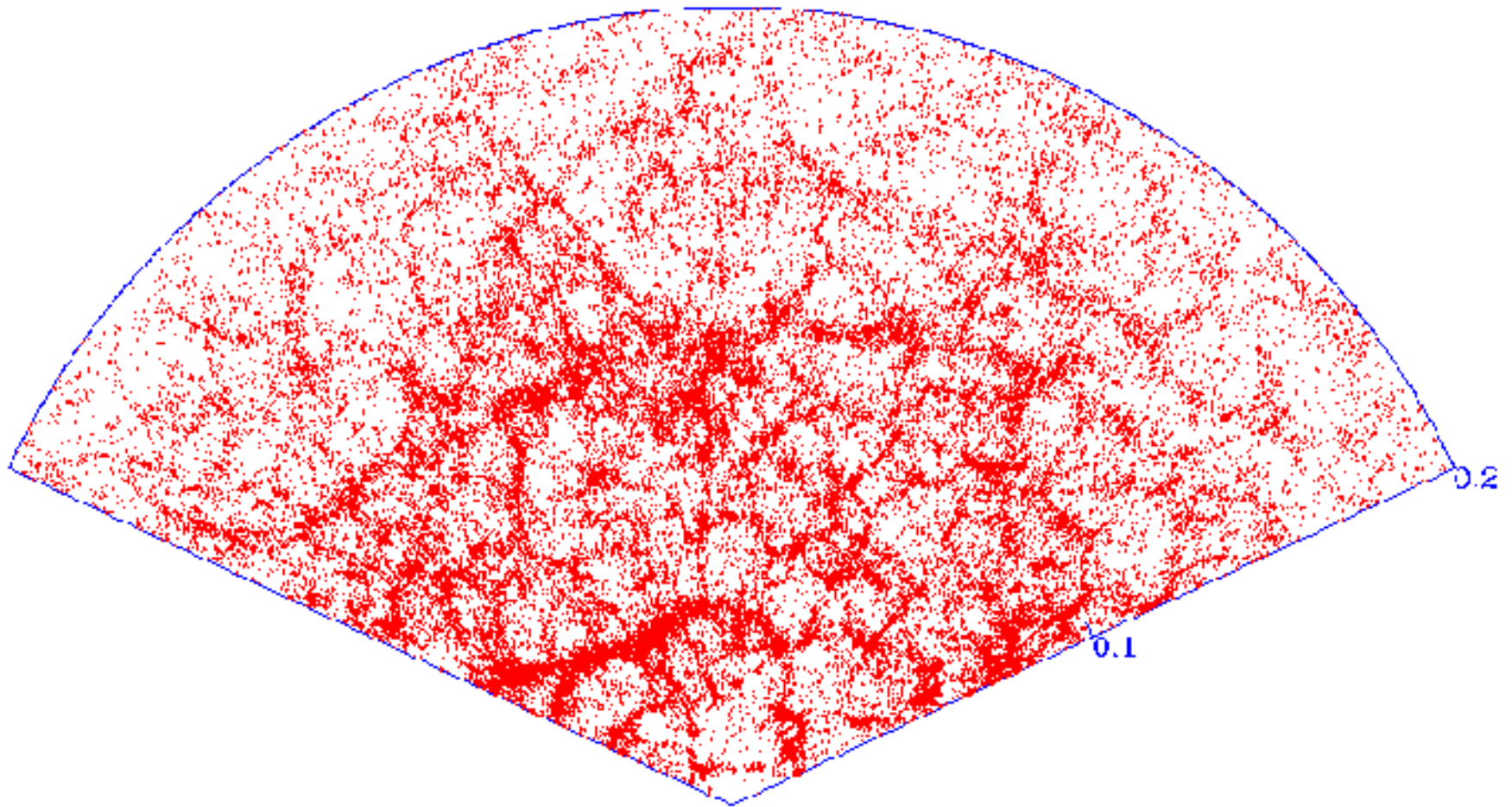
By July 2005...



In Hopes of Producing ...



A Little Closer Look at a Slice of SDSS Redshift Space



One Galaxy Left Behind...



