

# **Gaia-ESO Survey Workshop :**

## **Spectrum Analysis of FGK stars**

### **18-19 April 2012, Nice – France**

### **Scientific Report**

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#### **I. Summary**

Gaia-ESO is a VLT/FLAMES public spectroscopic survey, targeting  $10^5$  stars, systematically covering all major components of the MilkyWay, from halo to star forming regions, providing the first homogeneous overview of the distributions of kinematics and elemental abundances. This alone will revolutionise knowledge of Galactic and stellar evolution: when combined with Gaia astrometry the survey will quantify the formation history and evolution of young, mature and ancient Galactic populations. The survey will quantify the kinematic-multi-element abundance distribution functions of the bulge, the thick and the thin discs and the halo stellar components, as well as a significant sample of  $\sim 100$  open star clusters, covering all accessible cluster ages and stellar masses.

GIRAFFE spectra, with two settings, will be obtained for statistically significant samples of stars in all major stellar populations. These will be supplemented by UVES spectra of an unbiased sample of G-stars within 2 kpc of the Sun, providing the abundance distribution function for the local thin disk, thick disk and halo. The open cluster survey targets contribute to testing stellar evolution models from pre-main sequence phases right through to advanced evolutionary stages, and provide a legacy dataset that adds enormous value to the Gaia mission and ongoing ESO imaging surveys.

The spectrum analysis of FGK stars, the huge majority of the data, will be performed by WG10 and WG11, corresponding to GIRAFFE and UVES spectra. Their task is to process extracted spectra to refine astrophysical parameters, to deliver elemental abundances to a level appropriate for the relevant stellar type and available SNR, to derive stellar properties (e.g. activity, accretion, rotation -whenever relevant) and to provide detailed analysis-level quality-control. A common coordination group for the analysis of FGK stars has been established. This group includes R. Smiljanic & A. Korn (UVES analysis), A. Recio Blanco (OCA) & C. Allende Prieto (GIRAFFE analysis), L. Pasquini and V. Hill (OCA).

The workshop organised at OCA (Mont Gros) was the first joint meeting, after the beginning of the observations, of the groups involved in the spectrum analysis of all the FGK type stars observed by the Gaia-ESO survey. The meeting was centered in the analysis procedure of the first real data. The data quality control for each of the analysis nodes and the interfaces with the other Working Groups of the consortium were also examined.

## II. Description of the scientific content and discussion at the event

With more than 50 participants, the meeting was very successful. On the morning of the first day general presentations on the Survey status, reduction, radial velocity, and classification pipelines, model atmospheres, synthetic spectra were given. The remaining time was dedicated to the presentations from the individual nodes and to discussion. Much progress has been achieved in several aspects and by many teams –significantly, a preliminary analysis of the first Survey spectra was reported by some of the groups. However, several already known issues still need to be solved and new ones were identified. Efforts and new tests will be done in the next weeks to clarify all these. Timescales for the delivery of the analysis products for the first three runs were identified, with the ambition to be ready to start the science verification and early science phase in Autumn. This should apply not only to the FGK spectrum analysis products, but to the products from the other spectrum analysis WGs as well.

The talks presented at the meeting can be downloaded from the Great wiki pages, [http://great.ast.cam.ac.uk/Greatwiki/WP10\\_WP11MeetingNice2012](http://great.ast.cam.ac.uk/Greatwiki/WP10_WP11MeetingNice2012)  
A summary of the discussion and meeting outcome is also available in the same wiki page and here below:

### 1. Conclusions concerning WG10 analysis:

- Stellar parameters should be provided within 3 months (**deadline 31st July**) for:
- already available GIRAFFE data target stars (~10 000 spectra)
  - available benchmark stars (**several tenths of spectra**)

Four nodes have committed during the meeting to perform the above mentioned analysis.

More particularly:

- EPINARBO: will analyse the cluster's spectra and the benchmark spectra
- LUMBA: will analyse the field's spectra and the benchmark spectra. They will also determine the Ca abundance, whenever possible.
- CATANIA: will analyse the cluster's target spectra (HR15N)
- IAC: will analyse the field's and the cluster's spectra. They will provide the  $[\alpha/\text{Fe}]$  whenever possible.
- NICE: will analyse the field's and the cluster's spectra (HR10 and HR21). They will provide the  $[\alpha/\text{Fe}]$  whenever possible.

