The AMBRE Project

Metallicity Distribution with the FEROS archived spectra

C. Clare Worley

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Observatoire de la Côte d'Azur

SF2A, Nice, 6th June 2012

Outline

- The AMBRE Project
- AMBRE:FEROS Stellar Parameters
- Data-mining Catalogues
- Metallicity Distribution with FEROS

The AMBRE Project

Archéologie avec Matisse: aBondances dans les aRchives de l'Eso

Collaborators: P. de Laverny, A. Recio-Blanco, V. Hill, C. Ordenovic, F. Guitton, J.C. Gazzano and A. Bijaoui

Observatoire de la CÔTE d'AZUR

ESO/OCA project: 2009 - 2012

ESO

ESO Spectrograph	Resolving Power	Spectral Domain	Approximate No. archived spectra
FEROS	48,000	350nm - 920nm	20,000
HARPS	115,000	378nm - 691nm	125,000
UVES	40,000 to 110,000	300nm - 1100nm	100,000
Flames/GIRAFFE	5,600 to 46,000	370nm - 900nm	>1000,000
		Total Sample	>350,000

This extensive dataset covers a large range of wavelengths and resolutions, including the wavelength domain and resolutions of Gaia RVS.

MATISSE: MATrix Inversion for Spectral SynthEsis

Recio-Blanco, Bijaoui, de Laverny (2006), Bijaoui, Recio-Blanco, de Laverny (2008)

Local multi-linear regression method

- **Stellar parameters ($\theta = T_{eff}$, log g, [M/H], individual chemical abundances) are derived by the projection of an input observed spectrum $O(\lambda)$ on a vector function $B_\theta(\lambda)$.**

$$\hat{\theta}_i = \sum_{\lambda} B_\theta(\lambda) O_i(\lambda)$$

- **The $B_\theta(\lambda)$ function is an optimal linear combination of theoretical spectra $S(\lambda)$ calculated from a synthetic spectra grid (the learning phase).**

$$B_\theta(\lambda) = \sum_{i} \alpha_i S_i(\lambda)$$

The $B_\theta(\lambda)$ function reflects the sensitivity of the spectral region to θ.

The Grid of High Resolution Synthetic Spectra

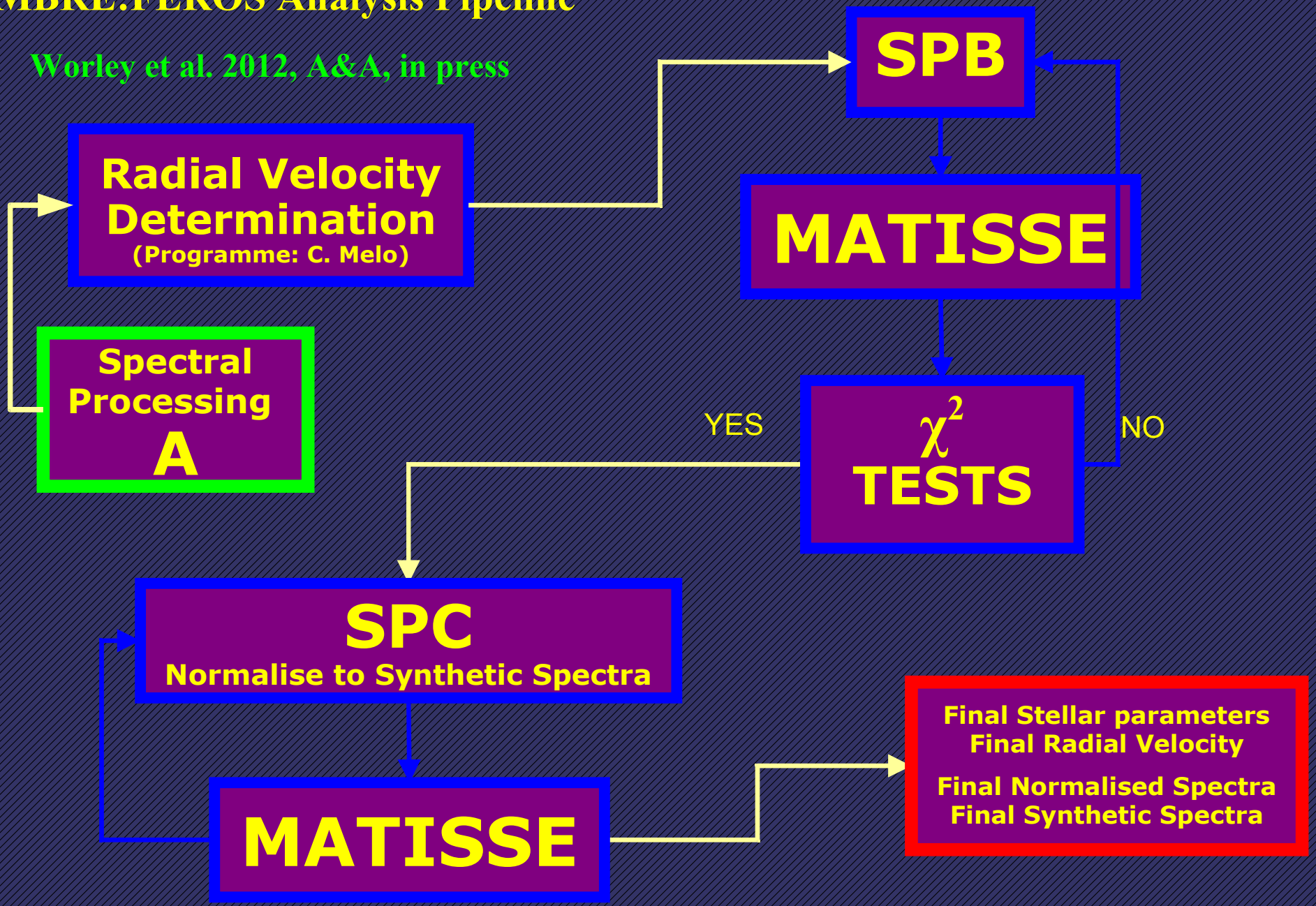
de Laverny, Recio-Blanco, Worley & Plez 2012, A&A, in press