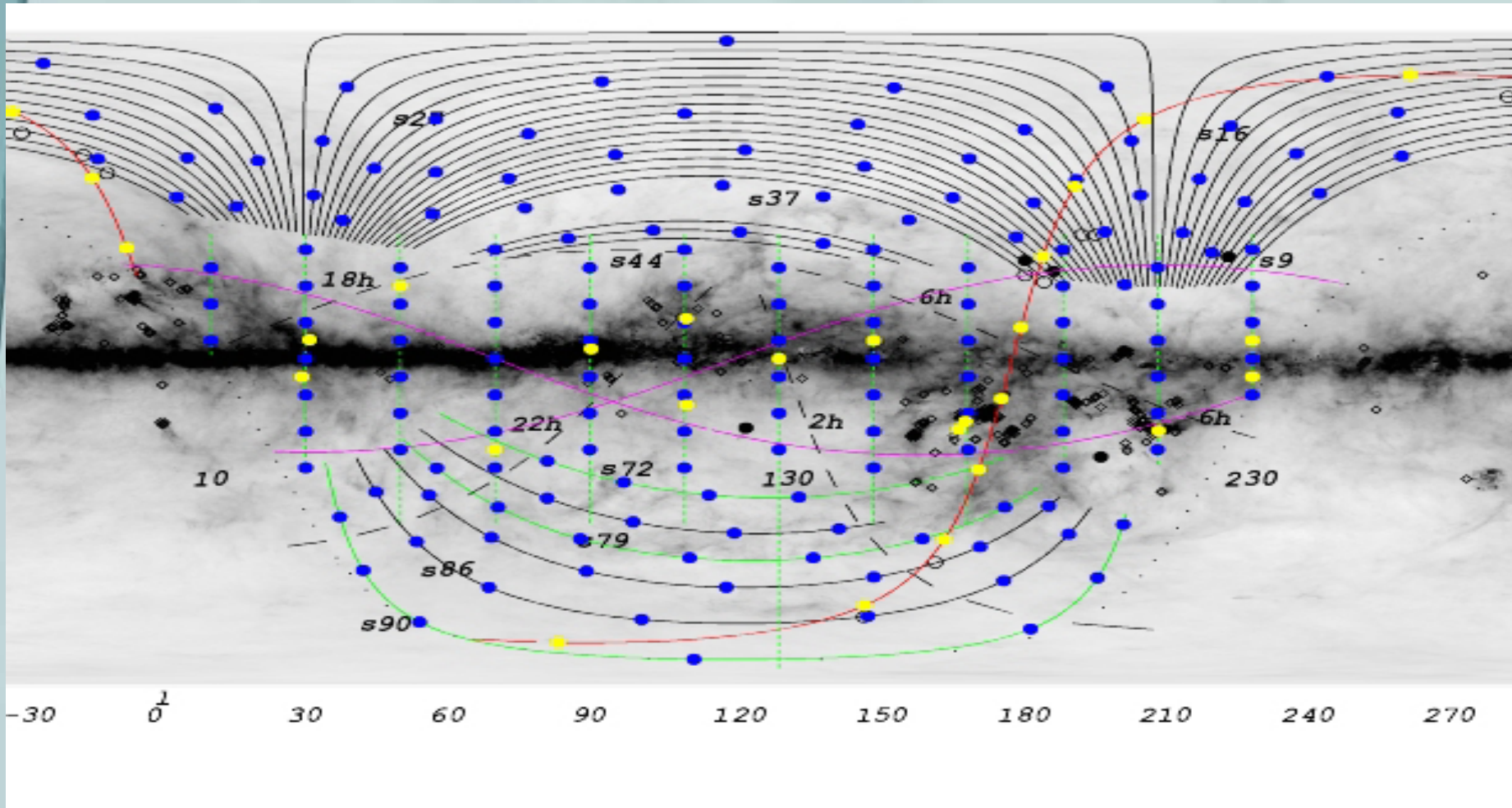
A Proposed Sloan Extension

- Beyond 2005, a proposal has been made (Sloan/NSF/Institutional Partners) to conduct additional SDSS observations for three years (2005-2008)
 - **Legacy**: Close the Imaging Gap
 - **Supernovae Survey**
 - **SEGUE**
- Already received \$5.4 Million from Sloan Foundation
- Similar amount to be proposed to NSF (June 2004)
- Institutional Partners (~\$ 250,000 each)

SEGUE: Sloan Extension for Galactic Understanding and Evolution

- An imaging and spectroscopic survey to unravel:
 - Structure
 - Formation history
 - Kinematical and dynamical evolution
 - Chemical evolution
 - Dark matter distribution in the Galaxy
 - Proposal is to complete within three years using existing SDSS 2.5m

Technical Details – The SEGUE Plan of Attack



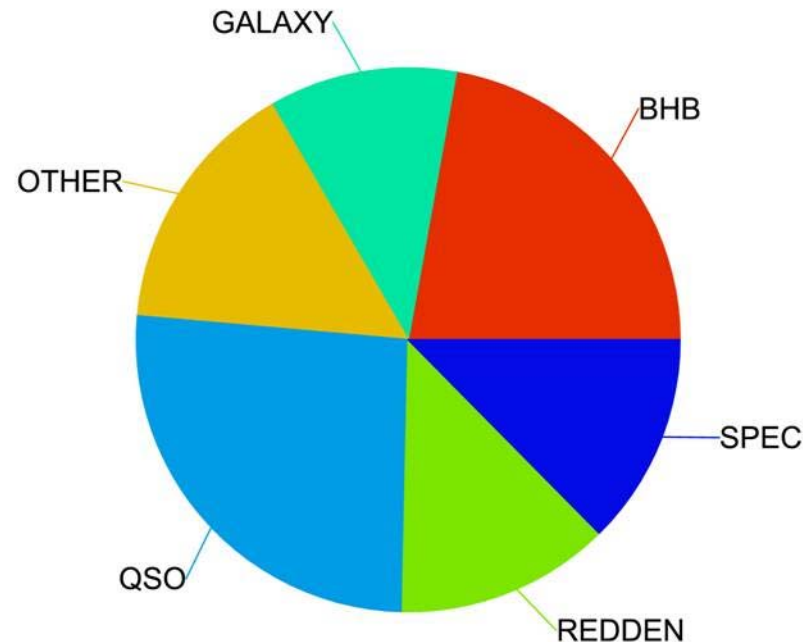
The Allure of Color-Selection

- Spectroscopic survey of $N \sim 250,000$ Galactic stars, $15 < B < 20$, which could be designed to include:
 - 50,000 stars, color-selected for $[\text{Fe}/\text{H}] < -2.0$
 - 5,000 stars with $[\text{Fe}/\text{H}] < -3.0$
 - 500 (?) stars with $[\text{Fe}/\text{H}] < -4.0$

Results “Without Even Trying” -- The SDSS Early Data Release Stellar Spectra

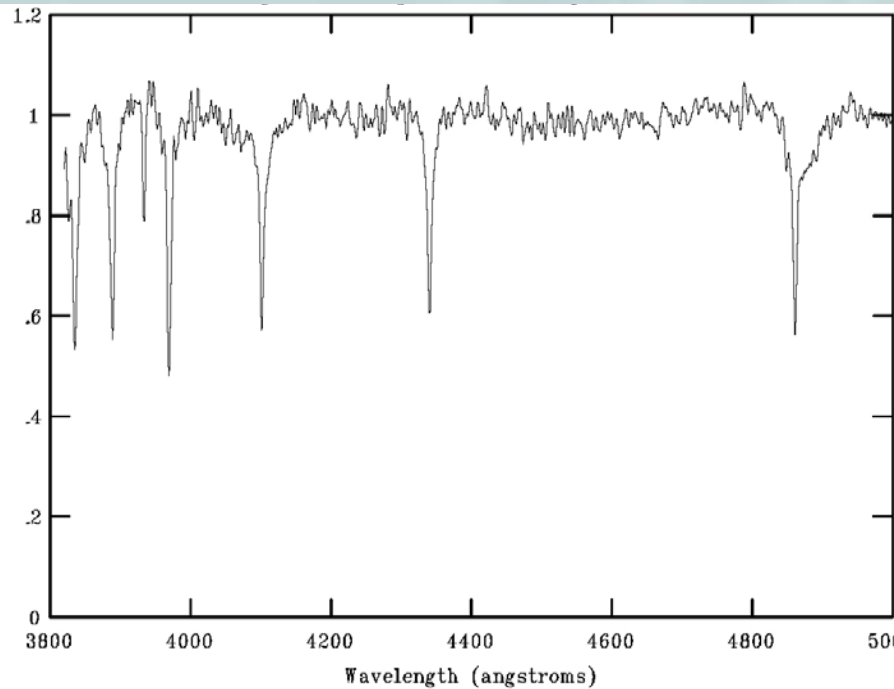
- QSO = 1461
- BHB = 1242
- Reddening Std = 714
- Spectrophot Std = 706
- Galaxy = 628
- Other = 853

