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Intermediate and old age Open Clusters science case for high resolution spectroscopy

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ABSTRACT

Open Clusters are dynamically-bound groups of stars tat formed from the same giant molecular cloud, having a similar age and bulk chemical composition.
Open Clusters are key objects for studying the formation and evolution of the Galactic disk.
They are targets in on-going large spectroscopic surveys like Gaia-ESO and the OCCASO surveys.
We discuss the science case of the intermediate age and old OCs for WEAVE, the upcoming multifiber spectroscopic facility in the WHT. In particular we do an overview of the target selection and the survey strategy.
Additionally, the impact of the discovery of new clusters by Gaia space mission is discussed.

Science case

Open clusters (OC) and their stellar populations are backbone of modern astrophysics to study:

- **Formation and disruption** of OCs → study of kinematic properties vs age/metallicity/position
- Assembly and evolution of the **Galactic disk** → OCs older than 300 Myr with a range of ages/galactocentric distances
- **Star formation** and **stellar evolution** → OCs of different ages and metallicities

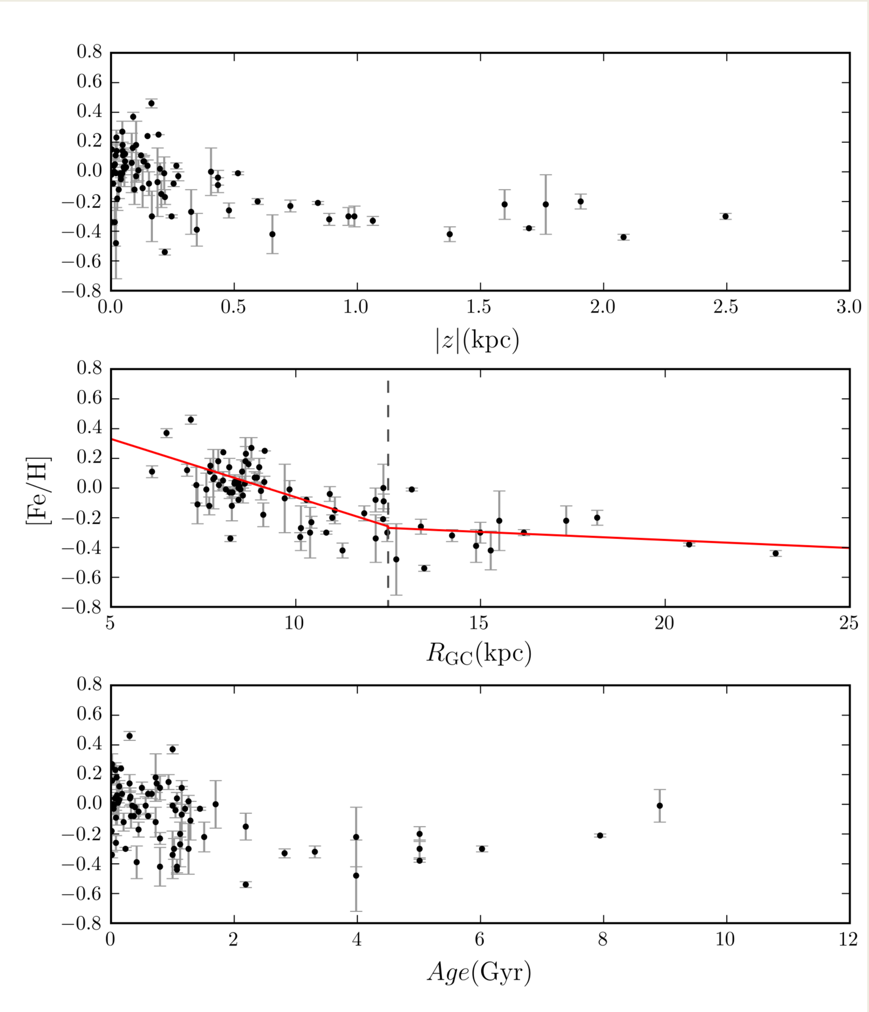

Figure 1. Vertical and radial trends of the chemical gradient of the disk, and age-metallicity relations in OCs.
Casamiquela et al. (2016)