Computed using OCA Mesocentre ~ 50,000hrs computing time

- **~16000 synthetic spectra**
- **Optical domain: 3000 Å - 12000 Å**
- **MARCS model atmospheres (Gustafsson et al., 2010)**
  - **$T_{\rm eff}$: 2500 → 8000 K**
  - **log g : 0.0 → +5.0 dex**
  - **[M/H] : -5.0 → +1.0 dex**
  - **[α/Fe] : -0.4 → +0.8 dex**
- **Molecular line lists from Bertrand Plez**
- **Atomic line lists : VALD**

AMBRE:FEROS Analysis Pipeline

Worley et al. 2012, A&A, in press



The AMBRE:FEROS Stellar Parameters

Worley, de Laverny, Recio-Blanco, Hill, Bijaoui & Ordenovic, 2012, A&A, in press

FEROS: **MPG/ESO 2.2m Telescope, La Silla**

Instrument Resolution ~ 48,000

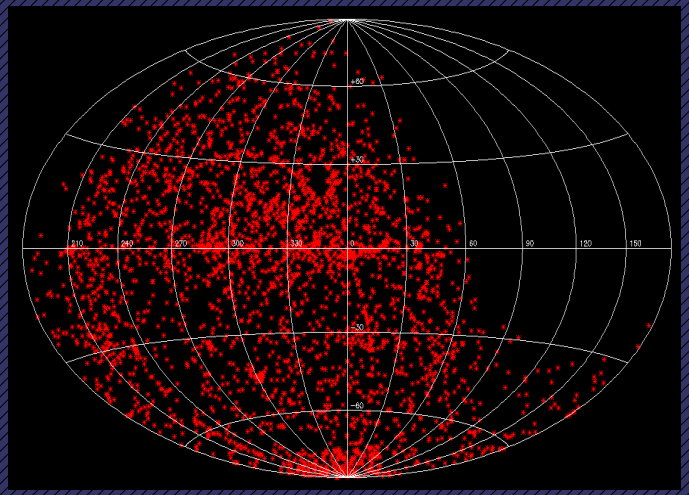
Wavelengths →350nm to 920nm

October 2005 → December 2009

No. Archived Spectra → 21551

No. Stars → ~ 6285

FEROS Targets in Galactic Coordinates



Majority of Southern Sky is sampled

MATISSE SET-UP: **17 Wavelength Regions → 1500 Å from 4000 Å to 7000 Å**

→ Mg triplet (~5160 Å), H_β (4861 Å)

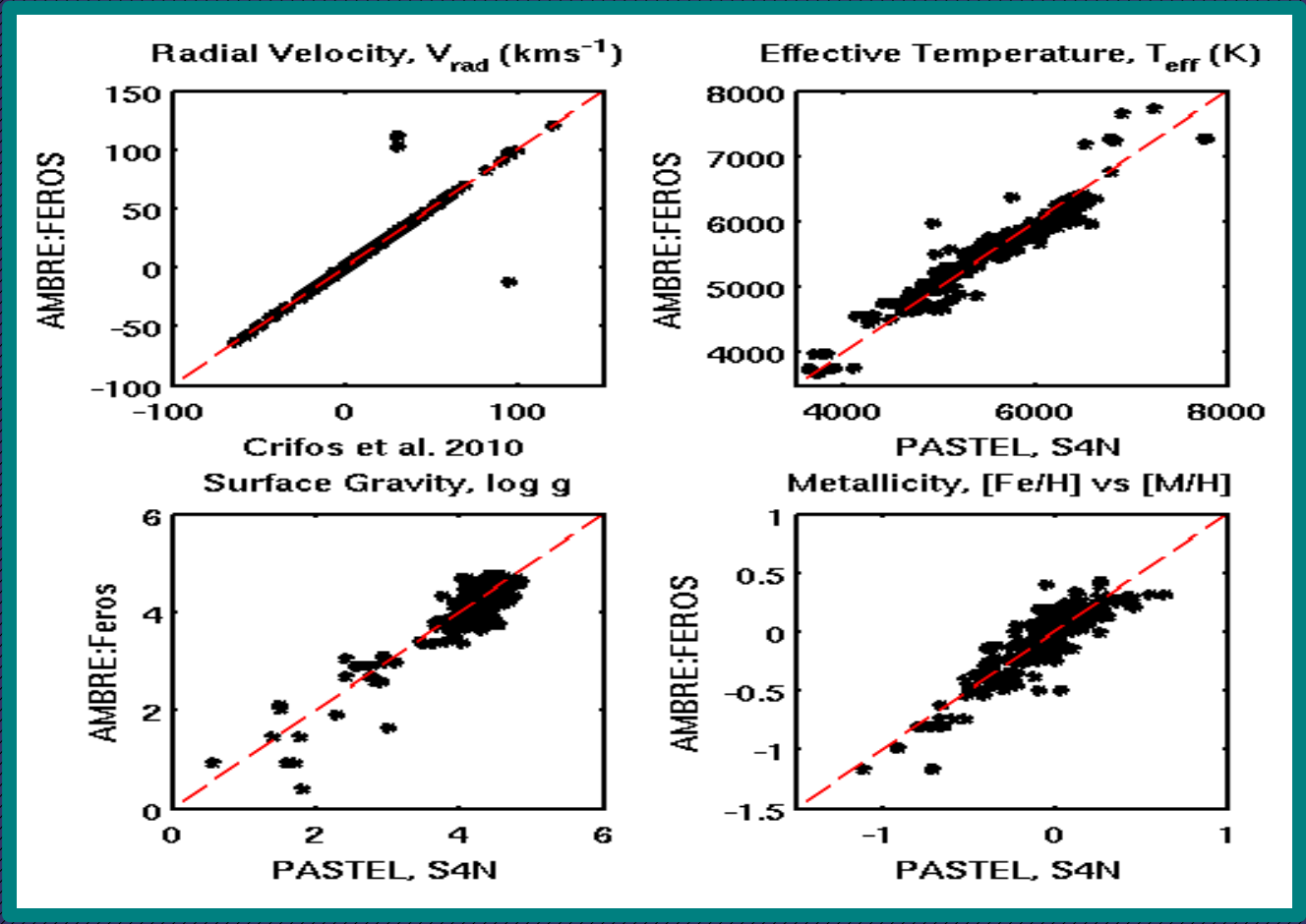
Validation: Homogeneous Reference Samples

