Open clusters through the eyes of WEAVE

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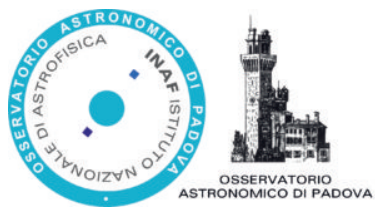


Open Clusters

Open Clusters

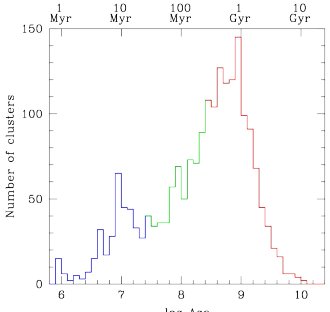
from 10 stars to 10^5-10^6 members.

Ages between 1 Myr and 10 Gyr.

$-0.6 \leq [Fe/H] \leq -0.4$ dex.

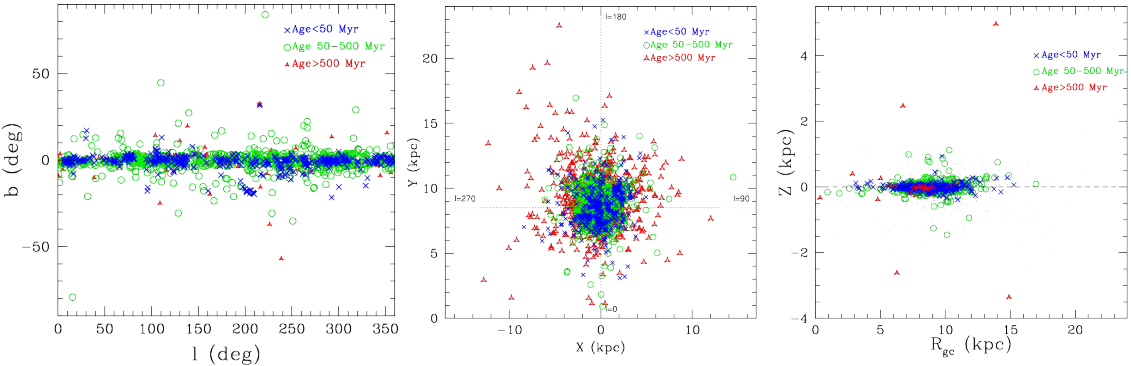
2 000-3 000 known systems

New Gaia discoveries



Dias et al. 2002

Open Clusters



Open Clusters with Gaia

Gaia provides:

Positions, proper motions, parallaxes, photometry.

radial velocities, metallicities

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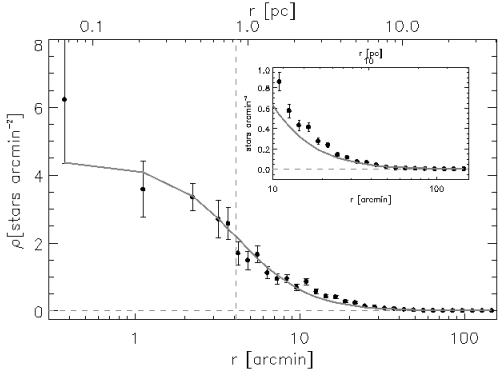

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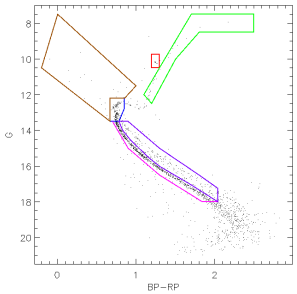

