Trends in the Galactic disc from Open Clusters

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Open clusters as Tracers of the Galactic Disc

Pros:

- Coeval groups of stars.
- Located at the same distance.
- Homogeneous chemical composition.

Cons:

- $>$ 2100 Known Open Clusters in the Milky Way.
- Ages for $\sim$70 % (mainly from isochrone fitting).
- Radial velocities for $\sim$24 %.
- Metallicities for $\sim$9 % (mainly from photometry, or low-resolution spectroscopy).
- Chemical abundances from high-resolution spectroscopy only for 89 systems (4 %), but in a heterogeneous way and in most cases only for [Fe/H].

Observational Material

High Resolution Spectroscopy FOCES@CAHA 2.2m

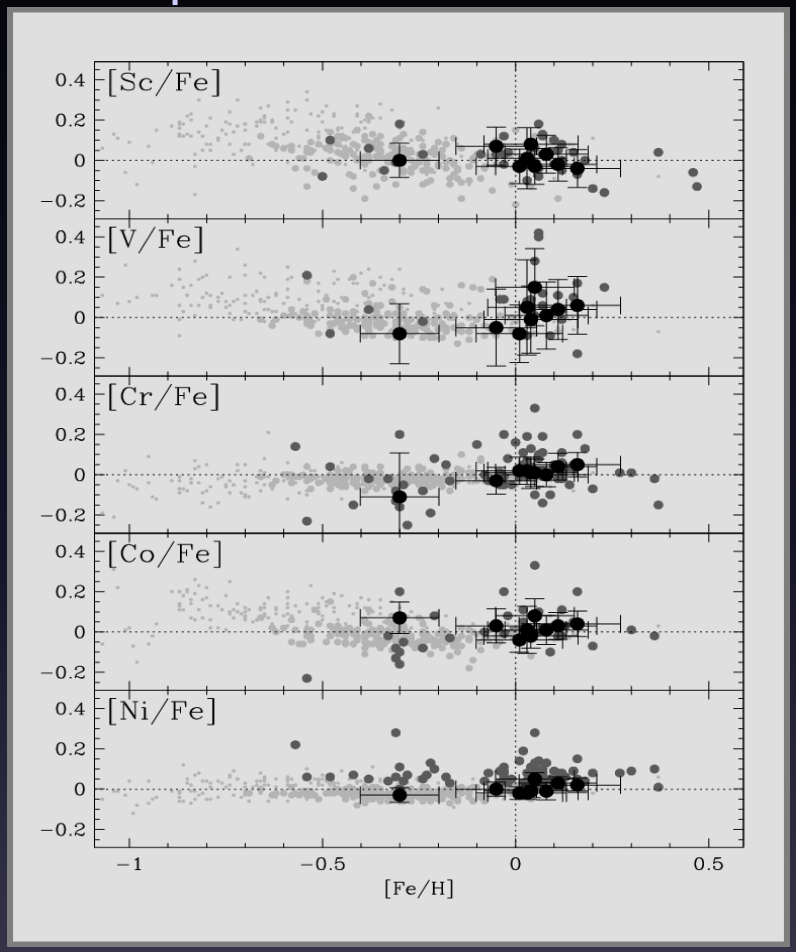
- R∼30000; S/N∼50–100 per pixel
- Pancino et al. 2010
  Cr 110; NGC 2099*, NGC 2420*, NGC 7789, M67
- Carrera & Pancino 2011
  Be 32; NGC 752*, Hyades, Praesepe

