Observations/Expansions In Astronomy & Astrophysics

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Present Observational Efforts

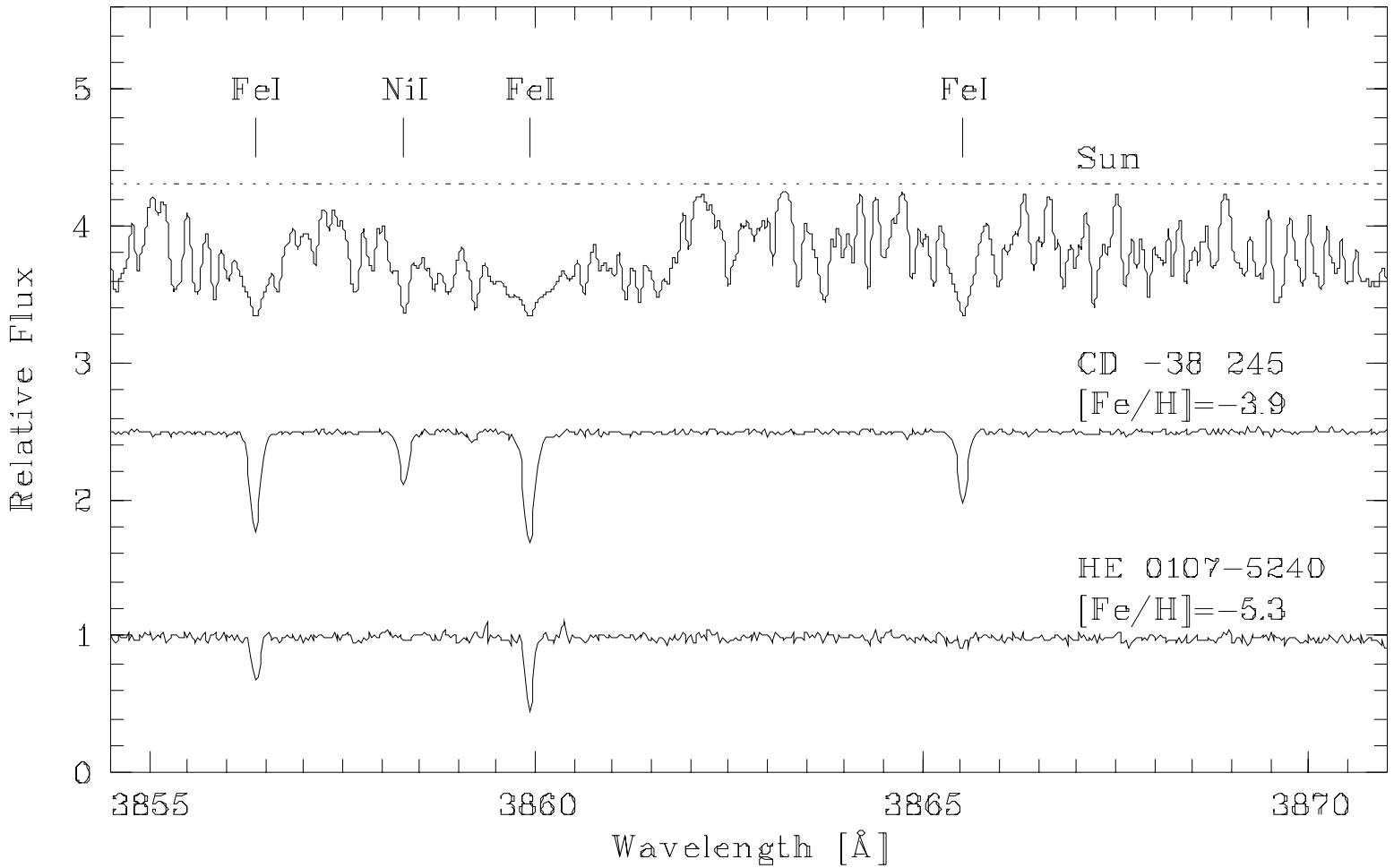
- MSU – Beers, Schatz, Brown, (Smith)
  - Medium-resolution discovery of VMP ([Fe/H] < -2.0) stars (HK Survey; Hamburg/ESO Survey; SDSS/SEGUE)
  - High-resolution analysis of EMP (< -3.0), UMP (< -4.0), and HMP (< -5.0) stars (VLT; Subaru; Keck)
  - HST near UV observations (CS 31082-001)
  - Beginning soon, access to SOAR 4.1m
- Notre Dame – Garnavich, Howk, Mathews
  - Center for Astrophysics at Notre Dame University (CANDU)
  - Beginning soon, access to LBT
  - Observations of VMP stars / Damped Lyman alpha systems
- University of Chicago – Truran, Davis
  - HST near-UV observations (CS 31082-001)
  - Access to ARC 3.5m
  - Meteoritic studies