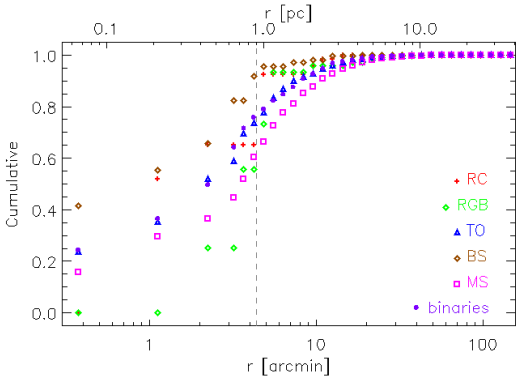

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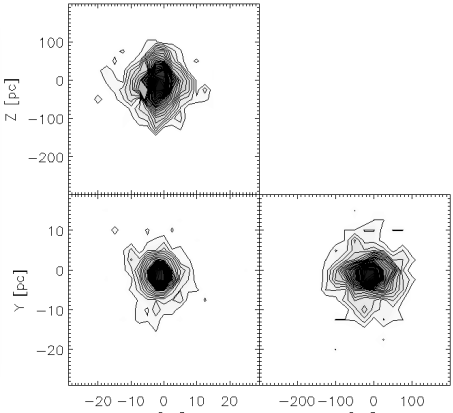

Complementary surveys from Ground

Massive spectroscopic surveys

Radial velocities + chemistry

North+South

H-band R∼22 500

e.g. Frinchaboy et al. 2013

South

Visible R∼28,000

Gao et al. 2018

LAMOST 介绍

郭守敬望远镜

North

NIR CaT R∼7 500

Hou et al. 2014

North

visible R∼7 500-20 000

South

Visible R∼47 000 (UVES) 20 000 (GIRAFFE)

e.g. Magrini et al. 2014

South

NIR CaT R∼7,500

Conrad et al. 2013, 2017

SEGUE

North

visible +NIR (385-920 nm) R∼2 000

e.g. Morrison et al. 2015

South

visible R∼7 500-20 000

Dedicated surveys

BOCCE

Photometry + spectroscopy

ages, chemical abundances, etc.

Bragaglia & Tosi 2006

WOCS

Photometry + spectroscopy

ages, radial velocities

von Hippel & Sarajedini 1998

High resolution spectroscopy

radial velocities, chemical abundances.

Casamiquela et al. 2016, 2017, 2018

WEAVE Open Cluster survey

WEAVE

A new wide-field spectroscopy facility for the prime focus of the 4.2 m William Herschel Telescope

Features

- Field of view: 2 degrees diameter.
- Fibres: 1000 (1.3 arcsec diameter).
- HR: (R$\sim$20 000) 404-465 nm (blue), 473-545 nm (green), 595-685 nm (red)
- LR: (R$\sim$5 000) 366-959 nm
- on sky May 2019?

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Surveys

- Galactic Archaeology (GA): HR disk, LR disk, LR high latitude, Open clusters
- Stellar, Circumstellar and Interstellar Physics (SCIP)
- Stellar Populations at intermediate redshifts Survey (StePS)
- Galaxy Clusters, Apertif, LOFAR, QSO, WD

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GA- Open Clusters

- Star forming regions.
- Young open clusters.
- Old open clusters.

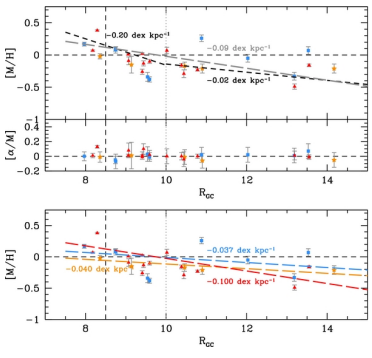
WEAVE Open Cluster survey: science goals

- Star formation:
  - ↦ stars formed in cluster Lada & Lada 2003
  - ↦ or in isolation Allen et al. 2007
- Disruption of open clusters
  - ↦ Only 5% only than 5 Gyr.
  - ↦ Processes involved in the dispersion: gas expulsion, relaxation, environment, etc.
  - ↦ Contribution to disk field populations
  - ↦ Internal dynamics.
- Open clusters as tracers of the Milky Way disc.
  - ↦ Chemical composition: gradients, abundance patterns, etc.
  - ↦ Disk kinematics: rotation, radial migration, etc.
- Stellar evolution.
  - ↦ Each cluster snapshot of stellar evolution at different age.
  - ↦ Atomic stellar diffusion.