High Resolution Spectroscopy Literature

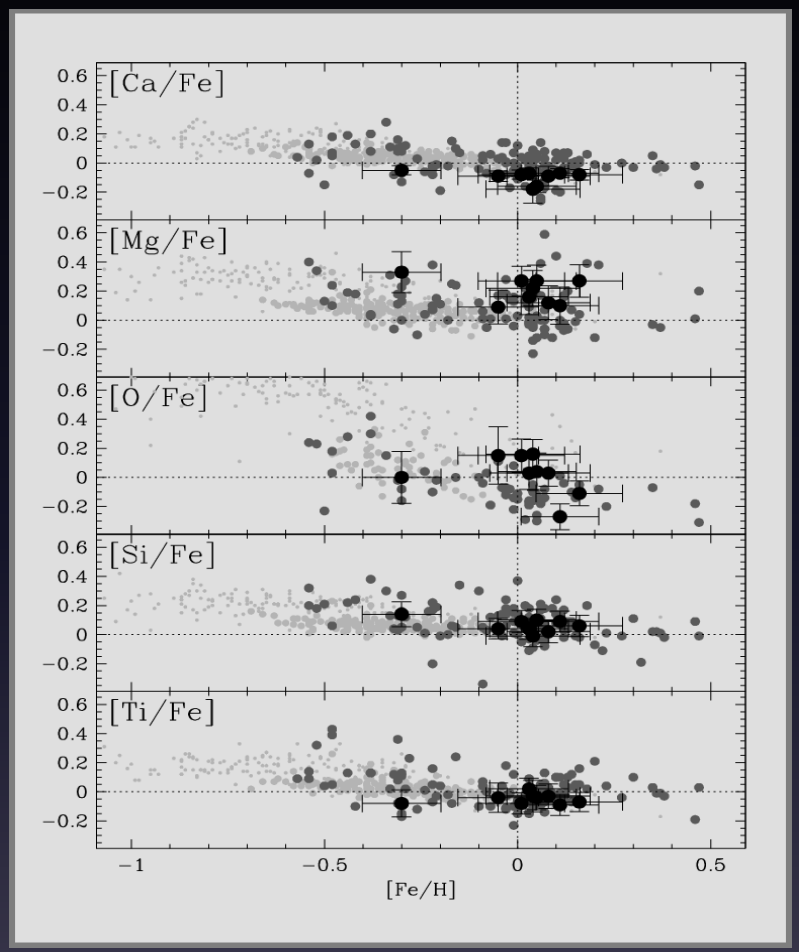
- R∼18000
- 89 Open Clusters
- In most of the cases only Fe abundances.
- Hetereogenety: different data quality, techniques, etc.

Chemical Patterns in the Galactic Disk

Fe-peak elements



α-elements

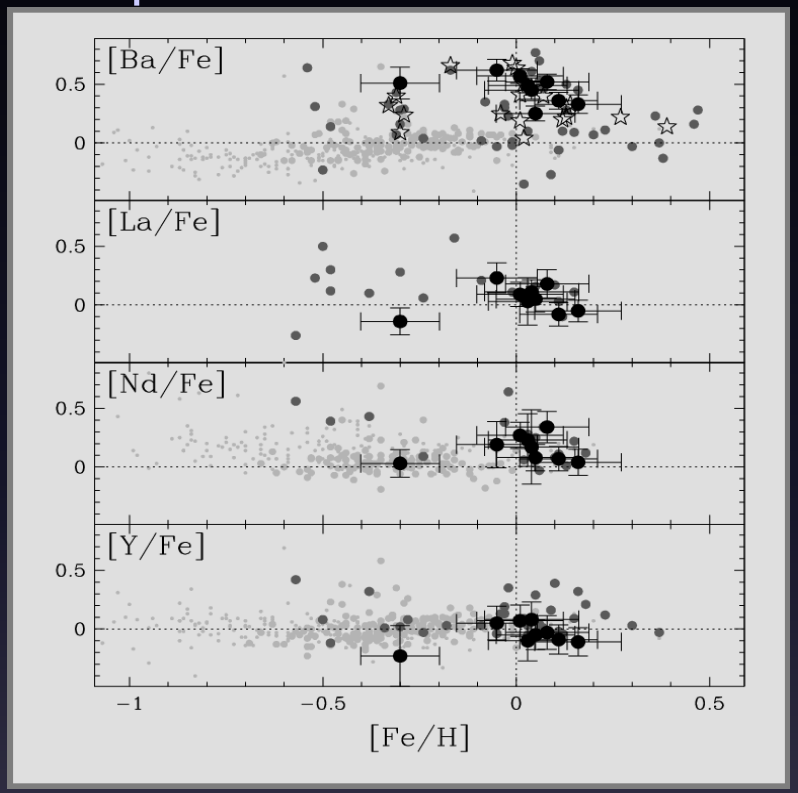


- Thick disk: Reddy et al. 2006
- Thin disk: Reddy et al. 2003
- Open clusters: literature
- Open clsuters: Carrera & Pancino 2011