Standard Star Atlases: Sun, Arcturus, Procyon

Spectral Libraries: S^{4}N, PASTEL

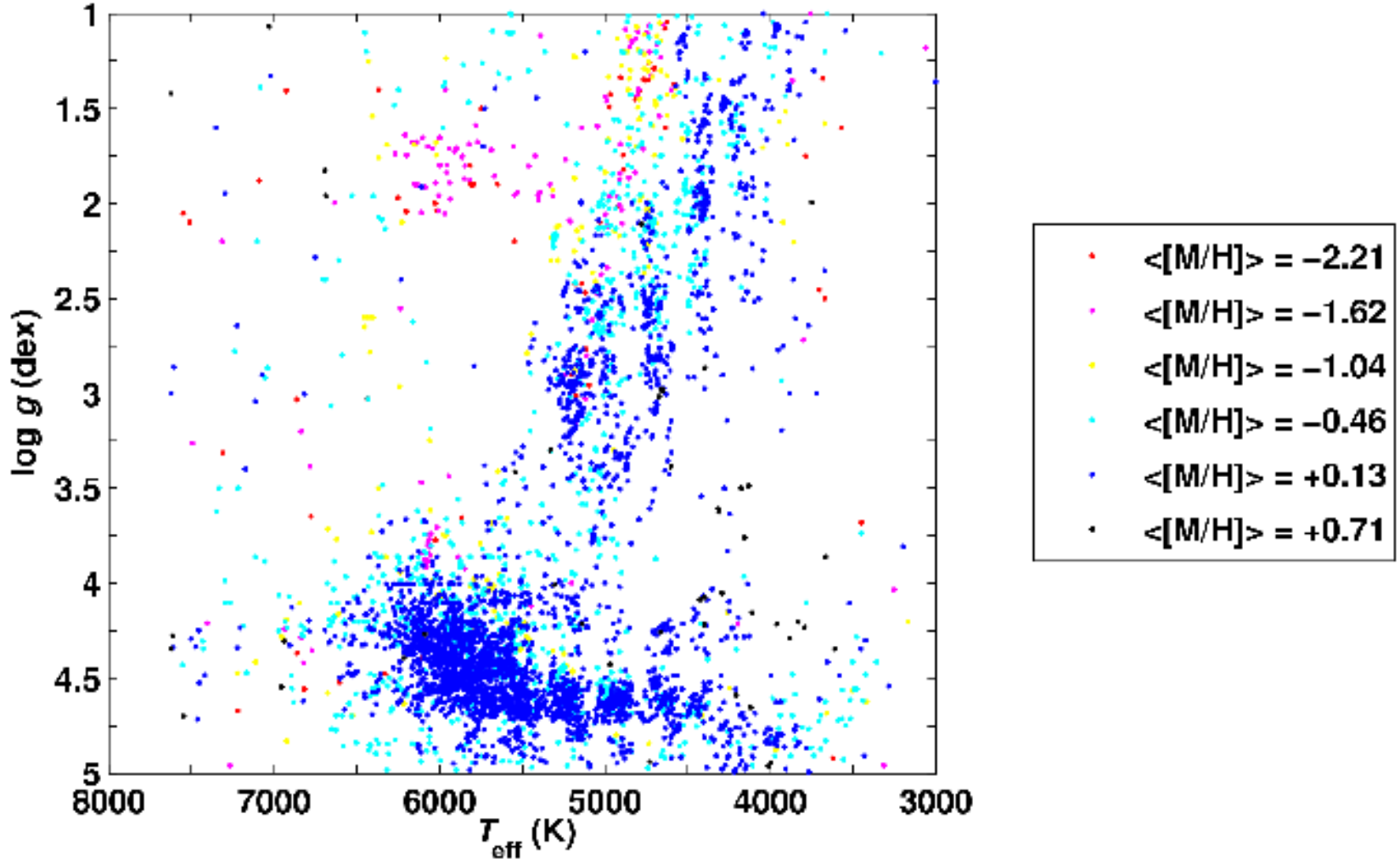
Key Studies: Crifo et al. 2010 → Gaia RVS Standards