Science with Open Clusters

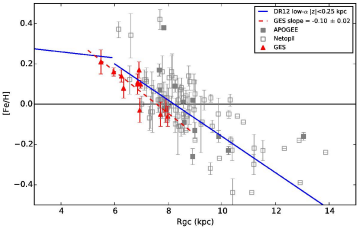
Galactic disc Chemical distribution

APOGEE



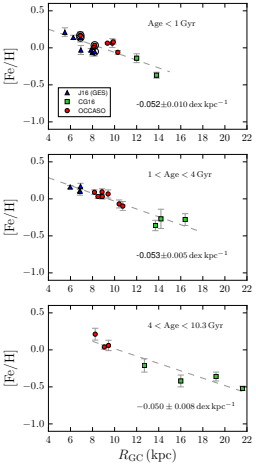
Frinchaboy et al. 2013

GES



Jacobson et al. 2016

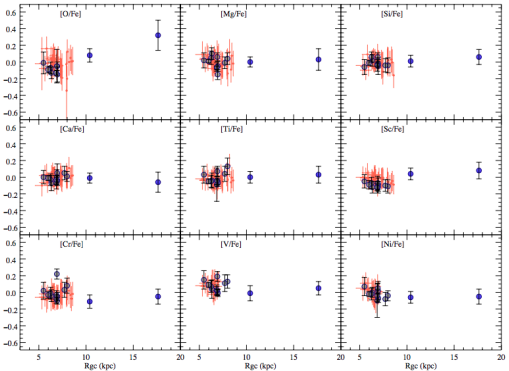
OCCASO+GES



Casamiquela et al. *in prep.*

Galactic disk Chemical distribution

GES



Magrini et al. 2017

Galactic disk Chemical distribution

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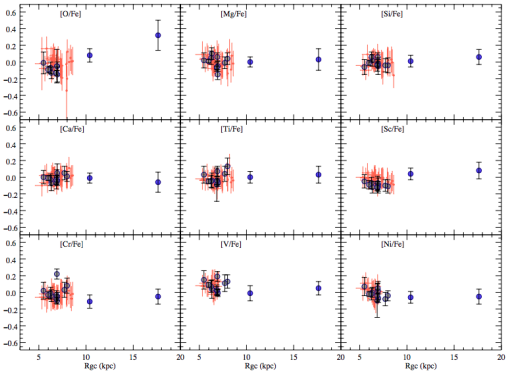
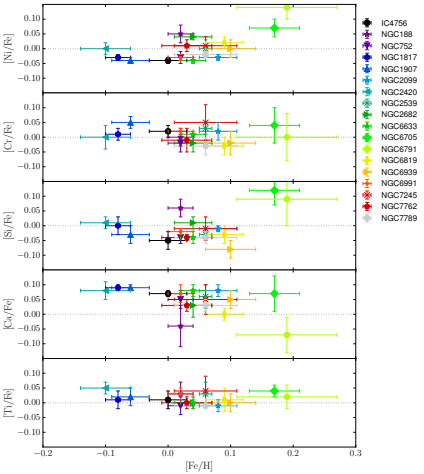