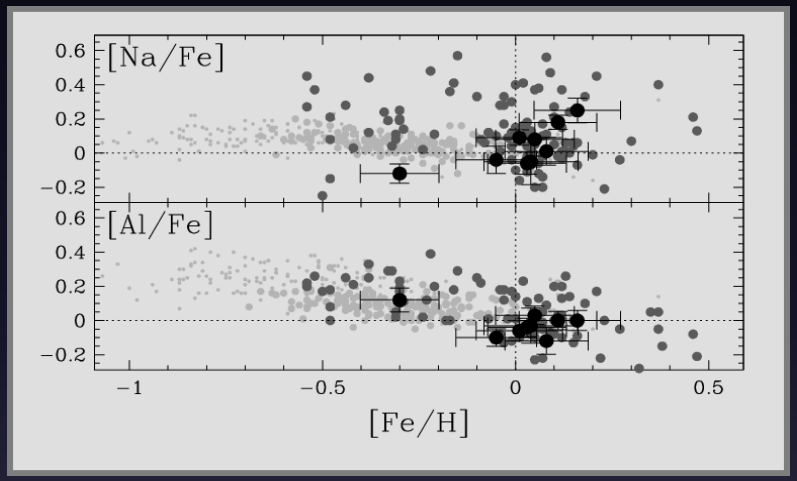
Carrera & Pancino 2011

Chemical Patterns in the Galactic Disk

s-process elements



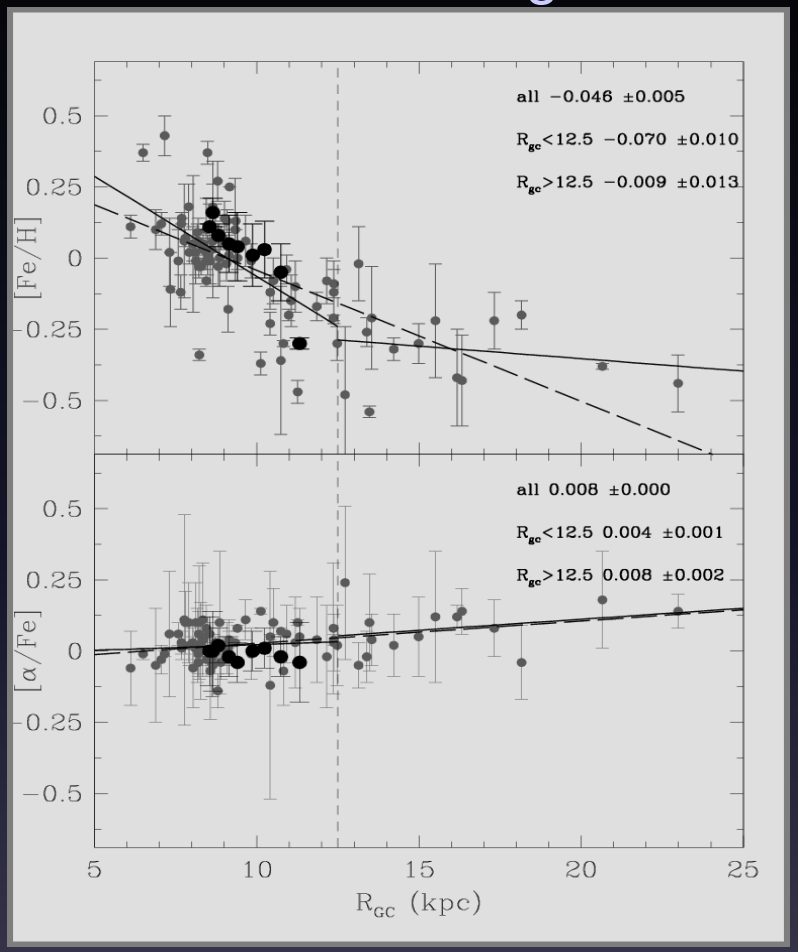
Na & Al



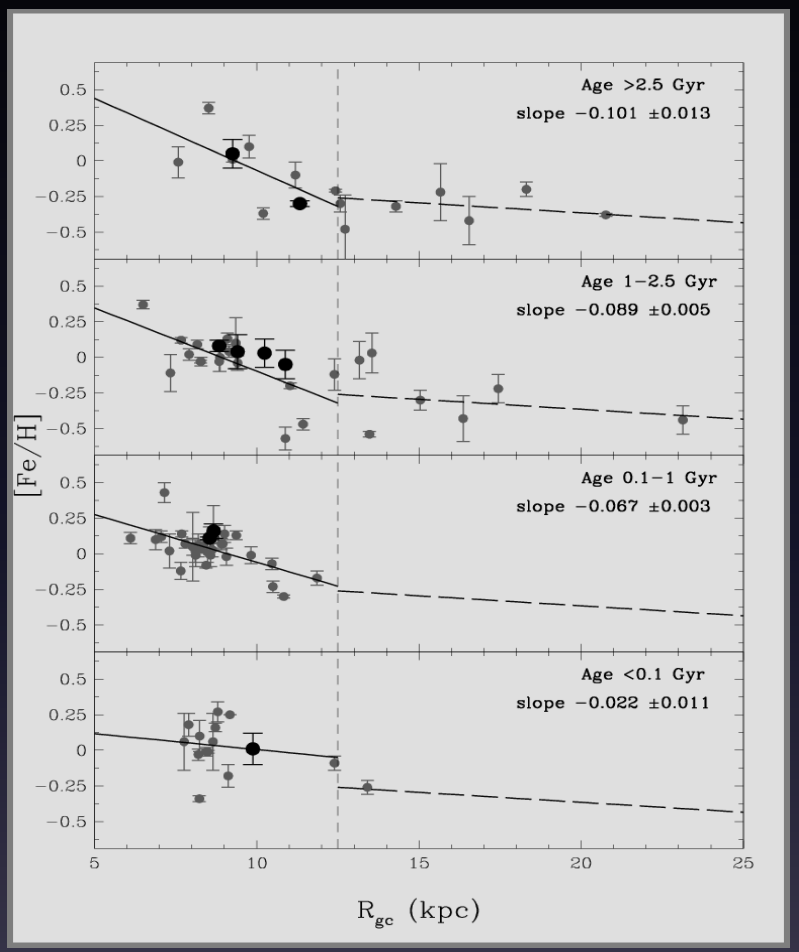
- Thick disk: Reddy et al. 2006
- Thin disk: Reddy et al. 2003
- Open clusters: literature
- Open clsuters: Carrera & Pancino 2011
- ☆ Open Clusters: D'Orazi et al. 2009

Existence of Trends in the Galactic Disk.