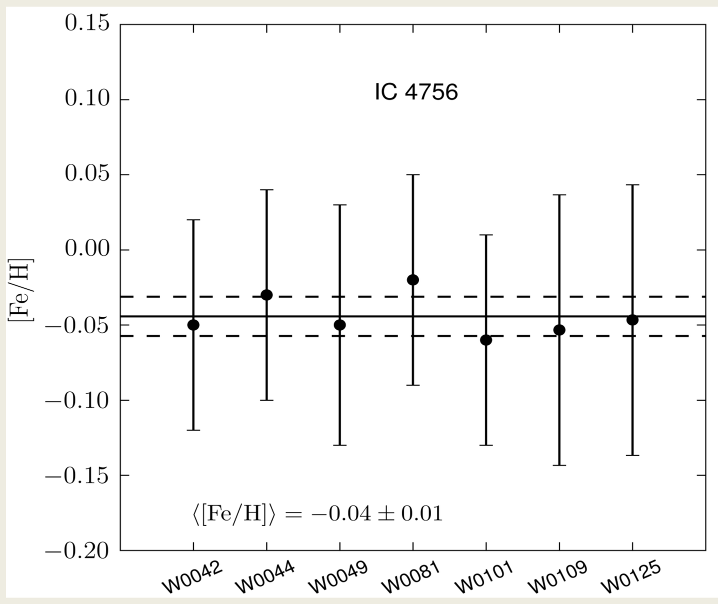

Figure 2. IC 4756 is a well known OC with roughly solar metallicity. From the spectroscopic study of 7 member stars we have derived the cluster metallicity. This is an example of the precision level in [Fe/H] from high resolution and high SNR (70) spectra.
Casamiquela et al. (2016)

Needs

To achieve the science case we need **large surveys** to obtain:

- **Complete kinematic information**
- Accurate **distances**
- Accurate **ages**
- **Chemical abundances** of various elements

Gaia

Complete census of OCs up to 5kpc from the Sun:

- **Known** OCs + **discovery** of new ones
- **Distances + proper motions** for individual stars (precision: 1% at 1.5kpc; 10% for almost all OCs)
- Accurate definition of **membership** even for distant objects

Limited spectroscopic capabilities in radial velocity and chemical abundance determination (see Fig 3)

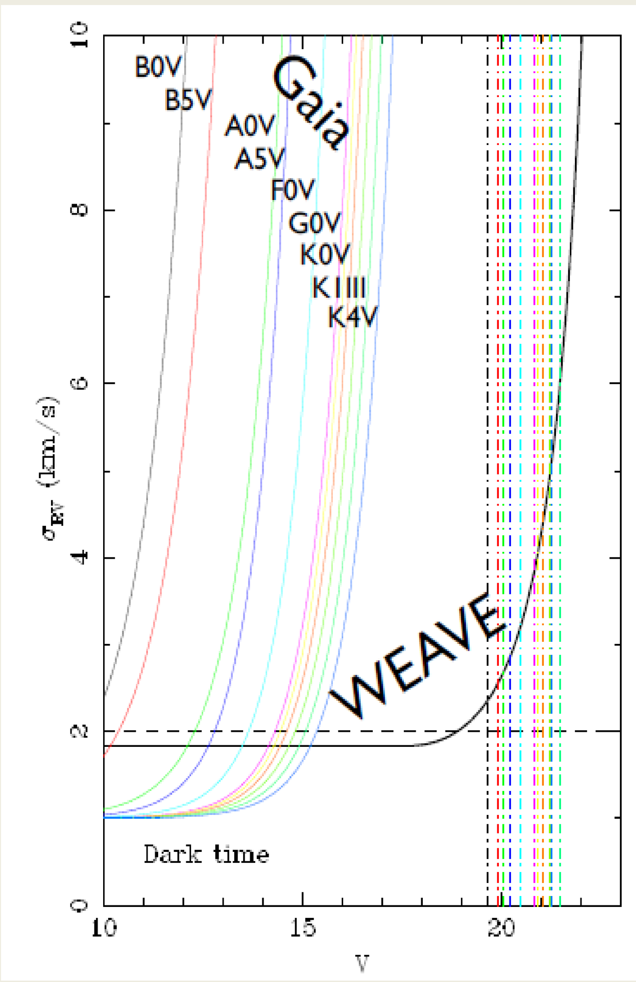

Figure 3. Predicted radial velocity precision of WEAVE LR mode, and Gaia at end of mission (different lines represent different spectral types). Dashed color vertical lines represent photometric limits for astrometry of different spectral types.
Internal report, WEAVE Science case (Dec 2013)

