Gaia-ESO progress update – I
after 320/340 VLT nights

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Gaia-ESO Survey in a nutshell - Targets

**MW field Giraffe:** Bulge: mostly giant stars; **halo /thick disc** FG TO stars (17 < r < 18);
Large sample of calibration stars – for all surveys

**UVES parallels:** Solar neighborhood: 5000- star sample.
Look at Mv~5.5 ➞ unbiased survey to 1kpc at V=15.

**60-70 Open Clusters in all phases of evolution**
(~1 Myr ➞ several Gyr), sampling the age-distance-R$_{GC}$-density-mass-[Fe/H]) parameter space.

**UVES:** Mostly known members (PMS, MS, evolved – V<16.5) – from 10 to 50 stars per cluster

**Giraffe:** unbiased samples, photometric candidates (V < 19) – several x 100 stars/cluster
Gaia-ESO Survey in a Nutshell - products

Giraffe, 132 fibers
R=16000-25000, H3...H21
403-476...848-900

Parallel UVES, 6/8 fibers
R=42,000, 520/580 nm
416-617/475-678

Plus ESO archive re-analysis

→ ADVANCED PRODUCTS
  • RVs (+variability), vsini
  • $T_{\text{eff}}$, log g, $[\text{Fe/H}]$, $[\text{X/Fe}]$ (Li, $\alpha$, Fe-, s-,...)
  • stellar properties: (activity, $M_{\text{acc}}$, $\dot{M}$, etc.)
Calibration Concept

**internal calibrations**: different stellar types and settings, several nodes analyzing the same stars

**external calibrations**: w.r.t other surveys and Gaia

**maximize legacy value** and provide a rich dataset for future inter-survey calibration

- RV standards
- Gaia benchmark stars: method/node performances, internal homogeneization
- Clusters: hot vs. cool; PMS vs. MS vs. evolved; test metallicity
- CoRoT Red Giants and Kepler II targets: asteroseismic gravities and ages
Survey top-level progress

- Observing close to completion: last runs Oct-Dec 2017, focus on open clusters. Total ~340 VLT nights.
- ESO DR3 released - DR3 (12/2016; data from 01/2003 – 07/2014, catalogue/parameters/abundances as well as spectra).
  - DR3.1 (05/2017; improved re-processed spectra from 01/2003 – 11/2014)
- 44116 spectra, incl ~2000 archive. Based on iDR4

Survey top-level progress

450 Co-Is – many new students and postdocs: about half of them “active” continuing dedicated hard work in the WGs and management teams

publications
- GES In title: (3 also in Gaia-ESO): 9 papers, 348 reads, 156 downloads, 4 cites
- Gaia-ESO in title: 116 total, 64 refereed
- 37388 reads (median=203), 19,728 downloads (median=166), 1586 cites, h-index=22

standards
- Corot update – in 2nd round homogenisation phase, then abundances: complete in 2-3 months
- K2 stars – Ben Rendle talk, other surveys overlap
- WG meetings this week – very important

iDR5 lessons, iDR6 plans – Sofia to elaborate
changes in WP management

-A. Recio Blanco resigned as WG10 coordinator
-C. Worley now WG10 responsible – C. Allende scientific supervision
-F. Damiani joined WG15 (responsibility on young stars)
-A. Casey moved to Australia, still does WG11 homogenisation
-L. Spina: abundance homogenisation in WG12
-E. Franciosini: Li abundance homogenisation in WG10 + new Li COGs, etc
  - Anais Gonneau has joined the Cambridge coordination team
  - Veronica Roccatagliata is a new post-doc at Arcetri
  ➔ Formalize changes for iDR6
Is Gaia-ESO the right approach?
no-one else is putting in this methods effort

• Involve all spectroscopic analysis methods
• Identify the dominant systematic variables, and fix them – version control
• Analyse spectra through all interested groups
• In principle, this allows us to identify both systematic method errors and random errors
  \[ \Rightarrow \text{parameter} \pm \text{random} \pm \text{systematic} \]
• More methods means more information
• Add seismic data for precision and systematics
• Share calibration across all the Surveys
• Bootstrap everything onto Gaia benchmark stars
Theoretical Grid of synthetic spectra

Parameters and abundances determination

Observations vs models

Resolution
Wavelength coverage
SNR
Reduction/flux calibration/normalisation

Empirical (Cannon)
Grid of reference stars

Theoretical
Grid of synthetic spectra

Parametrisation of the reference stars
Calibration/test of theoretical grid

WARNING: all parameters and abundances are interdependent/covariant
Rave systematics seen from Corot

Fig. 10: Difference in log(g), T_{eff}, [M/H](calibrated and not calibrated) and [Mg/Fe] (Δ computed as RAVE_Dr4 this work) for the 62 RAVE targets where the GAUFRE+Sp_Ace pipelines converged. On the top panel, the log(g) comparison, the fit used for calibrating log(g)RAVE_Dr4 is shown (red dashed line).

Fig. 27.— The difference in the asteroseismically calibrated gravities, log g_{sc} and that from various sources in the literature as a function of log g_{sc}. Only stars with Flag.M=1 are shown.
precision and accuracy
Back to Gaia-ESO: how good are the parameters? Scatter between individual determinations of Te from many pipelines – happily, the noise is correlated.

Great way to find screw-ups too....
Gaia-ESO node example
Teff: node vs standard

Fails at low Teff

Benchmark calibrators with fundamental parameters provide “ground truth”

Fails at low [Fe/H]
Gaia-ESO
why we homogenize

Ba/Fe data produced from several pipelines: note different scatter and systematics
Remove the systematics between pipelines ➞ reduced scatter, trends
Precision 2:  
*Data driven methods (the Cannon)*

Ness et al. (2015)  
Casey et al. (2016)
Many recent studies treat spectra via a simple data model. No astrophysics. eg 1706.00009

**WHY DOES THIS WORK?**

*Spectrum analysis does not extract the full information content.*
Target selection and observing teams have delivered
- Spectrum processing teams have delivered
- Current iDR5 processing cycle has provided much excellent data
- iDR6 to come, building on a lot of hard work in the WGs

› What lessons do we take from iDR5?
› How should we organise iDR6 – including Gaia DR2?
› How to involve the wider Gaia-ESO consortium in science analyses?
› Wider visibility of Gaia-ESO Science?
› Sofia will expand on these topics