- TOTAL = 5604

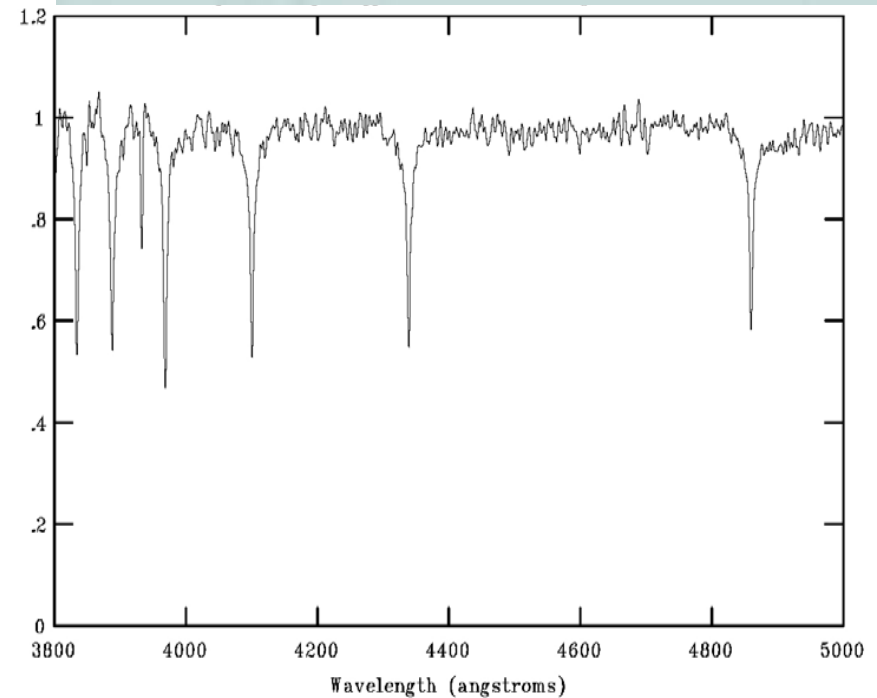


A $[Fe/H] = -3.3$ Star from EDR

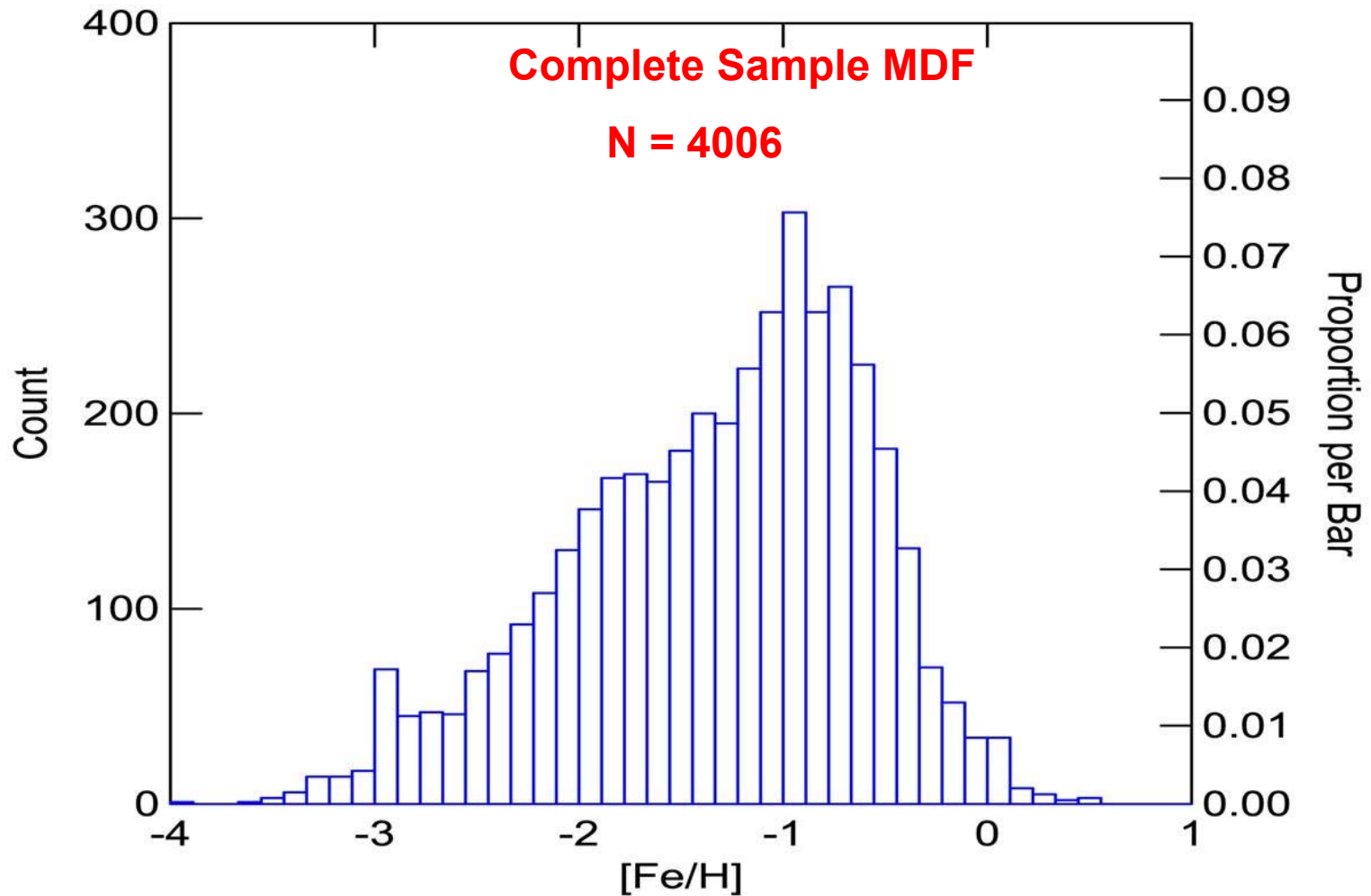
EDR 3907: SDSS 2.5m Spectrum



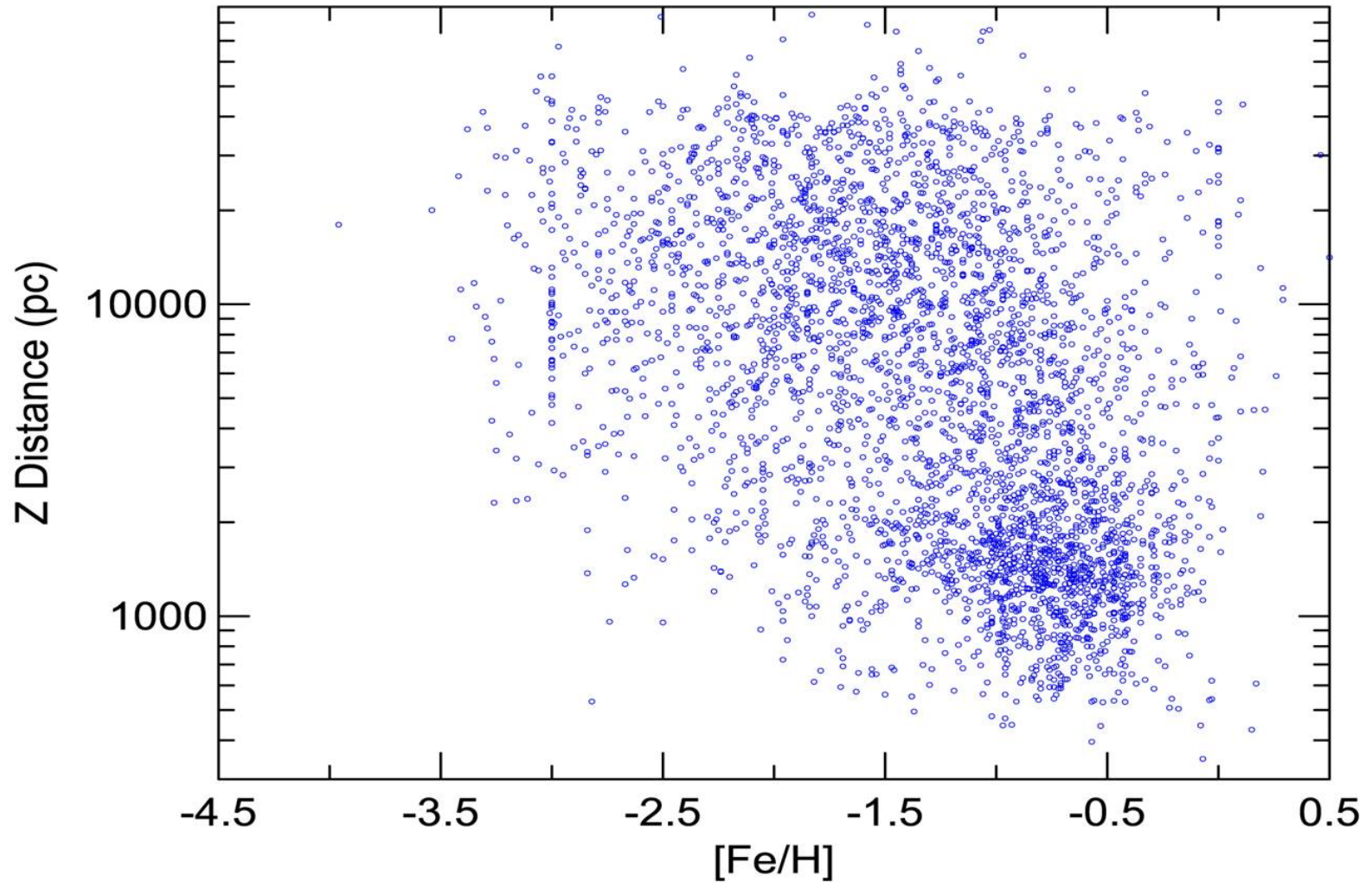
EDR 3907: CTIO4m Spectrum



RESULTS – Metallicity Distributions



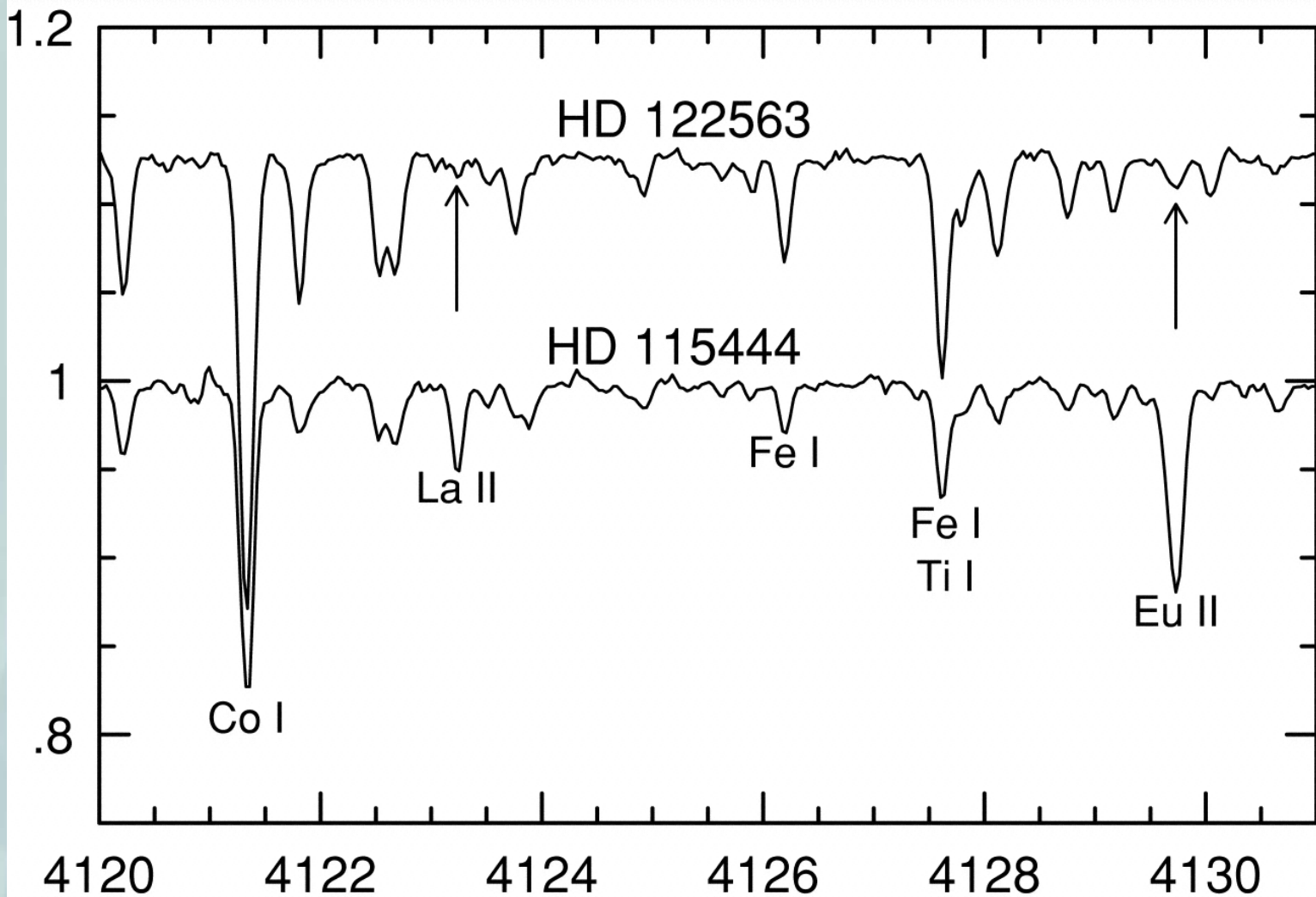
RESULTS – Distance Distributions



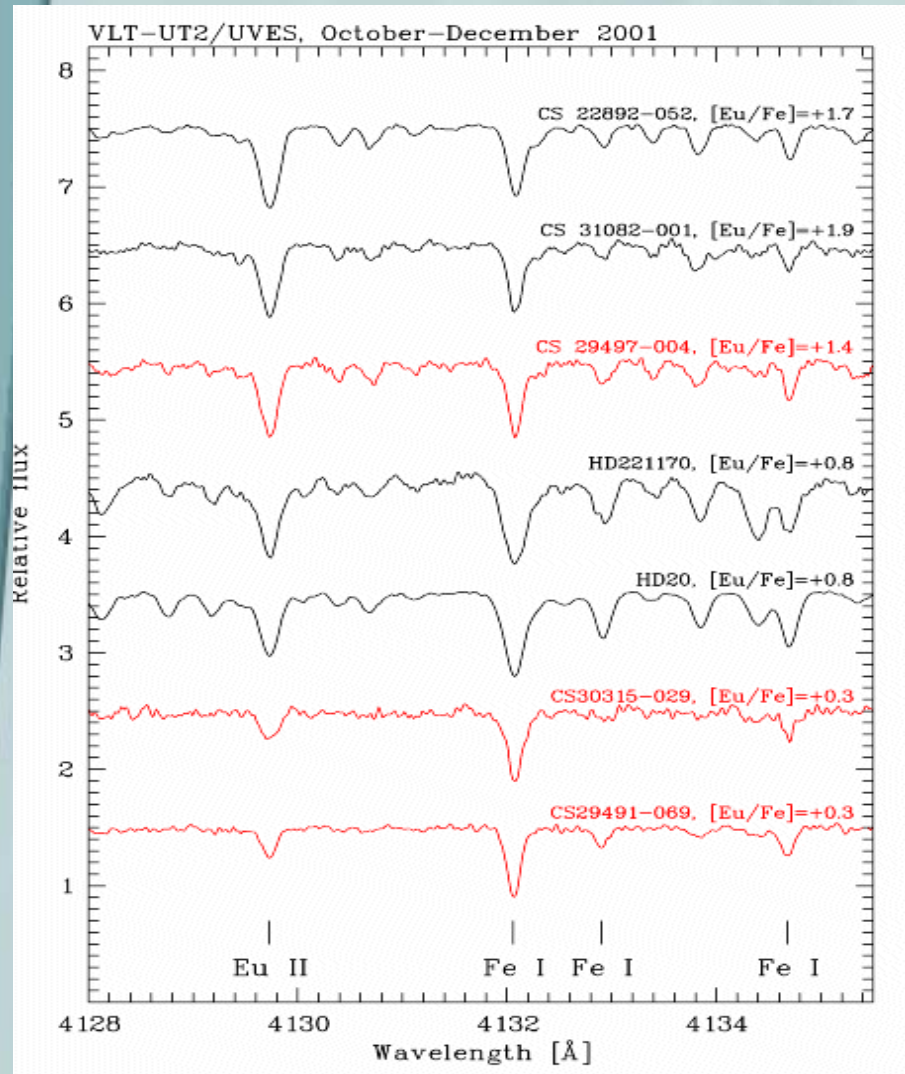
HERES: The Hamburg/ESO R- Process Enhanced Star Survey

- Based on 15-20 minute “snapshot” spectra of ~ 400 validated $[Fe/H] < -2.5$ giants with VLT/UVES
 - 350 hours (~ 44 nights of time) already assigned; last scheduled observations taking place in first semester of 2004
 - $R = 20,000$; $S/N \sim 30/1$ obtained (suitable for poor seeing conditions)
 - Should find 10-15 r-II stars, perhaps 20-30 r-I stars, and additional r-s stars (enhanced in BOTH r- and s-process elements)
- Searching for detectable absorption of Eu II 4129 A
- Obtain elemental abundances of ~ 20 additional elements, even for non r-process-enhanced stars

Sample Spectra in the Region of Europium (for an r-I Star)



Example HERES Survey Spectra and Results to Date



Thus far, a total of ~ 230 spectra have been examined. Among these are found:

