Status of the OCCASO survey for the analysis of the chemistry of the Galactic disc

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Galactic Open Clusters (OCs) are crucial to investigate the formation and evolution of the Galactic disc. OCs, found at all ages and throughout the disc, serve as excellent tracers of the overall history of star formation and nucleosynthesis across disc lifetime. Moreover, OCs ages and distances can be measured more accurately with respect to other tracers and field stars from their color-magnitude diagram. The OCCASO survey (*Open Clusters Chemical Abundances from Spanish Observatories)* targets old OCs, observing at least 6 Red Clump stars in each of them. OCCASO's goal is the study of the positional and age dependences of the chemical abundances in the Galactic disc. We use higher resolution spectroscopy (R 65,000 – 80,000), high signal-to-noise (SNR~70), and wider wavelength coverage (400-900 nm) than massive spectroscopic surveys such as APOGEE, GES, and the forthcoming WEAVE and 4MOST. These settings allow a very precise measurement of abundances (~ 0.05 dex) as well as radial velocities (10 m/s). Currently, the observations of 252 stars and 37 clusters have been completed. Radial velocities are determined and analysis of atmospherical parameters and abundances are ongoing.

Status of the observed open clusters suitable for Galactic disc studies.

Open clusters with at least 4 red clump stars observed by APOGEE, GES or OCCASO surveys.
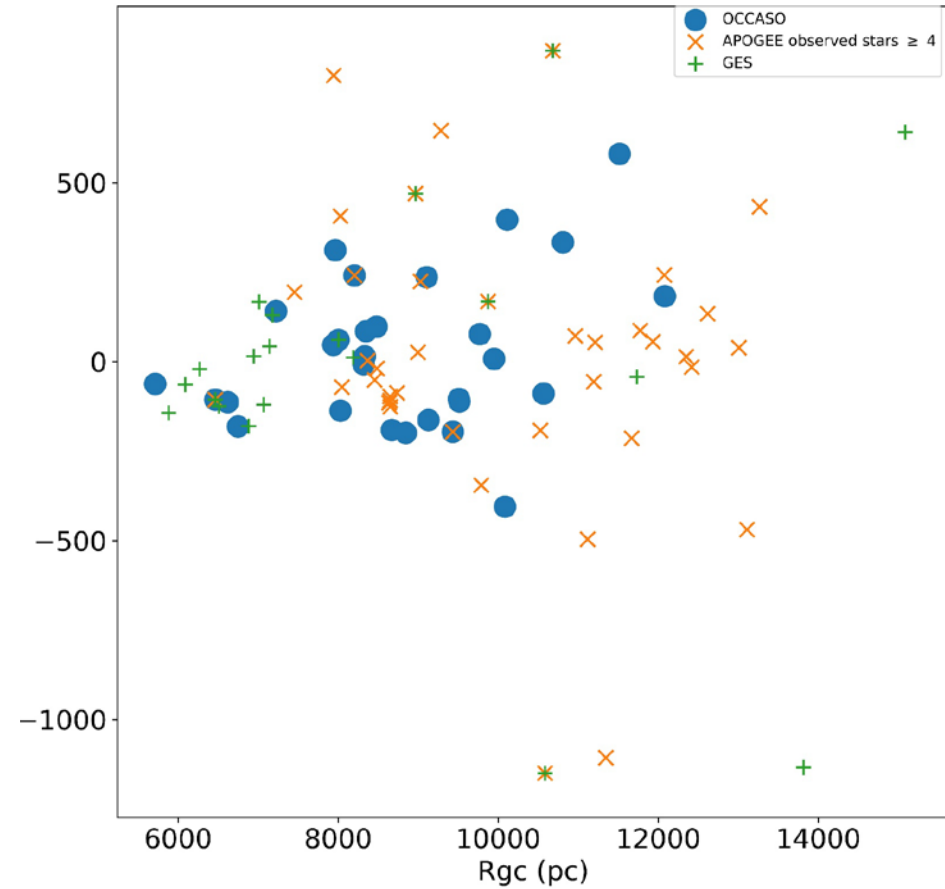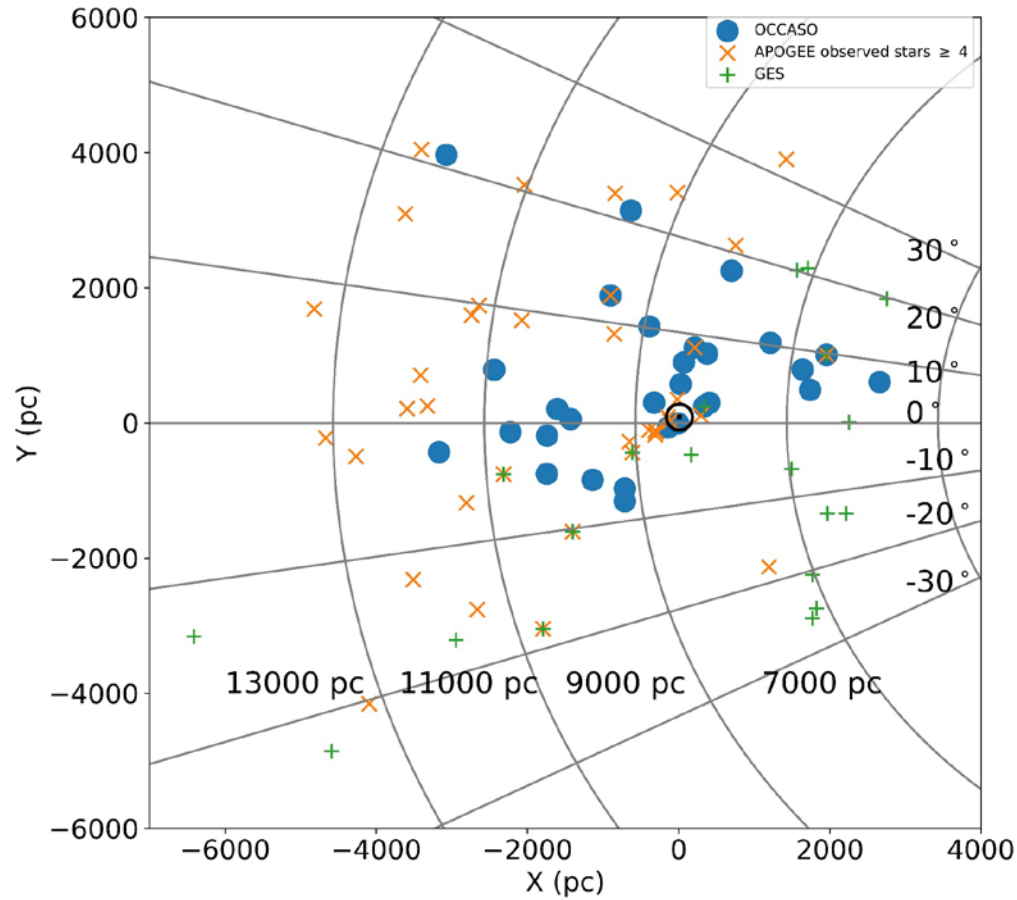
GALAH is not targeting specifically stars of clusters; the forthcoming WEAVE survey will only start observations in about a year; and 4MOST subsurveys are under definition.

Clusters selection

- Open clusters older than 300 Myr.
- At least 6 stars in the red clump.
- Selection firstly based on pre-Gaia literature. Once Gaia data has been available, the selection has been based on Cantat-Gaudin et al. (2018, 2020) and Castro-Ginard et al. (2018, 2019, 2020).

Survey Status

- 37 observed clusters reaching SNR > 70
- 252 observed stars (at least 3 spectra per star)
- 8 clusters to be completed (> 2 stars observed)
- 4 papers have been published, one paper is in preparation and other papers are foreseen in the future (i.e. Casamiquela et al. 2019)