Examples of Recent Progress

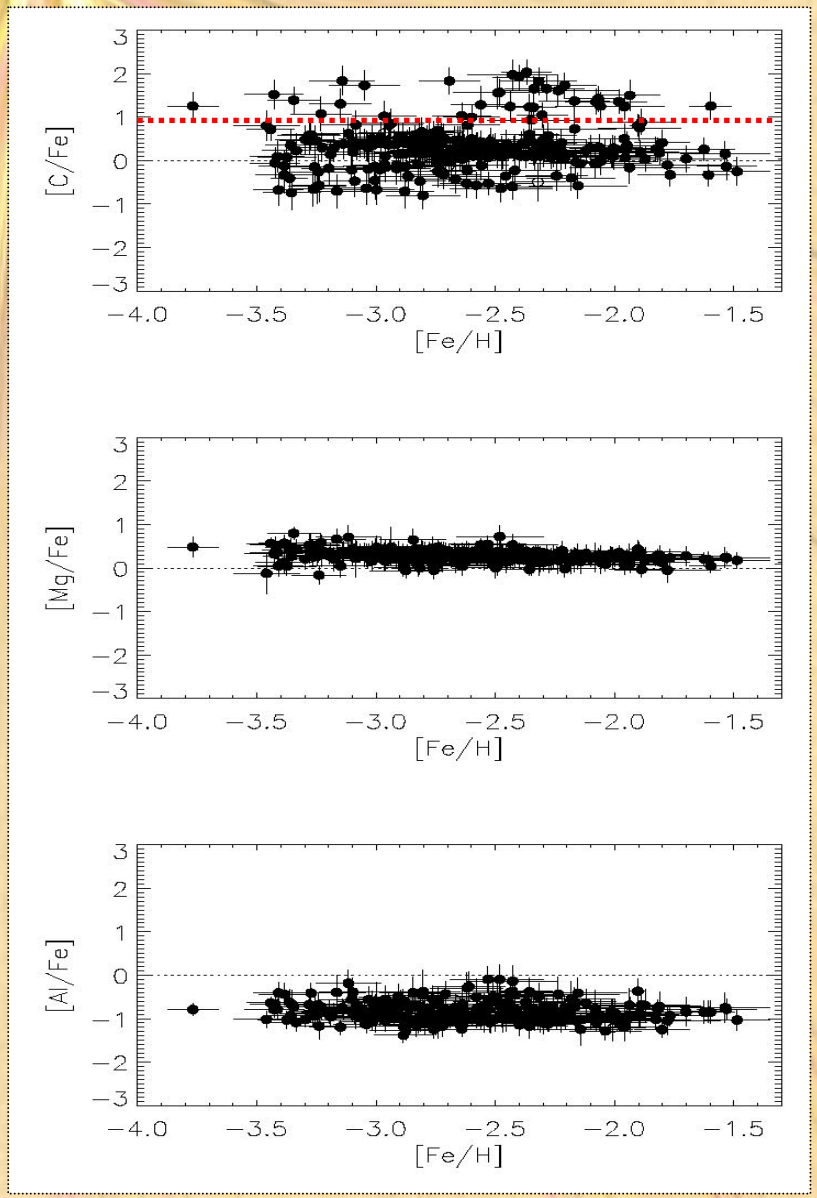
- Discovery of Hyper Metal-Poor star HE 0107-5240
  - [Fe/H] = -5.3