23 stars: $+0.5 < [\text{Eu}/\text{Fe}] \leq +1.0$

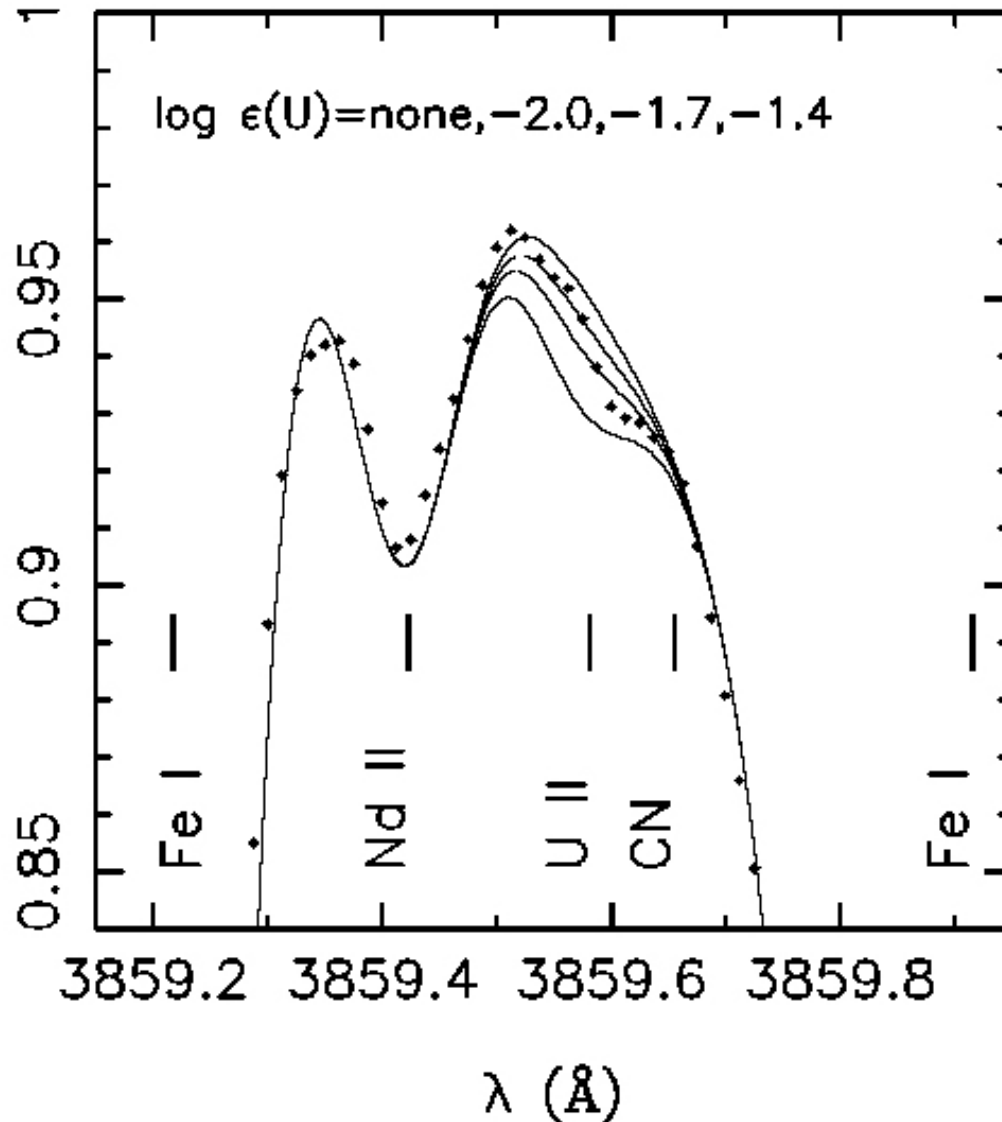
25 stars: $+1.0 < [\text{Eu}/\text{Fe}]$

Some of these will be s-process enhanced, some r-process enhanced. From detailed inspection to date, we have:

- 7 new stars with $[\text{r}/\text{Fe}] > +1.0$
(all except 1 have $[\text{Fe}/\text{H}] < -2.5$)
- 6 new stars with $+0.5 \leq [\text{r}/\text{Fe}] \leq +1.0$
(all have $-2.7 < [\text{Fe}/\text{H}] < -2.0$)

The apparent frequency of r-II stars is roughly consistent with preliminary estimate of $\sim 3\%$ of giants with $[\text{Fe}/\text{H}] < -2.5$

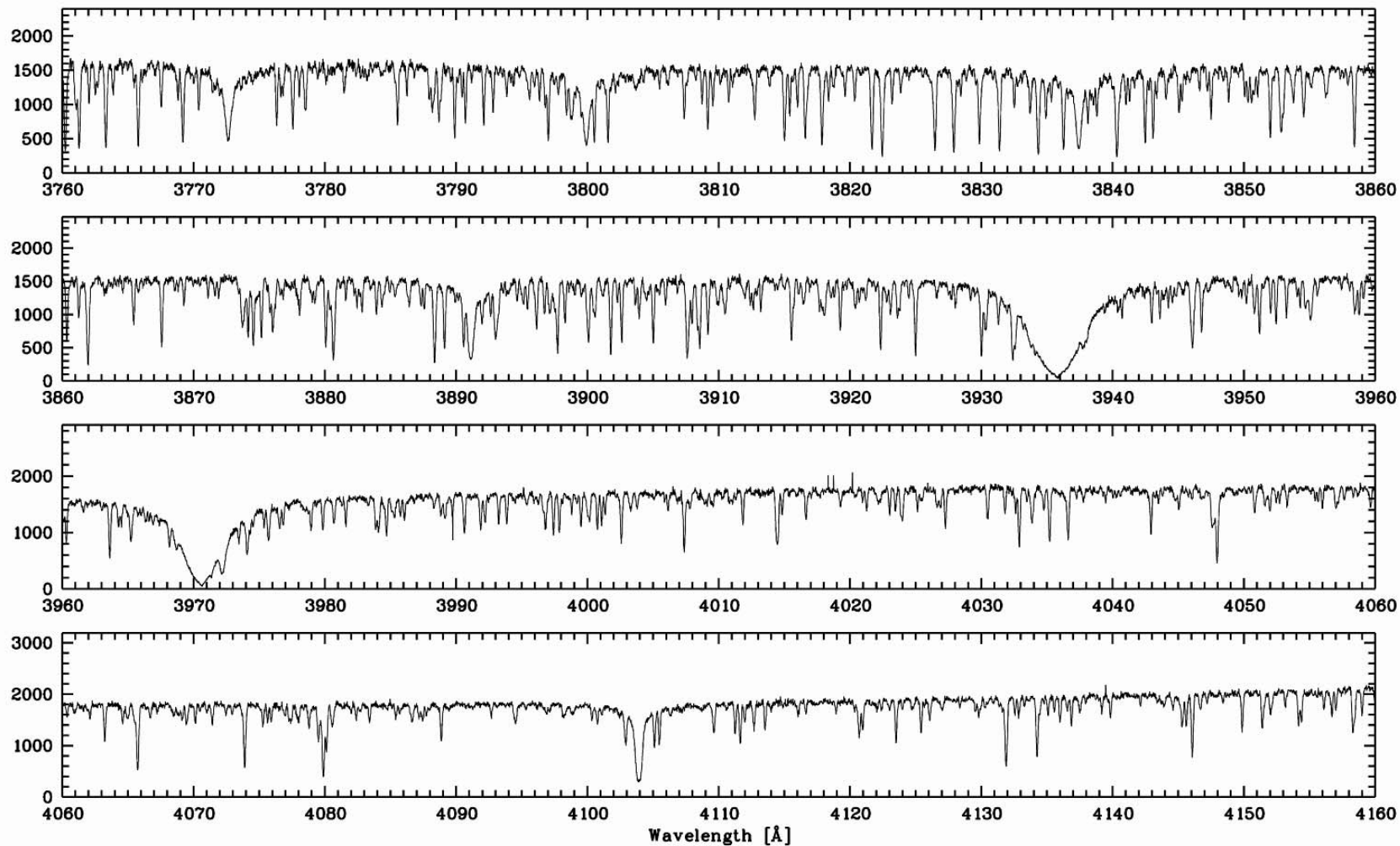
A New R-Process Enhanced Star with Uranium Detected: CS 29497-004 !



HERES Survey: Other Elements !