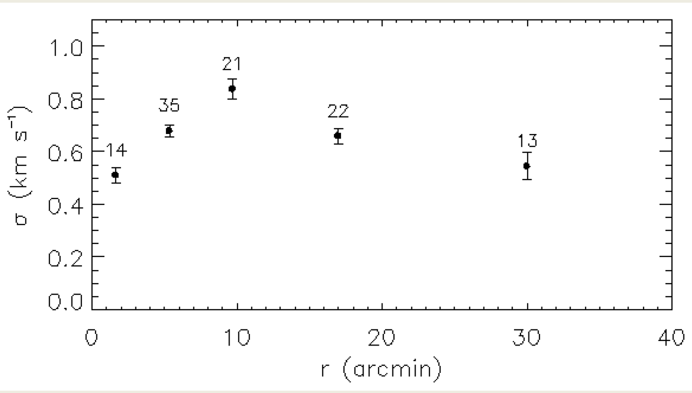

Figure 4. Radial velocity dispersion of the stars of M67 as a function of radius. The number on top of the points indicates the number of stars used to calculate the dispersion. High resolution is needed to do this kind of studies.
Data from APOGEE.

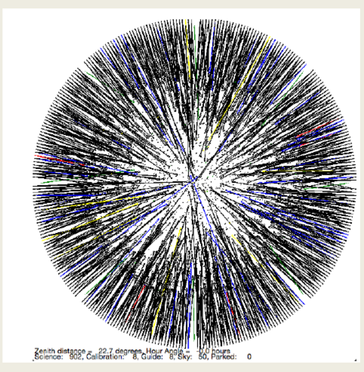

Figure 5. Example of a WEAVE fiber configuration.
Internal report, WEAVE Science case (Sep, 2015)

Surveys

Ongoing high resolution spectroscopic surveys with an OC program:

- **Gaia-ESO Survey** (GES; Gilmore et al. 2012)
- **APOGEE** (Frinchaboy et al. 2013)
- **BOCCE** (Bragaglia & Tosi 2006)
- **OCCASO** (Casamiquela et al. 2016)

Still to start:

- **WEAVE** (Dalton et al. 2012)

WEAVE

Wide-field multifiber (~1000 fib) spectroscopic facility, 4.2m William Herschel Telescope.

Three **subsets** were defined: essential, optimal, desirable.

Essential sample OCs located in external regions in R_{GC} and high z where **disk properties are ill-defined**.

Selection criteria:

- $\mathbf{R_{GC}}$ < 7.5 kpc , **|z|** > 100 pc, **age** > 300 Myr
- $\mathbf{R_{GC}}$ > 11 kpc, **age** > 300 Myr (all z)
- **|z|** > 400 pc, **age** > 300 Myr (all R_{GC})
- **Age** > 4Gyr (all z and R_{GC})

Additional clusters for scientific interest (IC4756, Melotte7, NGC2423, NGC2437, NGC7245, NGC6603)

39 accepted essential OCs, 8 of them regarded as **calibrators**.

Intersection with other surveys:

- 4 OCs observed by Kepler & K2
- 8 in common with GES
- 6 in common with APOGEE
- 11 in common with OCCASO

Survey **strategy**:

- Green and red high resolution grating (R ~ 20000). Required SNR ~ 70
- Exposure time: 3h/OC x 39 OCs

REFERENCES

Bragaglia A., Tosi M. 2006, ApJ, 131, 1544

Casamiquela L. et al. 2016, MNRAS, 458, 3150

Dalton G. et al. 2012, SPIE Conference Series, p0

Frinchaboy P. M. et al. 2013, ApJL, 777, L1

Gilmore G. et al. 2012, The Messenger, 147, 25

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