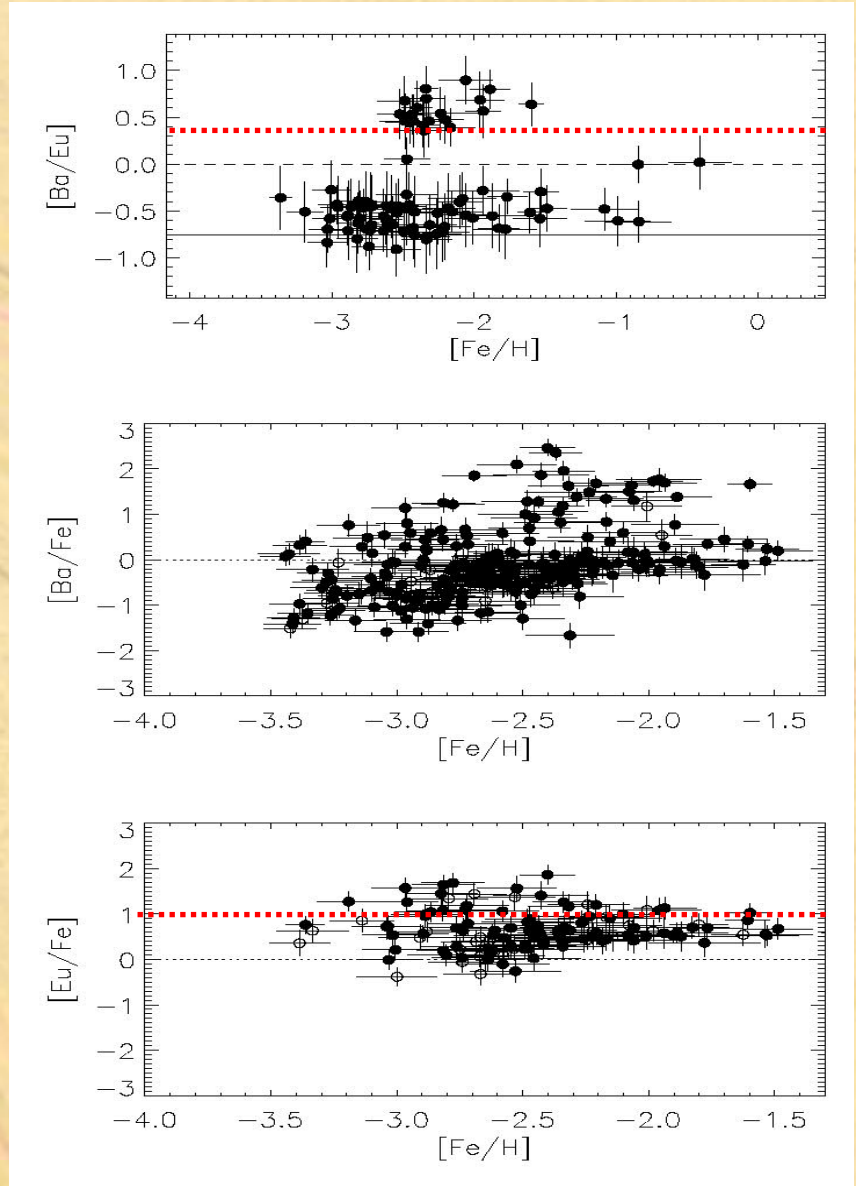
- Hamburg/ESO R-Process-Enhanced Star Survey (HERES) observations of [Fe/H] < -2.5 giants
  - Barklem et al. (2005)
  - "Snapshot" spectroscopy (R ~ 20,000, S/N ~ 30/1) of ~ 400 VMP giants with VLT/UVES
  - Discovery of 10 new r-II stars ; 30 new r-I stars; numerous s-process-enhanced stars, numerous carbon-enhanced stars
  - Discovery of new "U Star": CS 29497-004