Telescopes and instruments used

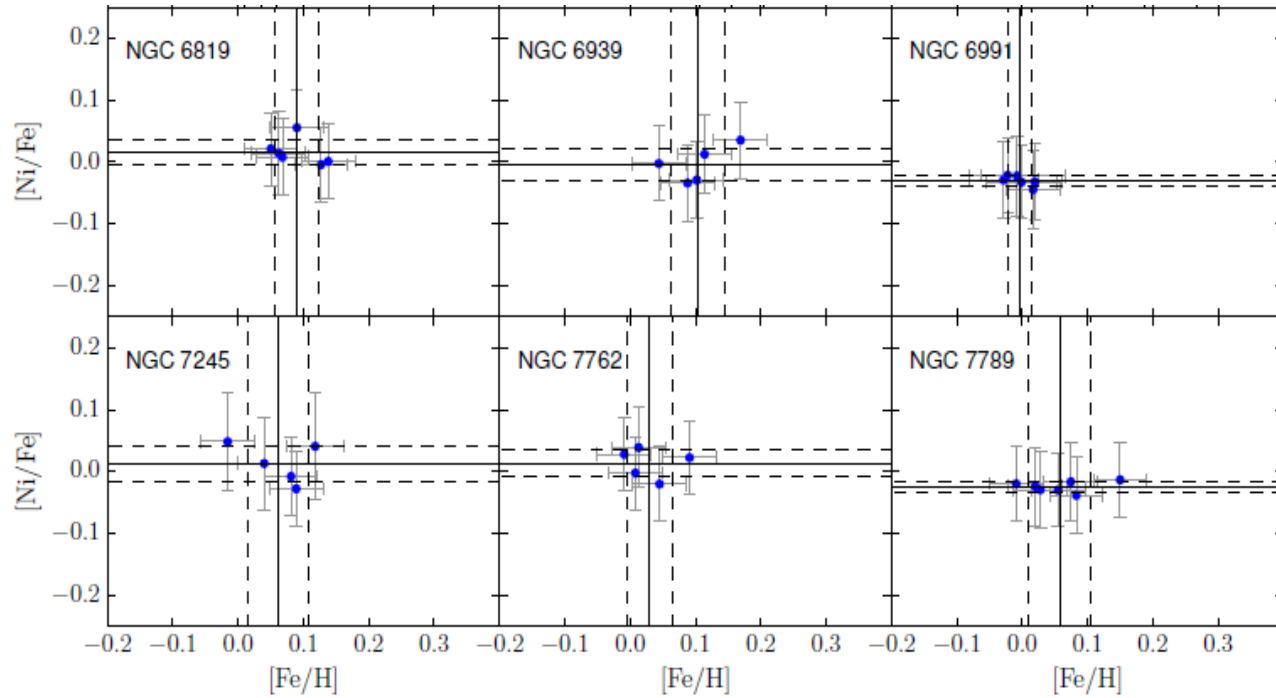| Instrument	Telescope Aperture	Resolving Power
Hermes @ Mercator (ORM)	1.2 m	85000
FIES @ NOT (ORM)	2.5 m	67000
CAFE @ CAHA 2.2	2.2 m	62000