Existence of radial gradients



and its evolution with time



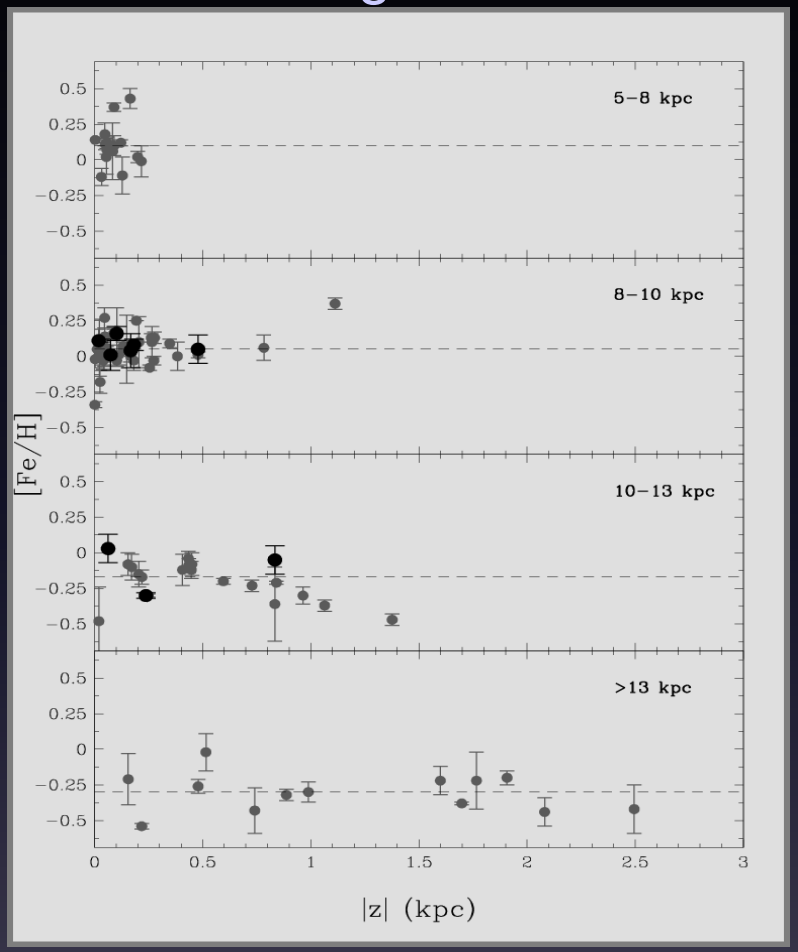
Open Clusters: Literature

Open Clusters: Carrera & Pancino 2011

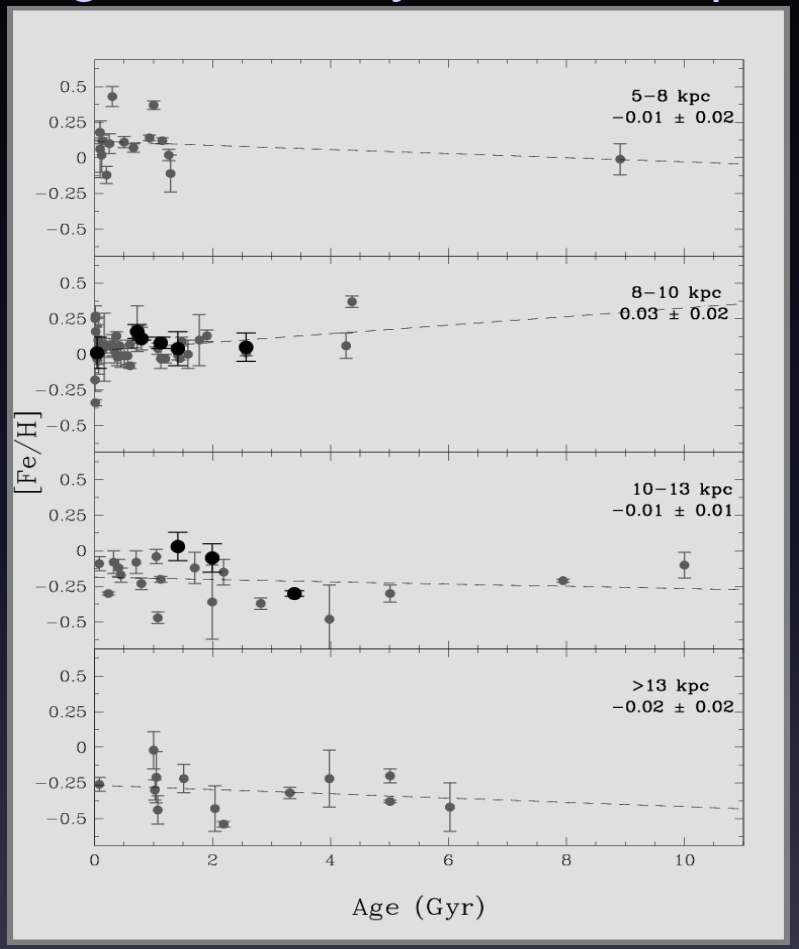
Carrera & Pancino 2011

Existence of Trends in the Galactic Disk.

Vertical gradients



Age-metallicity relationship



Open Clusters: Literature

Open Clusters: Carrera & Pancino 2011

Carrera & Pancino 2011

Problems & Needs

- Only a handful of clusters have been studied homogeneously.
- Larger samples are very heterogeneous.
- Larger and homogeneous samples are needed
  - Ages from homogeneous datasets.
  - Radial velocities and proper motions.
  - Chemical abundances from homogeneous analysis.
  - Increase the number of clusters studied.

The Gaia Mission and Gaia-ESO survey

Gaia Mission (C. Jordi talk)

- Parallaxes and distances: precision 2% within 1.5 kpc.
- Proper motions and tangential velocities: 0.23 km s^{-1}).
- Radial velocities: 15 km s^{-1}@ G_{RVS} $\sim$17).
- Chemical abundances: G_{RVS} $<$12.

Gaia-ESO Survey (S. Radich talk)

- 30–50 OC.
- Radial velocities (V$<$19).
- Multi-element chemical abundances (V$<$16.5).
- Limited to $\delta < +20^o$.