HE 0107-5240: Most Iron-Deficient Giant Known

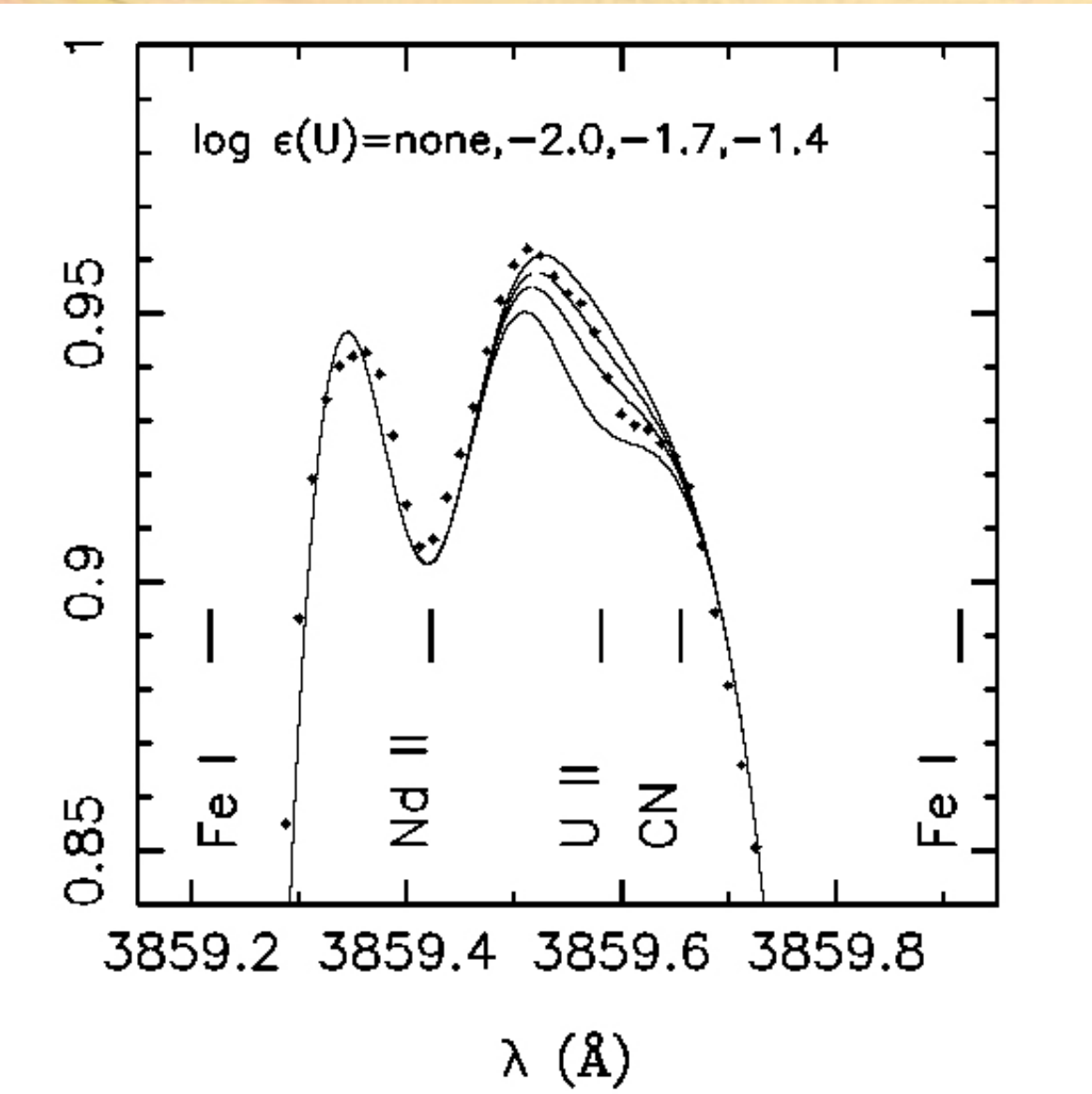


The Power Of Large N: 274 Stars from HERES





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



Opportunities for Expansion

- SDSS-II (Extension of SDSS)
  - SEGUE (Sloan Extension for Galactic Understand and Evolution
  - TISS (Type Ia Supernova Survey)
- Australian Research Council
  - CEEC (Centre of Excellence – Evolutionary Cosmology)
    - RAVE (RAdial Velocity Experiment)
    - SSS (Southern Sky Survey)
    - SSHS (Siding Spring/ Hamburg Survey)