Bensby et al. 2003 → alpha element abundances



FEROS Spectra: The Parameters

6508 spectra → ~3087 stars → 30.2 % of archived sample



FEROS Stars: Distances

- **Apparent Magnitudes: V, B, J, K (PPMXL)**
- **Distances**
  1. **Hipparcos new reduction (van Leeuwen 2007)**
  2. **Absolute Magnitudes using Isochrones: M_V, M_B, M_J, M_K**

Kordopatis et al, 2011a&b

& Interstellar reddening from Theoretical Colours

Gazzano et al. 2010, 2012; Gonzalez et al, 2009

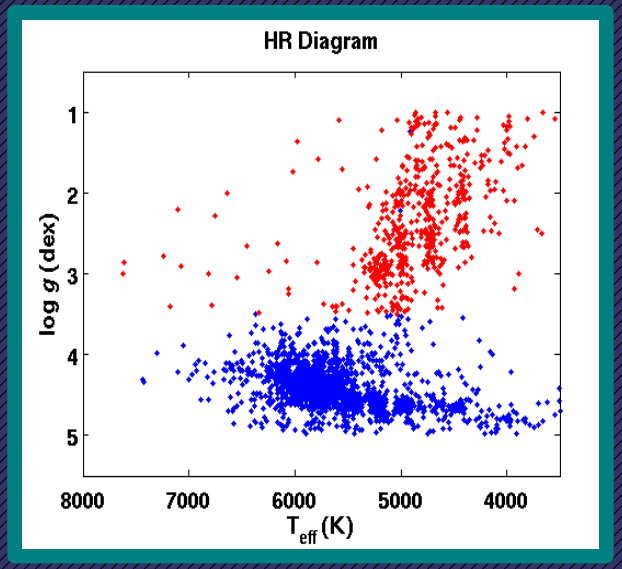
Distance from Sun & above Galactic Plane