Magrini et al. 2017

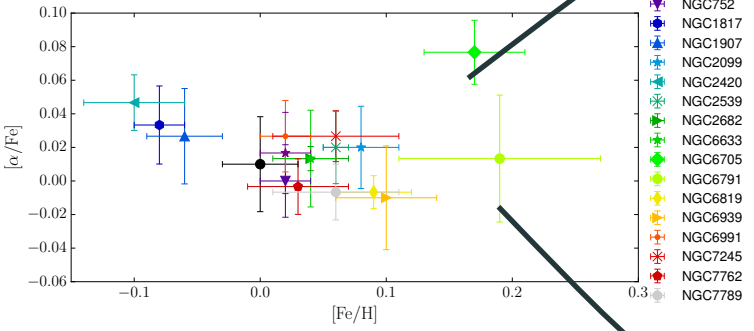
OCCASO



Casamiquela et al. *in prep.*

Galactic disk Chemical distribution

High α abundances clusters



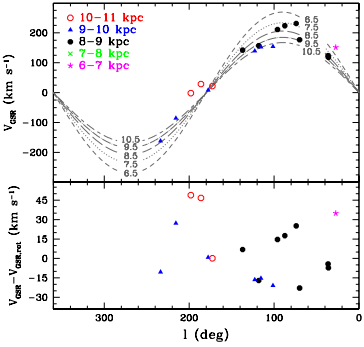
NGC 6705

Casamiquela et al. 2017

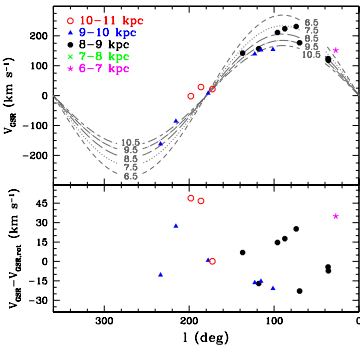
NGC 6791

Linden et al. 2017

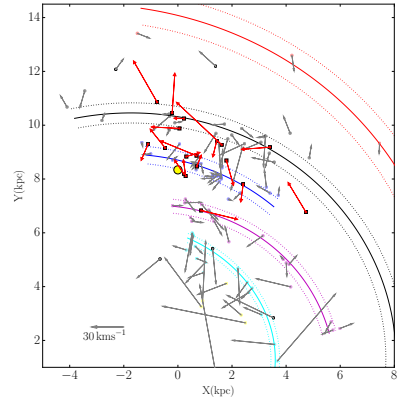
Galactic disk kinematics

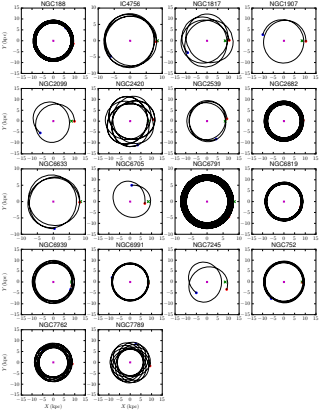


Galactic disk kinematics



Casamiquela et al. 2016

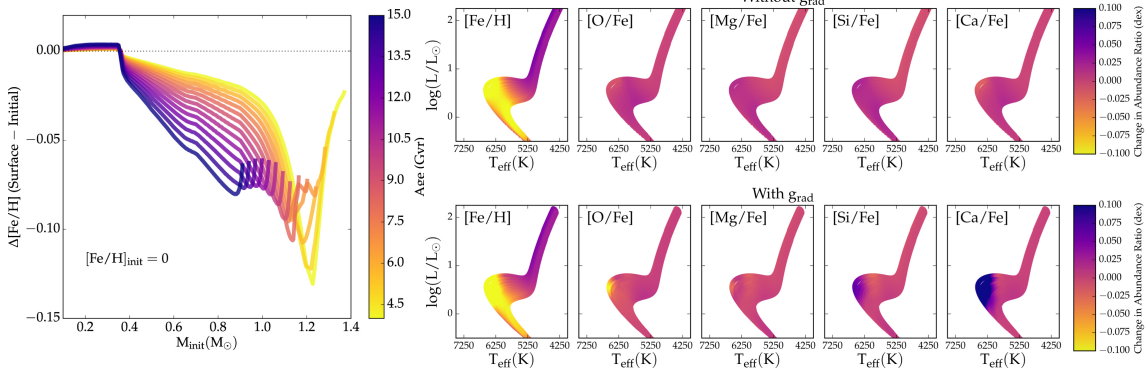




Casamiquela et al. *in prep.*

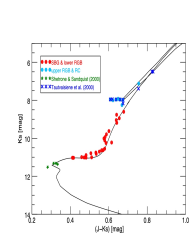
Stellar evolution: atomic diffusion

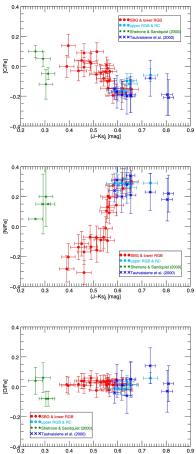
Redistribution of elements during stellar evolution



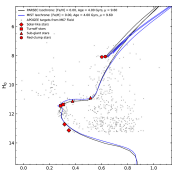
Dotter et al. 2017

Stellar evolution: atomic diffusion

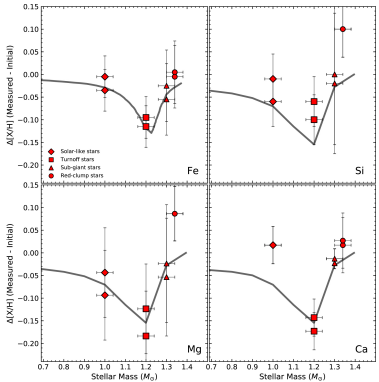




Bertelli Motta et al. 2017



Souto et al. 2017