The ARC 2.5m and 3.5m Telescopes

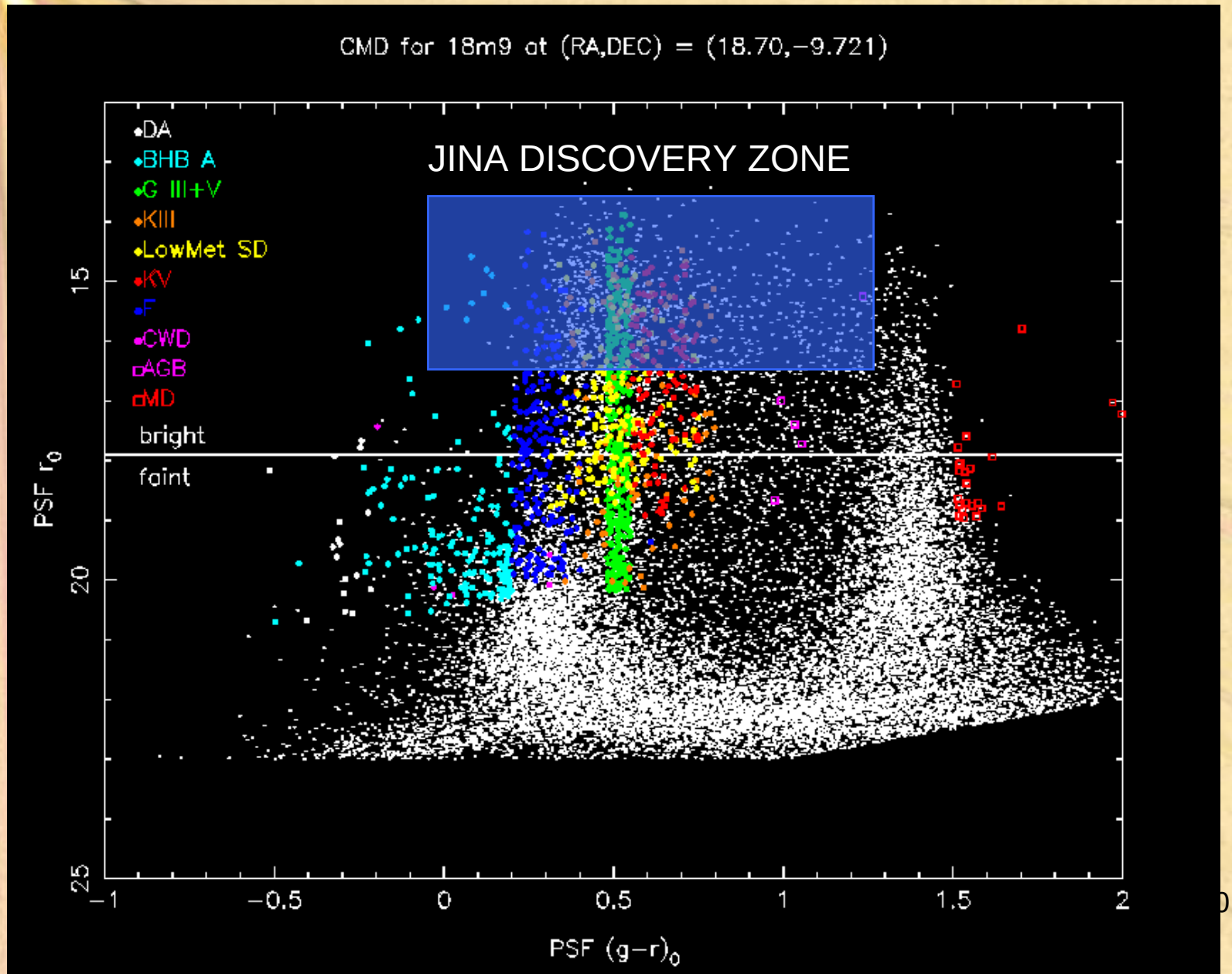
ARC 2.5m SDSS Telescope (3 deg FOV)

ARC 3.5m Telescope

SEGUE: The Sloan Extension for Galactic Understanding and Evolution

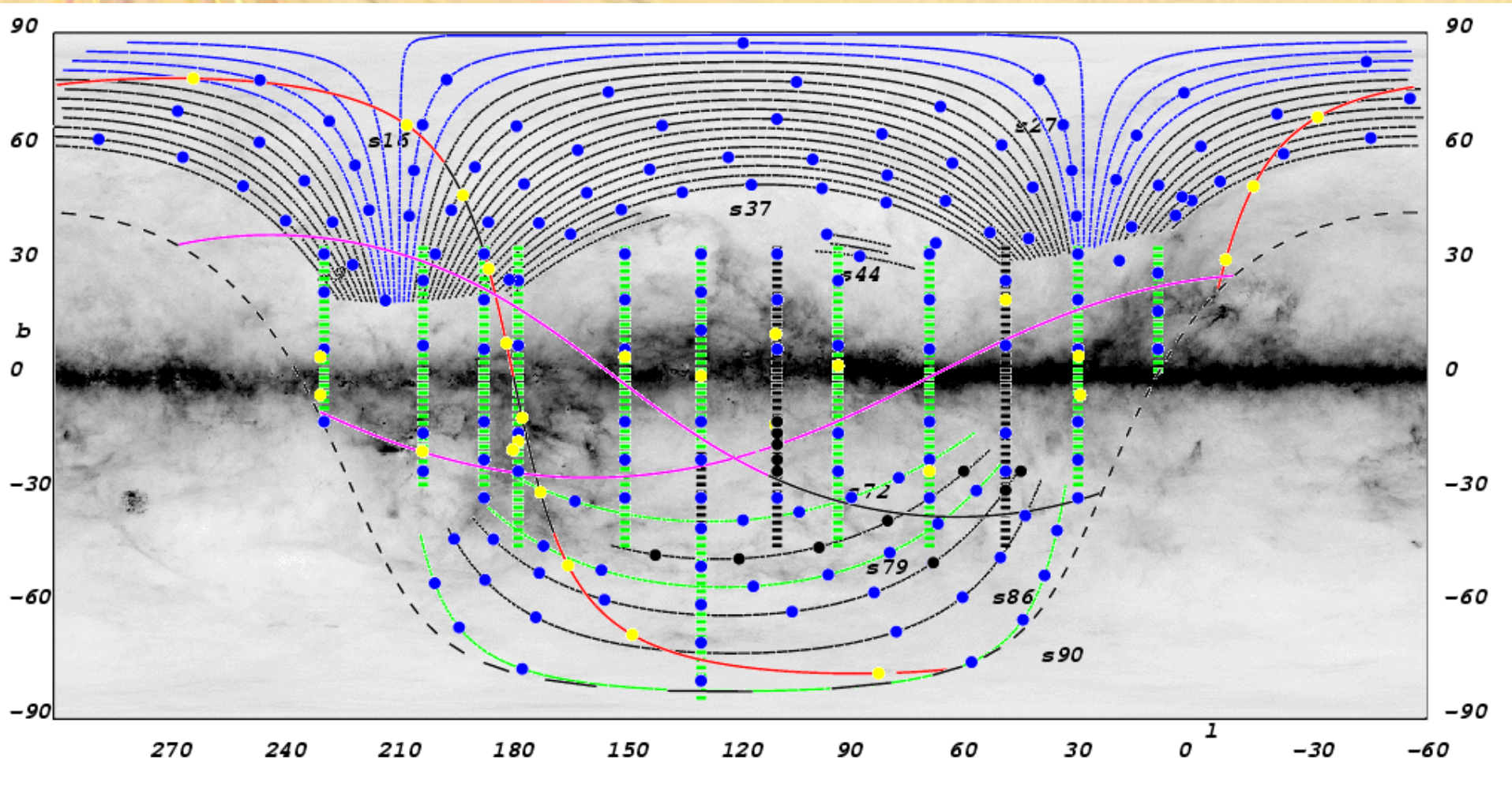
- Use existing SDSS hardware and software to obtain:
  - 4000 square degrees of additional *ugriz* imaging at lower latitudes
    - Stripes chosen to complement existing areal coverage; includes several vertical stripes through Galactic plane
  - Medium-resolution spectroscopy of 250,000 “optimally selected” stars in the thick disk and halo of the Galaxy
    - 200 “spectroscopic plate” pairs of 45 / 90 min exposures
    - Objects selected to populate distances from 1 to 100 kpc along each line of site
    - Proper motions available (from SDSS) for stars within ~ 5 kpc