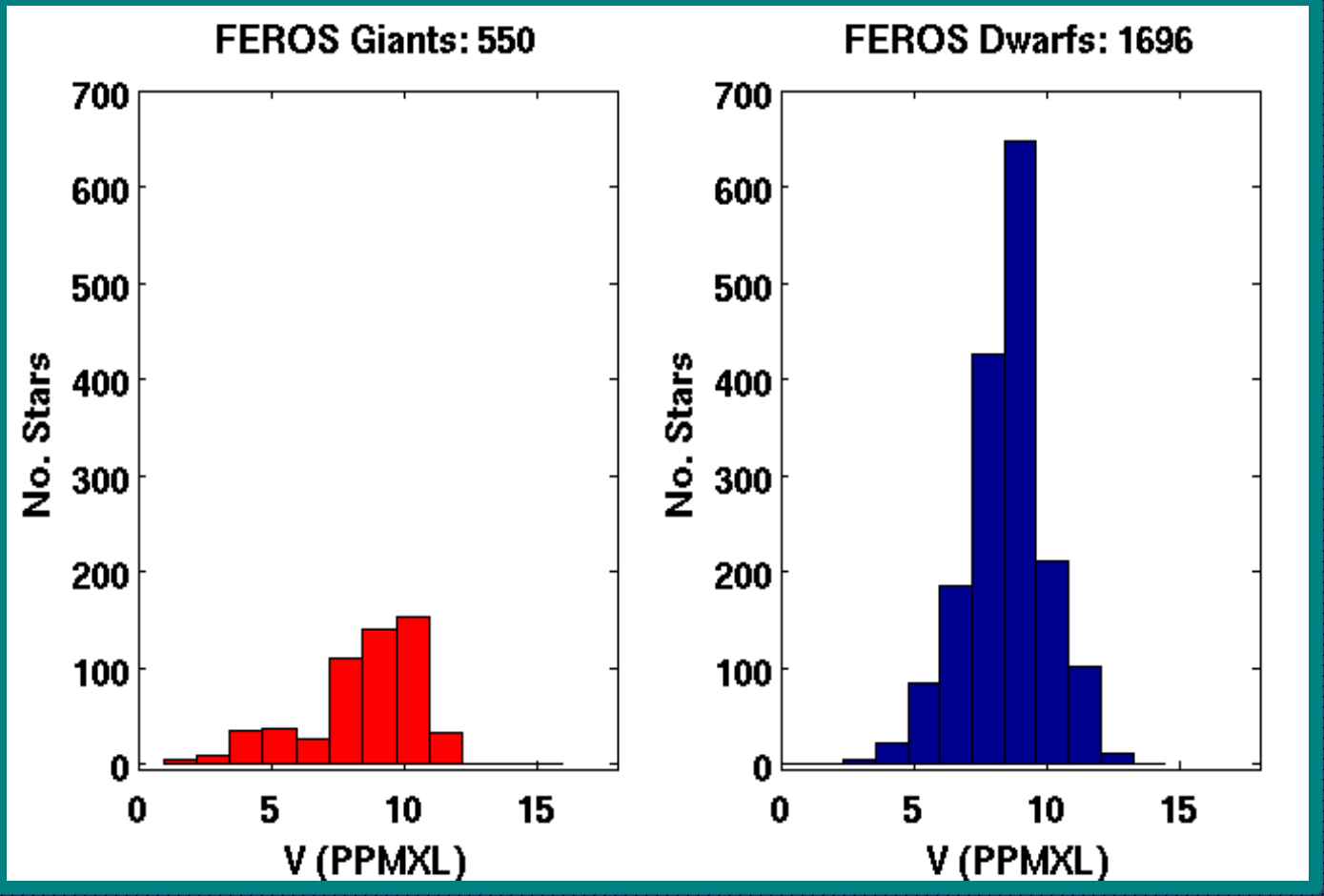
$$D = 10^{0.2(m - M + 5)}$$

$$Z_{GC} = Z_{\odot} + D\sin b$$

FEROS Stars: PPMXL

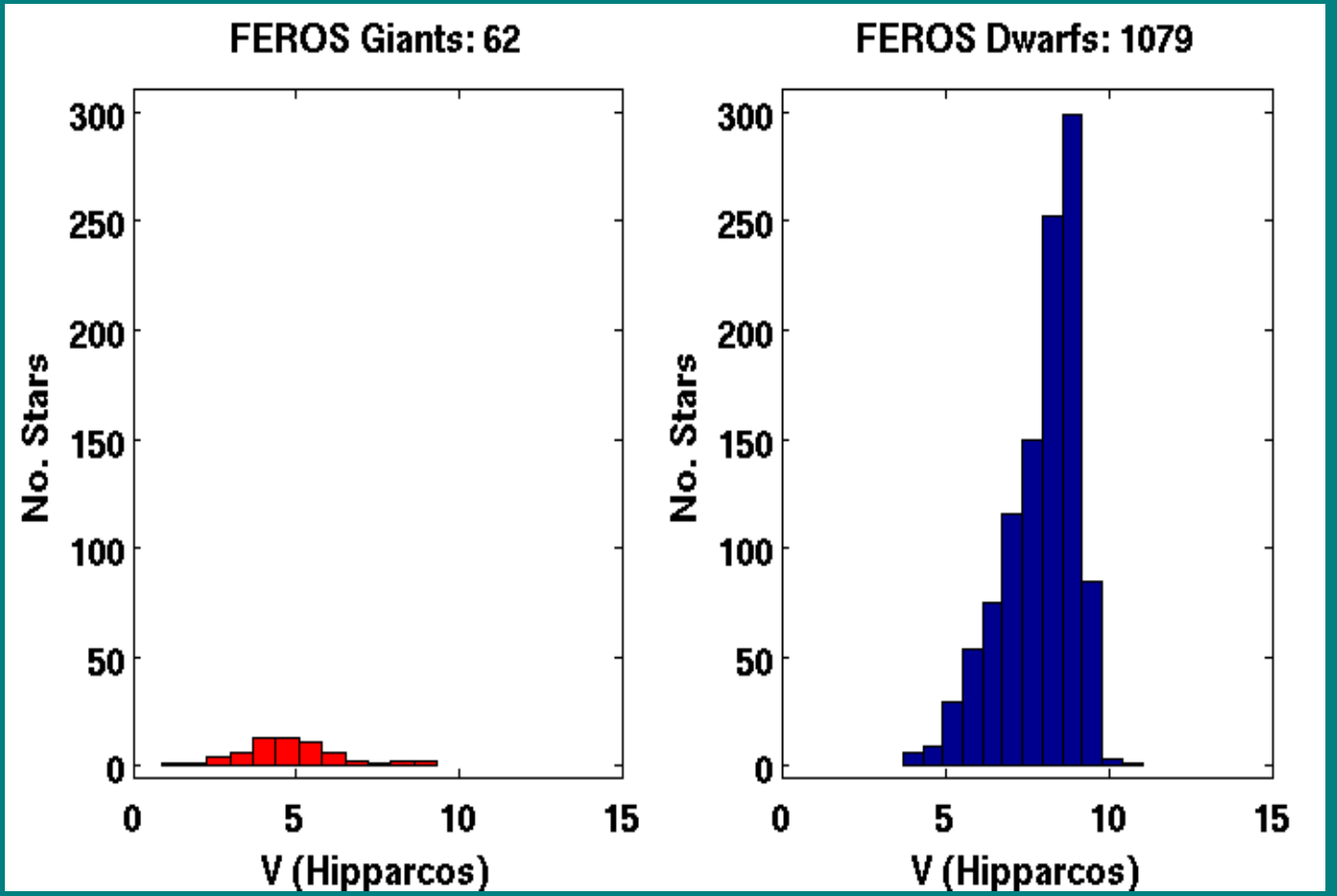
V,B,J,K, Proper Motions:
5135 spectra → ~2248 Stars