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

HERES Blue Spectrum

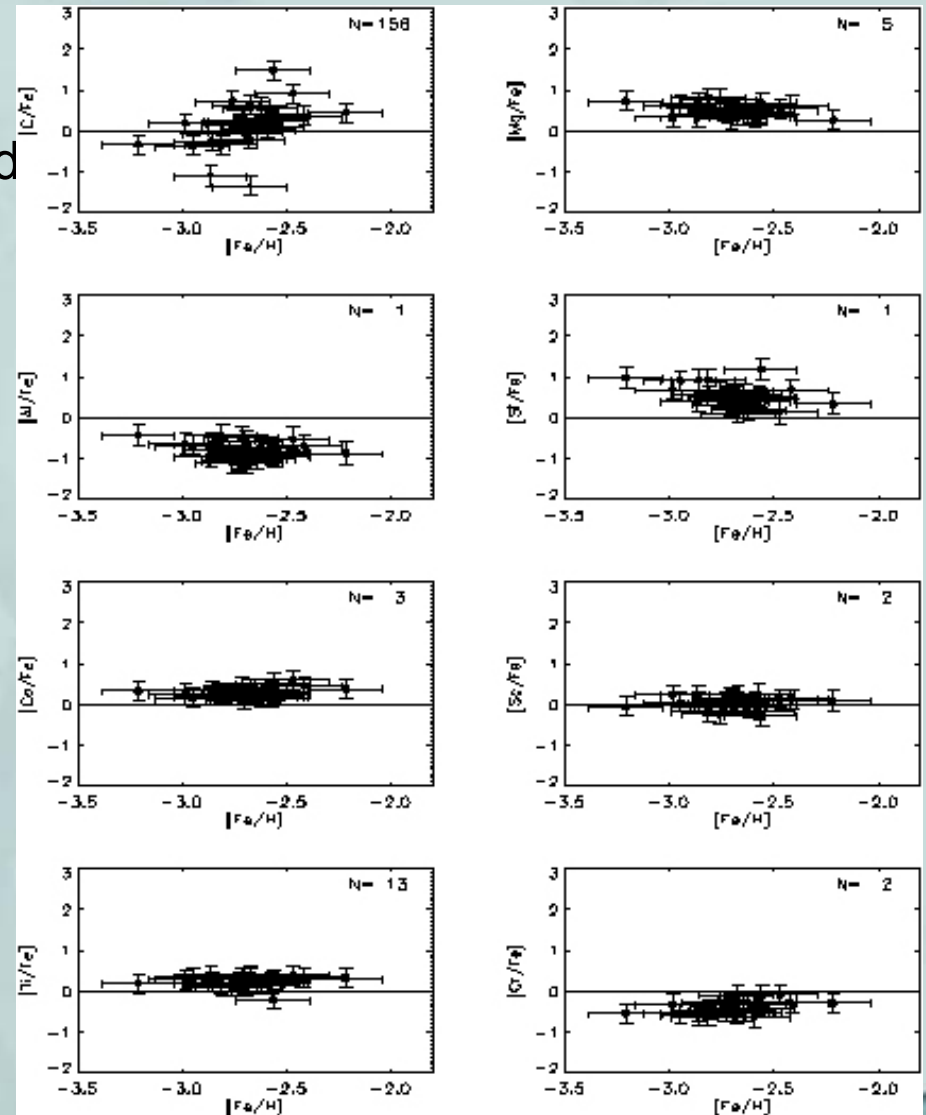


HERES Pilot Survey Results (N ~ 45 Stars Fully Analyzed)

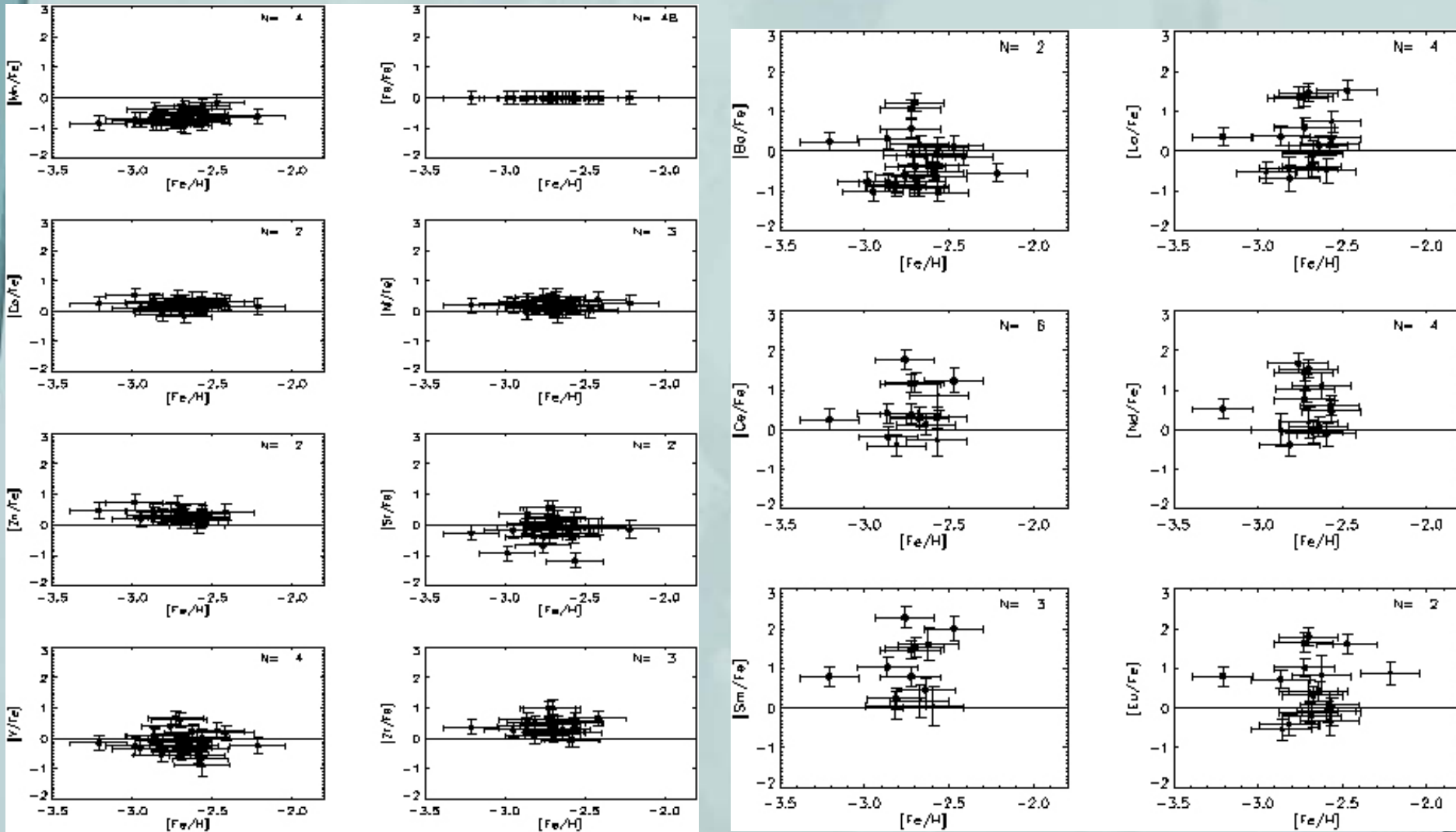
- There are already some **300 total stars** with $[\text{Fe}/\text{H}] < -2.5$ observed on this program, with another ~ 100 to go
- Barklem et al. (2004, soon!) describe automated abundance analysis techniques
- Derived (relative) abundances for **N ~ 20** elements per star, with accuracies on the order of 0.15 to 0.25 dex
- Definitive determinations of abundance patterns, scatter, below $[\text{Fe}/\text{H}] = -2.5$