SEGUE Target Selection– “JINA-fied”

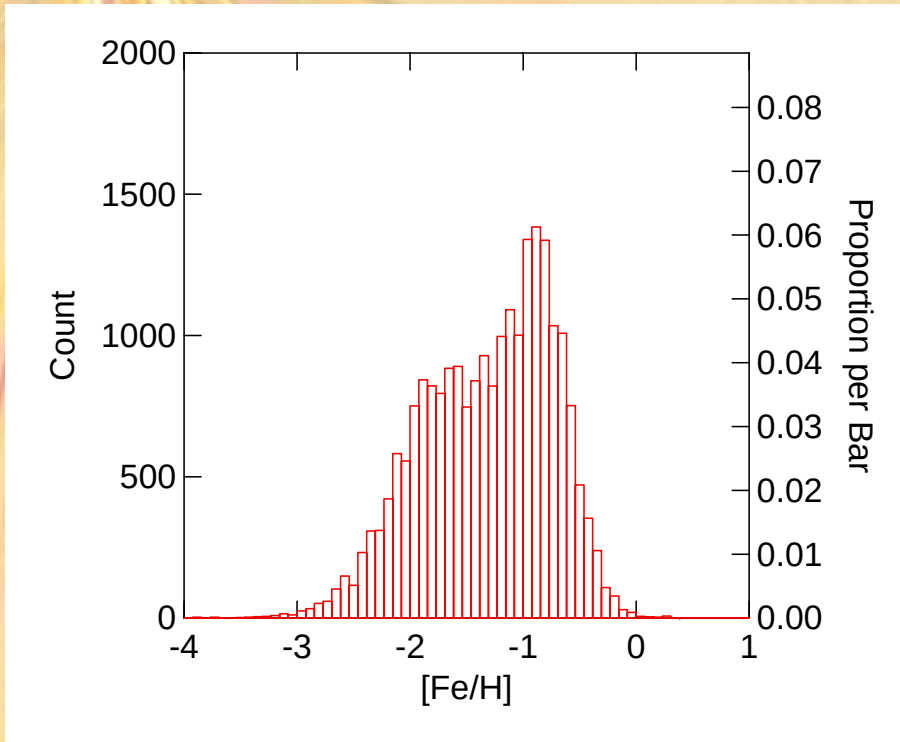


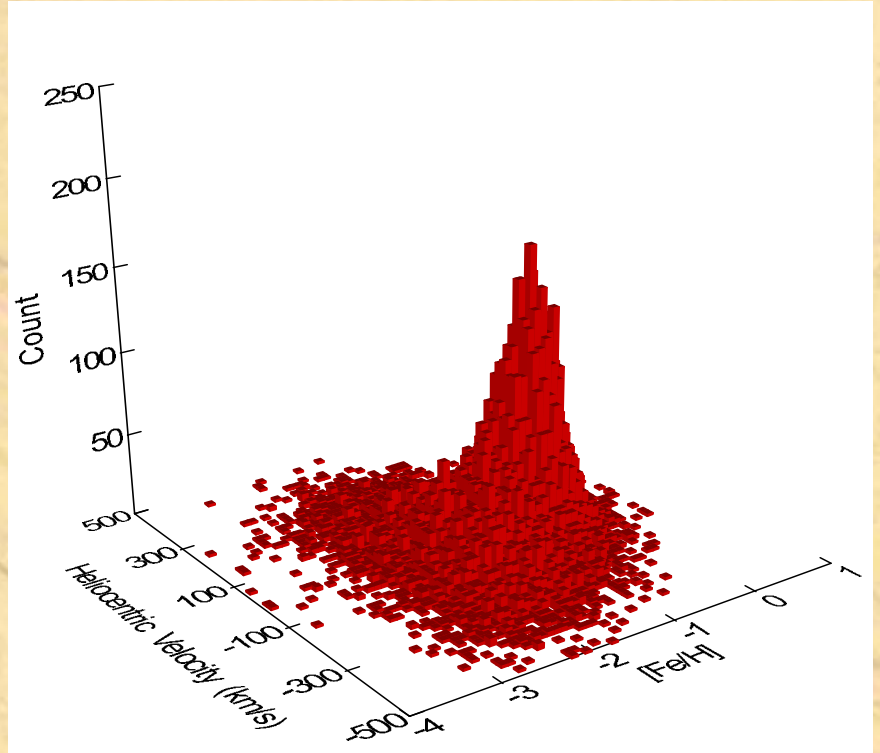
SEGUE Footprint as of Jan, 2005

Black = Completed / 40 of 400 plates observed



SDSS DR3 -- Distribution of [Fe/H] and Velocity vs. [Fe/H]





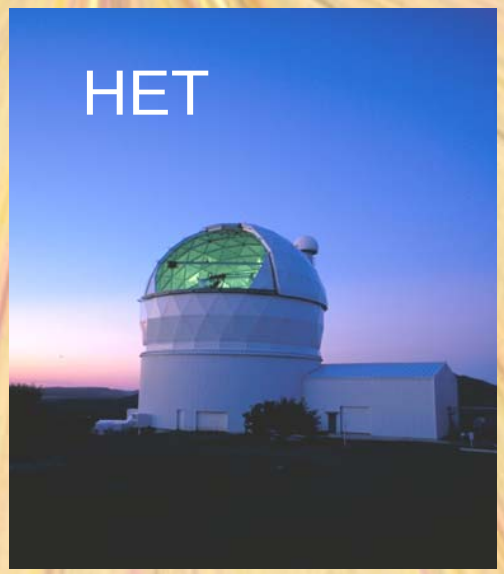
- Even though SDSS does not specifically target the most metal-poor stars, it finds plenty of them !
- There are N ~ 3000 stars with [Fe/H] < -2.0 (with well-measured parameters) and cooler than the halo main-sequence turnoff included in DR-3, and N ~ 100 such stars with [Fe/H] < -3.0
- This is more than the SUM OF ALL PREVIOUS [Fe/H] < -2.0 stars found over the past half-century by other survey efforts

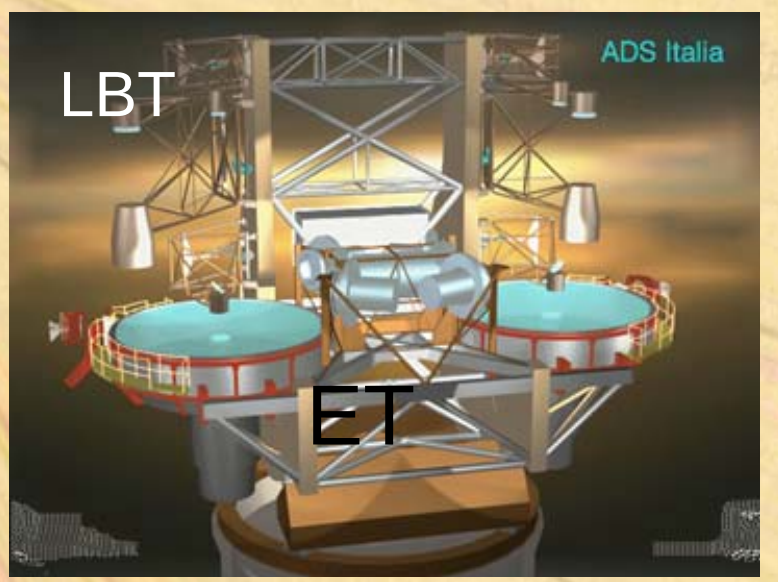
Likely Numbers of Detected MP Stars from SEGUE