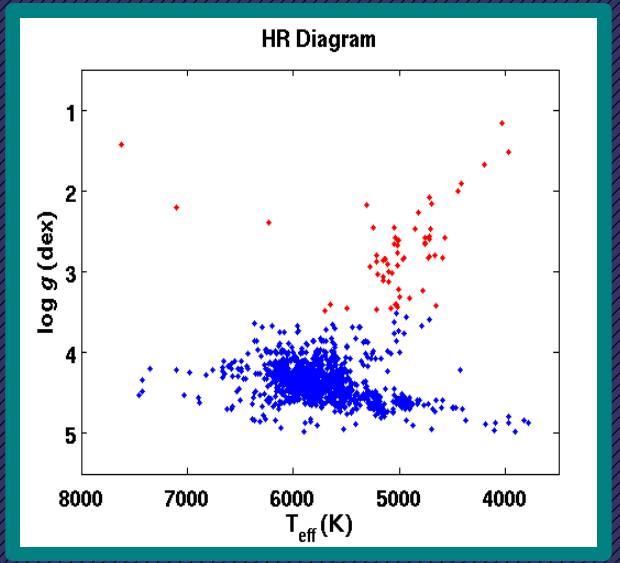




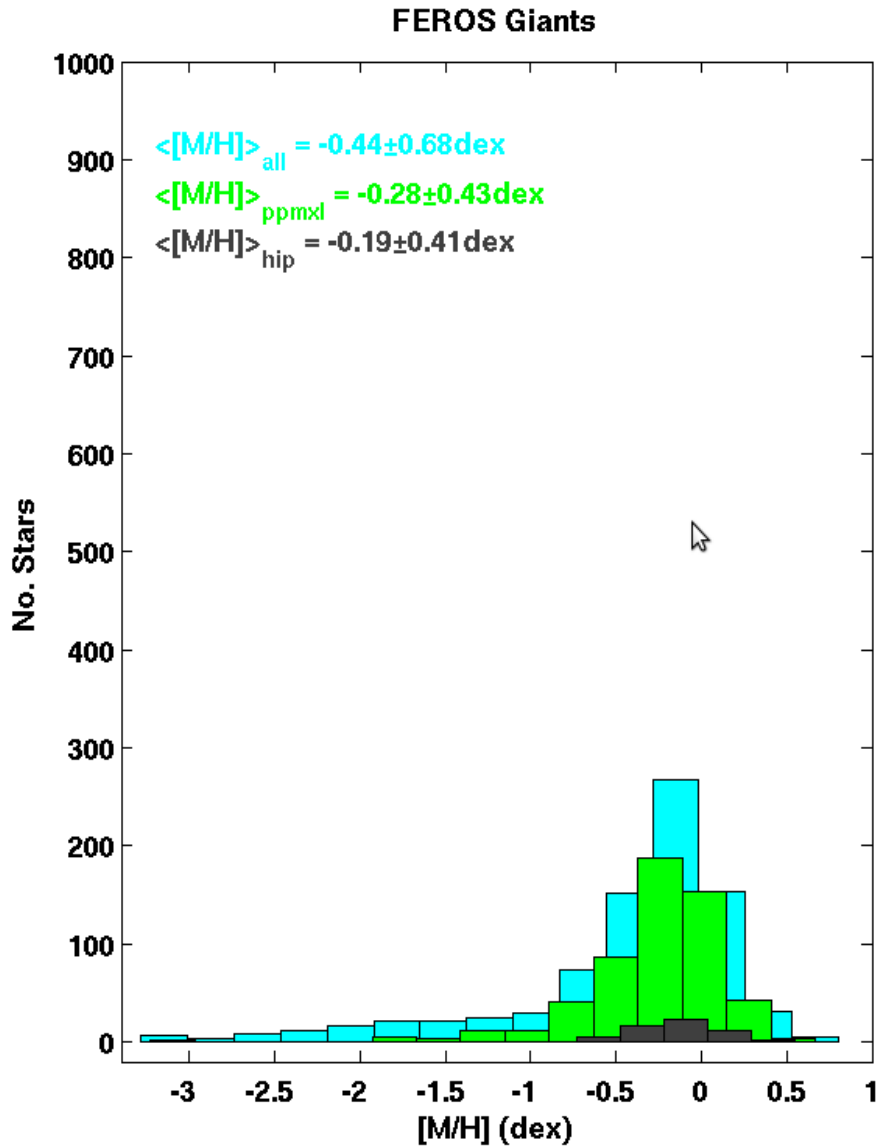
FEROS Stars: Hipparcos

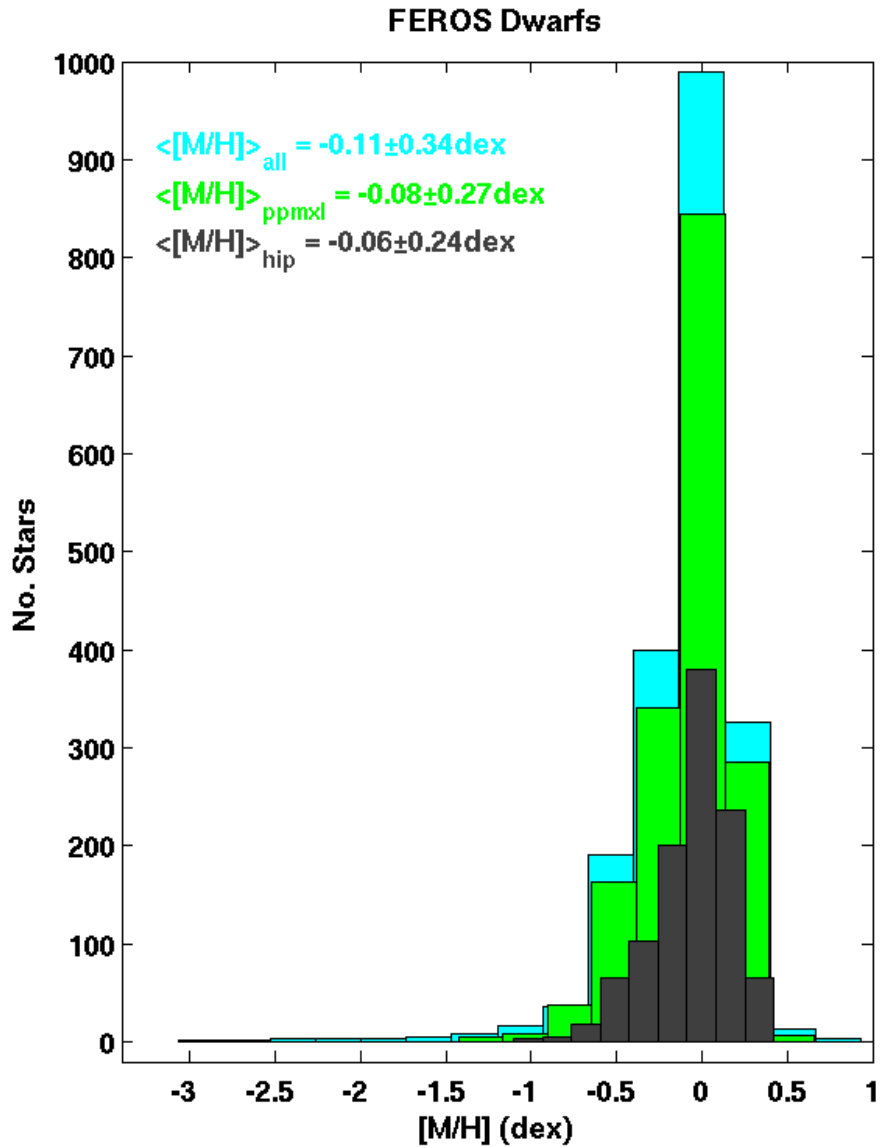
V, Parallax, Proper Motions
2531 spectra → ~1141 Stars