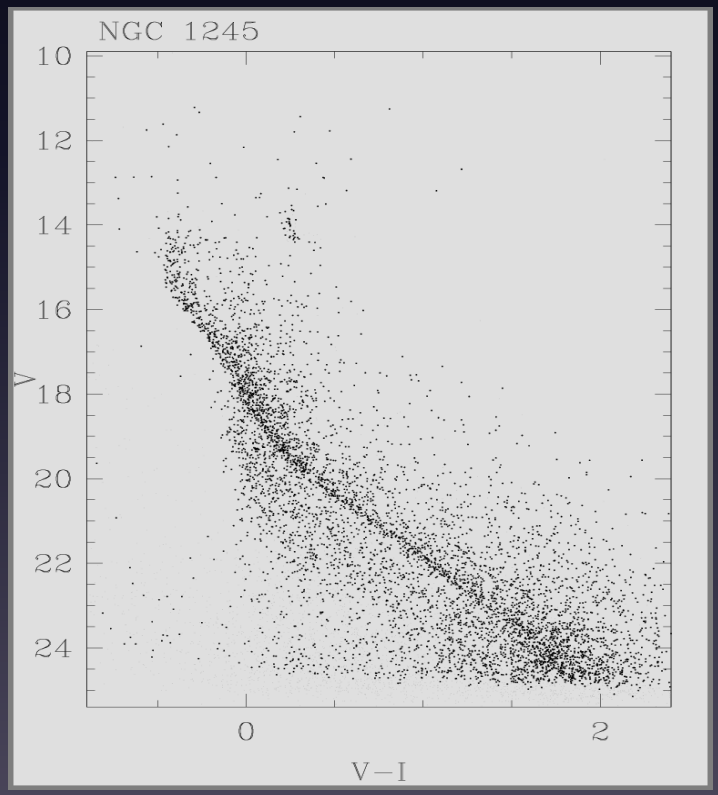
Open Clusters Chemical Abundances from the North

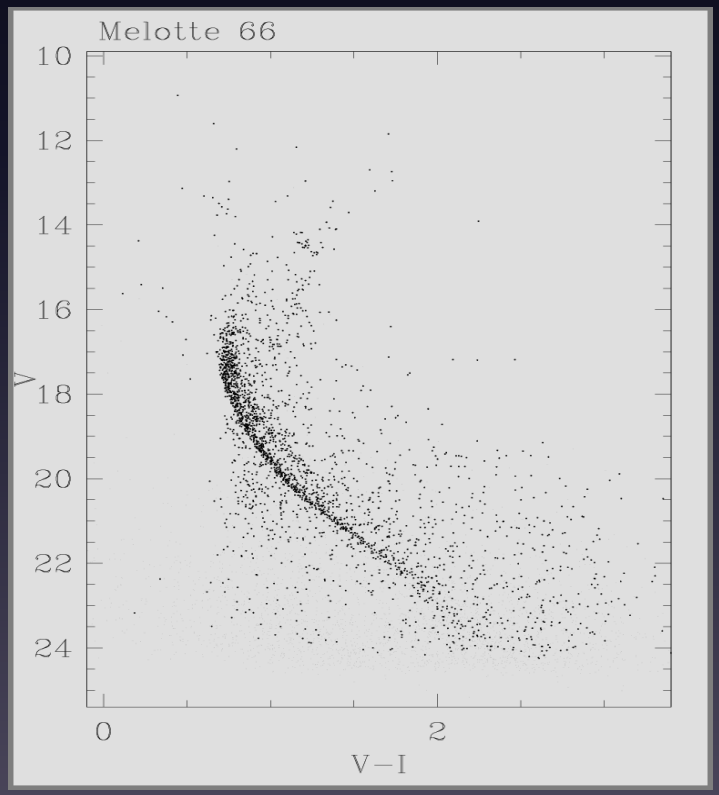
- Use of Facilities in Spain: CAFE@CAHA 2.2m; FIES@NOT 2.5 m; .HERMES@MECATOR 1.2m.
- Complement the UVES observations within the Gaia-ESO Survey.
- Limited to brightest targets V$<$15.
- $\sim$6 red-clump stars in each cluster.
- $\sim$20 OC: Be 17; NGC 6791; anticeter clusters, etc.

CoI: Allende-Prieto, Aparicio, Balaguer-Nuñez, Gallart, Jordi, Pancino, Recio-Blanco

Homogeneous CMD database

- 100 OC older than 1 Gyr (60 North 40 South).
- Homogeneous CMD: same exposure times, analysis, etc.
- Similar instrument/telescopes both hemispheres: WFC@INT 2.5 m & WFI@MPIA/ESO 2.2m





Col: Aparicio; Conn; Gallart; Monelli; Murabito; Nöel; Pancino; Rosenberg; Rix; Stetson

Summary

- Open clusters are key particles to study the formation and evolution of the Galactic disk: i.e. chemical patterns; radial gradients, evolution of gradients with time, etc.
- The heterogeneity of available data forces us to be extremely cautious when drawing any conclusion.
- Homogeneous samples with larger number of clusters are needed.