Workflow
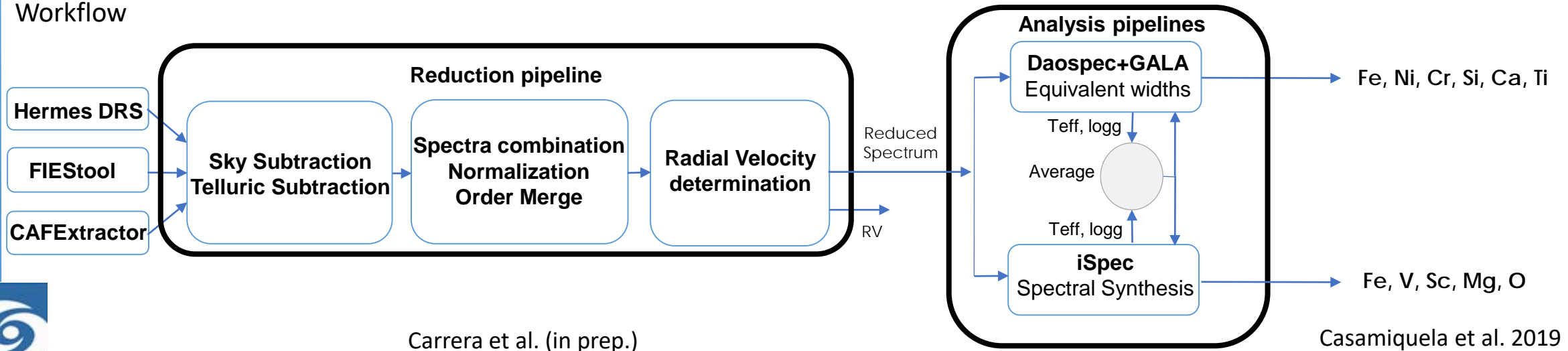
Uncertainties per star in [X/H] 0.04-0.05 dex in all elements
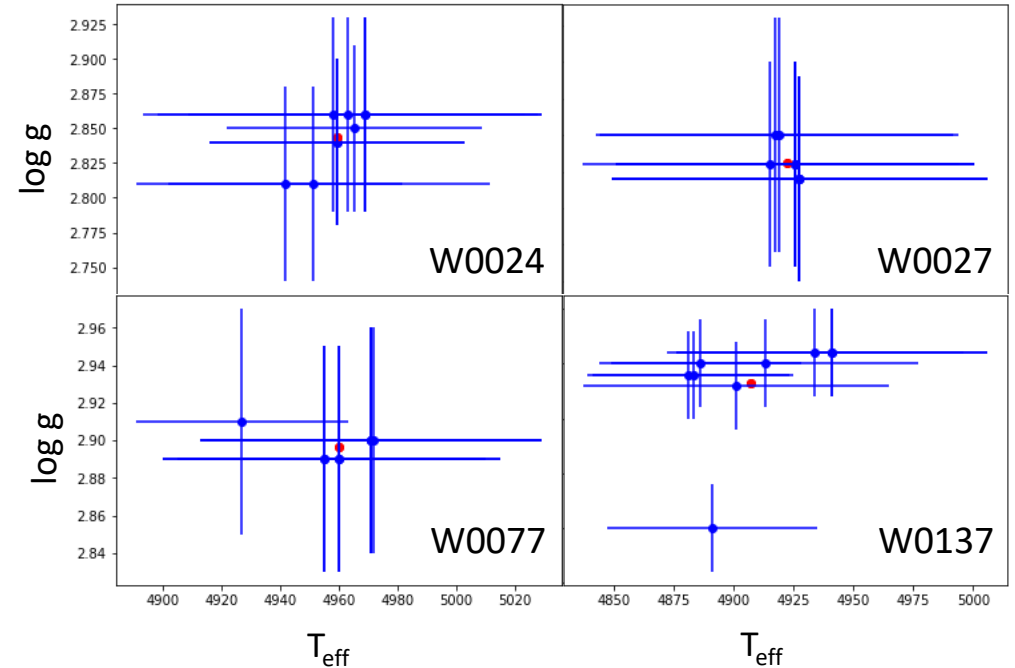
Examples of [Ni/Fe] vs [Fe/H]

Internal cluster dispersions:

$\sigma_{[Fe/H]}$: 0.03 $\sigma_{[Ca/Fe]}$: 0.03

$\sigma_{[Ni/Fe]}$: 0.02 $\sigma_{[Ti/Fe]}$: 0.03

$\sigma_{[Cr/Fe]}$: 0.03 $\sigma_{[Mg/Fe]}$: 0.08

$\sigma_{[Si/Fe]}$: 0.03 $\sigma_{[O/Fe]}$: 0.09

Casamiquela et al. 2019

Study of the dependency of the results on the input parameter values

Example with stars of the cluster NGC 752

Output values of T_{eff} and log g derived using different initial guesses in GALA (blue dots) and their average (red dot). Mean dispersions are 12 K and 0.03 dex.

- All pieces of the pipeline have been revised to improve the internal uncertainties of the results.
- Determination of atmospheric parameters and abundance determination (Fe-peak and alpha elements) for the 37 observed open clusters.
- Abundances of other elements: CNO (in collaboration with Vilnius University); Neutron capture elements as Ce, Zr, Ba, Eu.
- Complementary observations accounting for a wide coverage in Galactic azimuth.
- Study of Large Galactocentric radius OCs based on Gaia Data supported with medium resolution spectroscopy (MEGARA@GTC)

Highlights of OCCASO survey

- Abundance uncertainties in each cluster lower than 0.05 dex (except for NGC 6791)
- The intrinsic homogeneity of the OCCASO survey makes our results very suitable for calibration of other projects.
- The open cluster sample combining OCCASO (37 clusters in the North) and GES-UVES (41 clusters in the South) is the largest sample observed with high resolution spectroscopy (> 40 000) currently available.