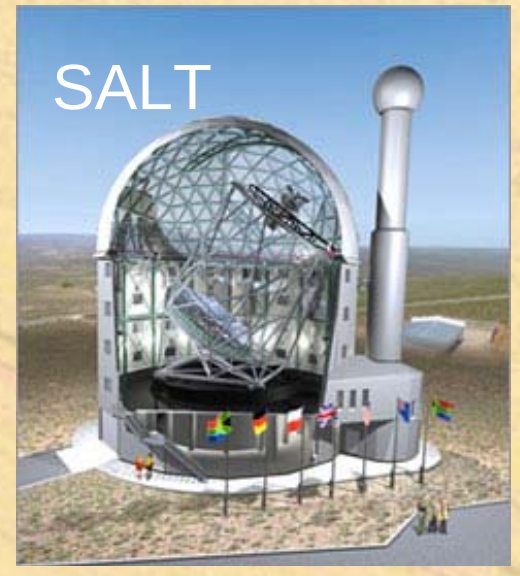
- Actual numbers will depend on the shape of the halo Metallicity Distribution Function

–	[Fe/H] < -2.0	~ 50,000 (VMP)
–	[Fe/H] < -3.0	~ 5,000 (EMP)
–	[Fe/H] < -4.0	~ 500 ? (UMP)
–	[Fe/H] < -5.0	~ 50 ? (HMP)
–	[Fe/H] < -6.0	~ 5 ? (MMP)

HERES-Like Follow-Up of VMP Giants with B < 17







CEEC – Col's

- Brad Gibson (Swinburne)
- Brian Schmidt (ANU)
- Mike Dopita (ANU)
- Ken Freeman (ANU)
- Franklin Briggs (ANU)
- Ralph Sutherland (ANU)
- Gary DaCosta (ANU)
- Geoffrey Bicknell (ANU)
- Martin Asplund (ANU)
- John Norris (ANU)
- Mike Bessell (ANU)
- John Lattanzio (Monash)
- Mathew Colless (AAO)
- Joss Bland-Hawthorne (AAO)

AIP (Germany) / JINA (USAO / Silicon Graphics

A$11.6 Million / 5 Year Project

CEEC --

- Using UK Schmidt 1.2m + 6dF (150 fibers)
  - R =10,000 spectroscopy for 250,000 stars
  - Abundance/radial velocities accurate to 1 km/s
- Eventual expansion to UKidna (2500 fibers)
  - Spectroscopy for 25,000,000 stars
- Possible expansion to northern hemisphere
- Follow-up medium- and high-resolution spectroscopy
  - SSO 2.3m / AAT 3.8m
  - SOAR 4.1m
  - VLT 8m
  - SALT 9.2m

CEEC – Southern Sky Survey

- Southern equivalent of SDSS imaging survey
  - Newly constructed Skymapper 1.3m Telescope
    - Expected completion ~ 2007
  - *ugriz* photometry of 20,000 square degrees (twice SDSS footprint)

CEEC – Siding Spring/Hamburg Survey

- Siding Spring Observatory 1m telescope
  - 10 A resolution (slitless spectroscopy of southern extragalactic sky)
  - Reaching to B ~ 18.0
  - *ugriz* photometry from SSS
- Follow-up medium-resolution spectroscopy
  - SSO 2.3m
  - SOAR 4.1m
- Follow-up high-resolution spectroscopy
  - VLT
  - SALT

Summary of Opportunities

- For relatively small investment (SEGUE: $250K, CEEC: $150K) JINA will become a prime-time player in present/future surveys of the Galaxy
- Discovery/analysis of several hundred neutron-capture rich MP stars
- Discovery of other rare objects of interest to JINA:
  - HMP ([Fe/H] < -5.0) and MMP ([Fe/H] < -6.0) stars
  - Carbon-enhanced MP stars
  - Halo planetary nebulae
  - Pre-supernova binaries
  - Type Ia supernovae