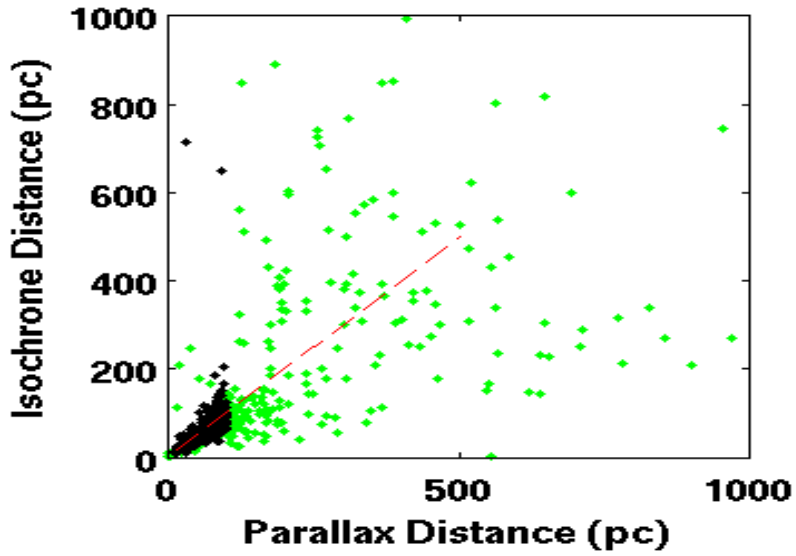


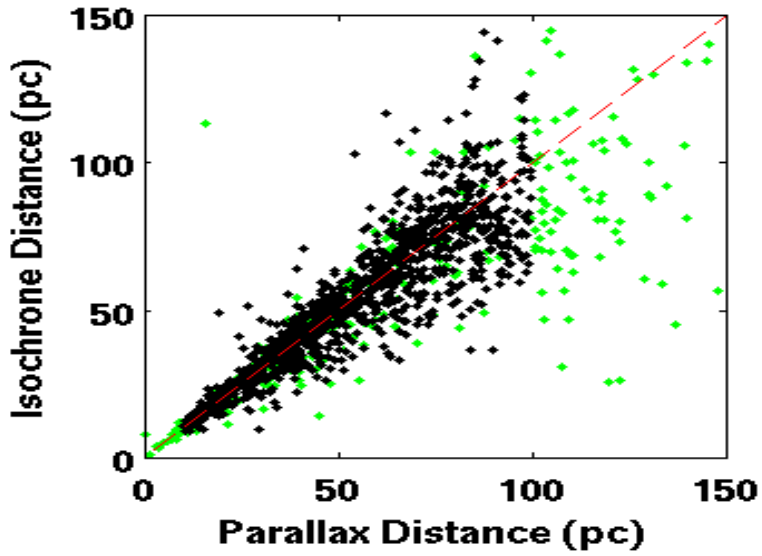
FEROS Stars: Metallicity Distribution

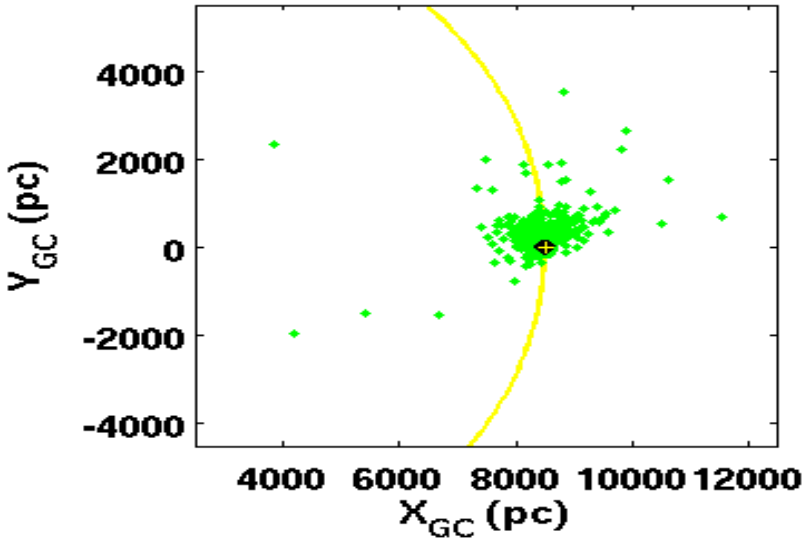


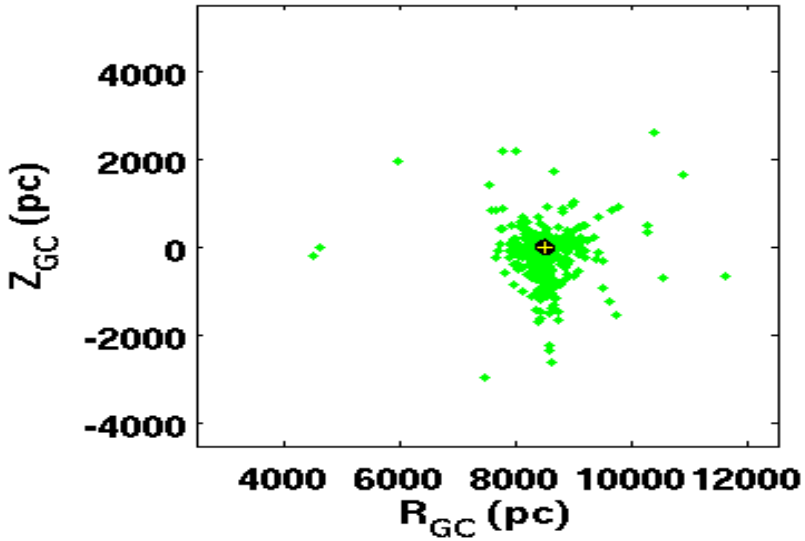


FEROS Stars: Where are they?









Metallicity Gradients?

Not a good sample for gradients

PPMXL Sample: $\Delta R_{GC}, \Delta Z_{GC} \approx 1.5$ kpc

Hipparcos Sample: $\Delta R_{GC}, \Delta Z_{GC} \approx 0.5$ kpc

Population Characterisation of Local Solar Neighbourhood

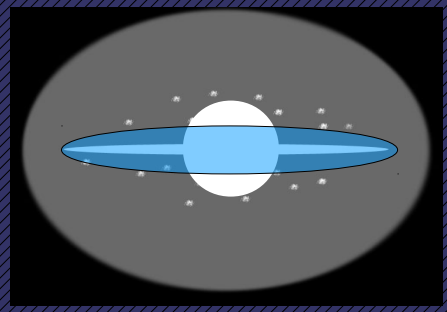
Toomre Diagram of Hipparcos Sample

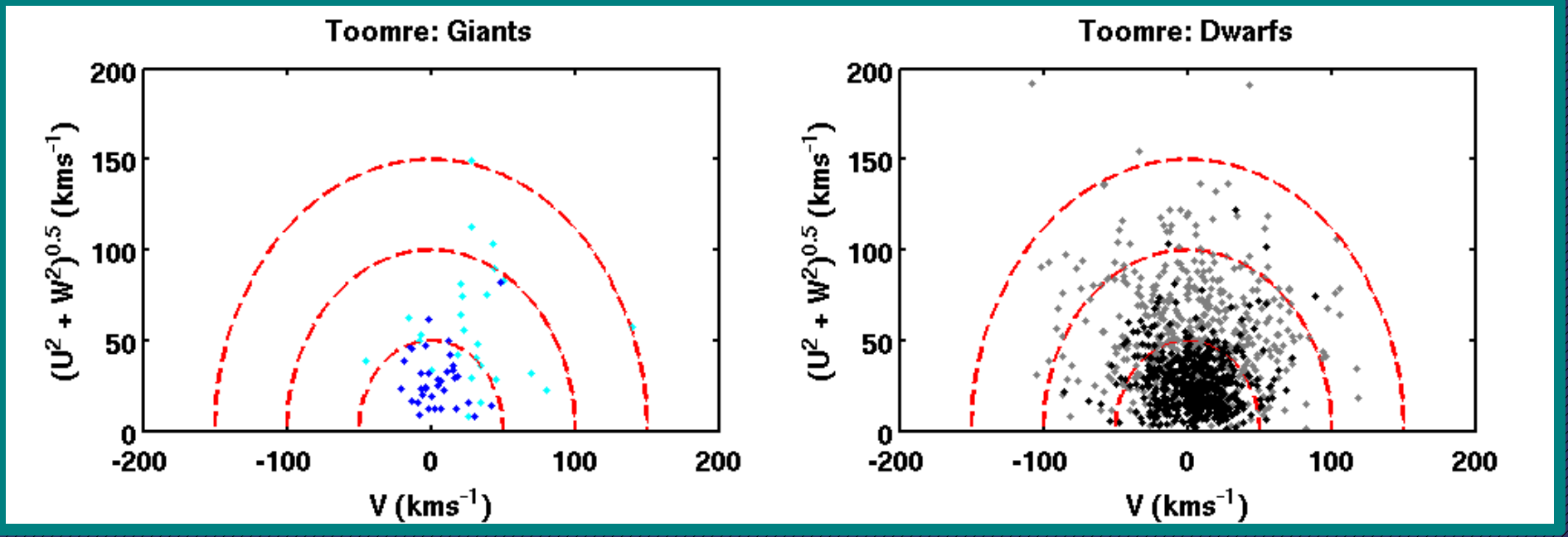
→ Total kinetic energy of stars vs their rotational energy.

Thin Disk: $< \sim 50 kms^{-1}$

Thick Disk: $\sim 50 kms^{-1} \rightarrow \sim 150 kms^{-1}$

Halo: $> \sim 150 kms^{-1}$ **(Bensby 2009)**





Conclusions & Future Work

- **AMBRE: FEROS analysis complete, UVES & HARPS underway**
- **Supplemental photometric & kinematic information obtain for FEROS stars from PPMXL & Hipparcos**
- **Final FEROS sample provides an interesting dataset of local solar neighbourhood giants (1696) and dwarfs (552)**
  - **Not useful for gradients**
  - **Useful for Population Characterisation (thin & thick disk)**
    - **AMBRE:FEROS α-elements**
    - **Space motions (U,V,W)**
    - **Individual chemical abundances**