Internal kinematics

Velocity dispersion (OCCASO)

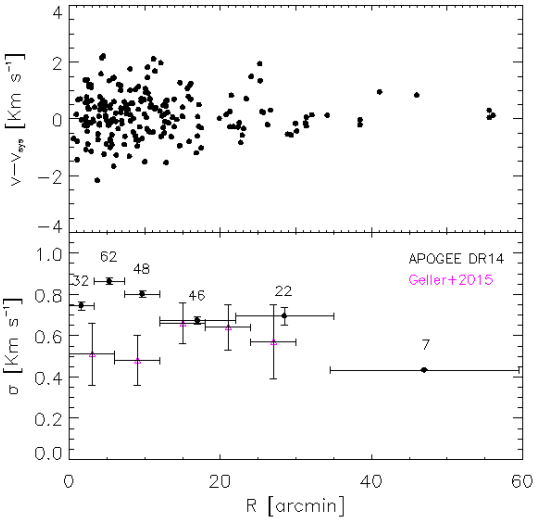
Cluster	Age (Gyr)	σ (km s^{-1})
IC 4756	0.5	0.8
NGC 752	1.1	0.5
NGC 1907	0.3	0.3
NGC 2099	0.34	0.8
NGC 2539	0.4	0.5
NGC 2682	2.8	0.5
NGC 6633	0.4	0.2
NGC 6705	0.2	1.7
NGC 6819	2.4	0.9
NGC 6939	1.6	0.6
NGC 6991	1.3	0.6
NGC 7762	2.0	0.6
NGC 7789	1.4	0.7

$\sigma \sim 1\,\mathrm{km\,s^{-1}}$ for $M_{tot} \sim 10^3\,M_\odot$ and R$\sim$1 pc

but for OCs $M < 10^3\,M_\odot$

Internal kinematics

M 67



Summary

Summary

Open clusters are simple stellar populations but

they are key to study a variety of topics:

- Tracers of the Galactic disk (chemestry, kinematics, distribution).
- Stellar evolution (atomic diffusion)
- Internal kinematics (disruption)

not all addressed only with Gaia

Ground complementary surveys are necessary.

- Ongoing: GES, APOGEE, GALAH, RAVE, LAMOST, SEGUE
- Future: WEAVE, 4 MOST
- Dedicated: BOCCE, WOCS, OCCASO, others