Trends and Scatter of Light, Alpha- and Fe-Peak Elements for HERES Pilot Survey

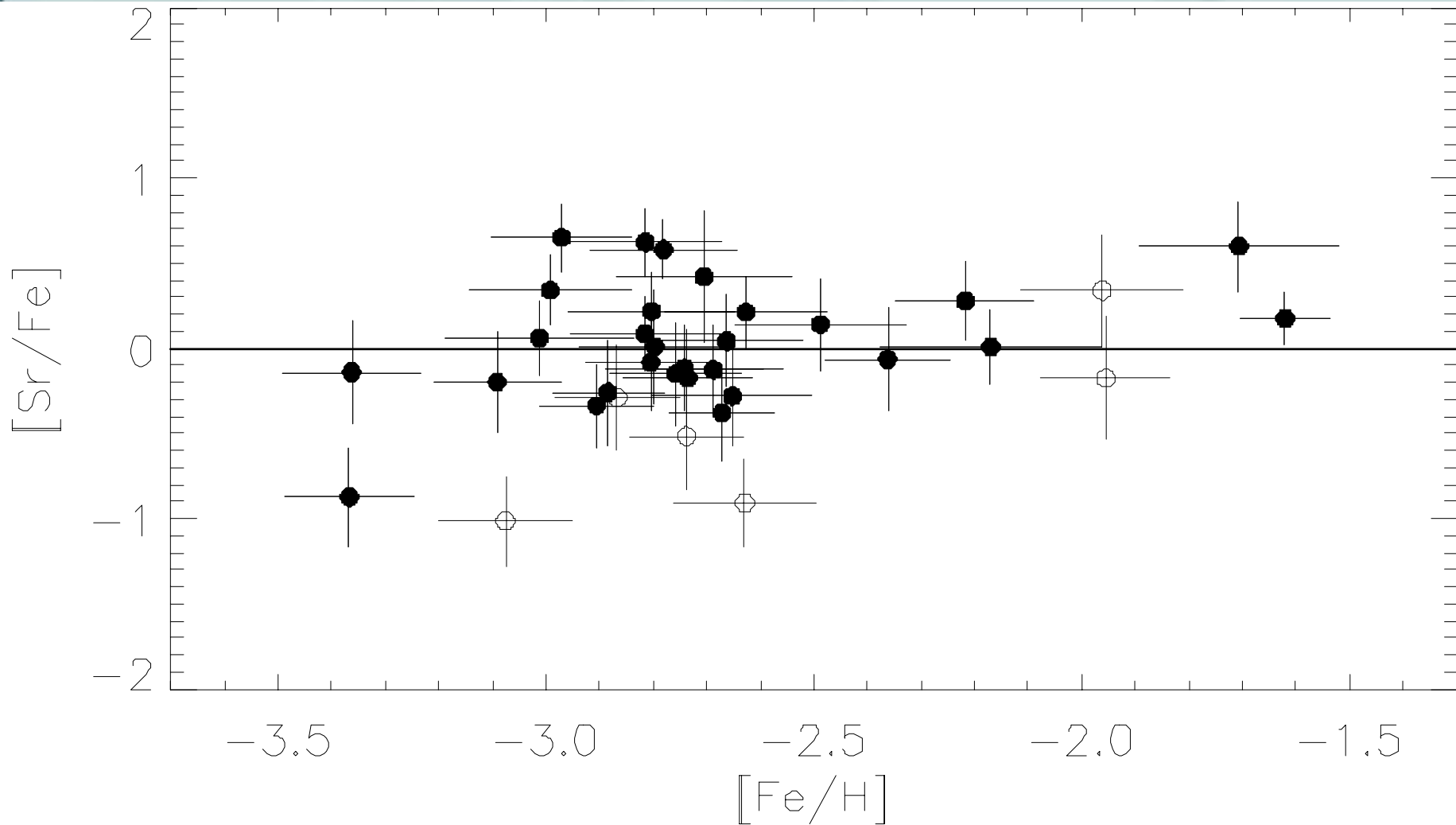
- Estimates of individual elemental abundances obtained from automated analysis procedure (Barklem et al. 2004, in prep.)
- Behavior of trends is as expected, when compared with higher S/N spectroscopic surveys conducted to date, e.g., the “First Stars” program of Cayrel et al. (2004, in press)
- Final database will provide unprecedented detail for the **largest sample of $[Fe/H] < -2.5$ stars yet assembled**



Iron-Peak and Neutron-Capture Elements for HERES Pilot Survey Stars



A Few “Close Ups”



HET-RES and SALT-RES

- Conduct a similar survey as HERES, but using input bright stars from SEGUE discoveries
 - $14.5 < B < 17.5$
- HET-RES: Hobby-Eberly 9.2m Telescope (Texas)
- SALT-RES: South African Large (9.2m) Telescope
- Each target N ~ 1000 candidates with $[Fe/H] < -2.0$
- High S/N Follow-up with SUBARU 8m Telescope (Hawaii)
- Should result in (at least) ~ 100 new r-II stars, ~ 200 new r-I stars, and a host of other neutron-capture rich objects

Advantages for JINA Involvement in SEGUE

- Fulfills NSF call for “new ventures and collaborations”
- Provides mechanism by which nuclear physics community is directly involved with astronomical discovery of objects that matter most to them
- Provides mechanism for training of students as nuclear astrophysicists, as opposed to just nuclear physics or astronomy
- Establishes JINA as a participant in the most revolutionary study of our Galaxy to date