In addition to this, a new test concerning a set of synthetic spectra will be implemented for the evaluation of the internal errors (~4000 spectra) in a longer time-scale (deadline next autumn).

### 2. Conclusions about auxiliary data:

- a) All the nodes (GIRAFFE and UVES analysis) have agreed to use exclusively:**
- The MARCS model atmospheres. Bengt Edvarsson is in charge and will manage

the work concerning model atmospheres. New models for different  $[\alpha/\text{Fe}]$  at any metallicity have already been computed and possible updates will be considered in the future.

- The same line list. There will be two linelists, one of "clean lines" (for EW and spectral synthesis of individual lines), and one "master linelist" including all relevant transitions in the whole domain. Updates to the clean linelist will be retrofitted into the master linelist on a regular basis, but not more often than every ~6 months-12months basis. Sarunas Mikolaitis has agreed to continue to act as a co-ordinator for the "clean linelist", with the input from many nodes that have worked towards clean linelists. Laura Magrini volunteered to help Sarunas with the clean line-list and in particular with the log gf values. Jennifer Sobeck and Maria Bergemann agreed to act co-ordinators for the "master linelist". Each of them had already done a large part of the work for GIRAFFE\_H10\_H21 and UVES\_R580 respectively and will now homogenize their approach. An updated version of the clean and the master line-lists will be produced on a six-months time-scale.

- The same reference spectra grid (if needed) based on the above MARCS model atmospheres and line list. Patrick de Laverny is in charge and will manage the work concerning synthetic spectra grids. New grids for UVES and GIRAFFE will be computed by June 2012, including the new computed MARCS model atmospheres, and more adequate microturbulence values depending on  $T_{\text{eff}}$  and  $\log g$ . The valid line-list and adequate molecular linelists will be used for this cycle of analysis, although an update of the grids will be done next autumn, when the new version of the master line-list will be available. The AMBRE grid will be also available from the beginning of May for those who will need a grid to start their developments before the reference grids for this cycle will be available (June 2012). The work by Sergey Koposov will be done, in the future, with the same synthetic spectra grid as the one used by the WP10 nodes.

**b) Version controlled** complete sets of MARCS models, synthetic spectra grids, and line-list will be maintained under version control on IoA database system, to be the main download centre for these.

**3. Observed spectra:** The available spectra will be re-reduced where necessary. In particular:

- issues identified in formats, zero points, file names, etc... will be fixed
- sky-subtraction will be improved for GIRAFFE spectra
- normalized spectra will also be produced for UVES spectra
- GIRAFFE spectra will be released again by the IoA pipeline after comparison with other pipelines.

### **III. Assessment of the results and impact of the event in the future direction of the field.**

The main results of the meeting concern, on one hand, the useful discussions between the pipeline groups and the people involved in the spectrum analysis. The different needs were exposed and a new reduction procedure was foreseen after the meeting. The resulting improved version of the reduction pipelines has produced a new data release at the beginning of June.

The second important decision taken during the meeting was to expedite the observations of the benchmark stars, given their importance for the tests and the validation of the analysis procedures of the different nodes. Thanks to the discussions concerning this point that took place at the Nice meeting, an important number of benchmark stars were observed during the runs of May, and are now included in the last data release.

Finally, the deadline for the first delivery of the stellar parameters for all the already observed stars was fixed. Thanks to the GREAT funding, all the analysis nodes were represented at the meeting, and this decision was possible to take in agreement with the P.I.s of the Gaia-ESO project. The agreed deadline will allow the people involved in the project to work on the scientific exploitation of the data, in advance to the first public release of the spectra parameters.

In addition to the above described decisions, the meeting was crucial to maintain the necessary interaction between the working group in charge of the analysis of FGK stars GIRAFFE spectra and the UVES spectra one. Several details of the analysis concern the homogeneity of the results of the above mentioned working groups and therefore, the scientific results that the project will produce for the solar neighbourhood and the other, more distant Galactic regions targeted by the survey. In the framework of the interaction between the two working groups, several decisions described in the previous section, were taken during the meeting. They concern the choice of the model atmospheres, the atomic and molecular line-lists and synthetic spectra reference grid. The actions identified during the Nice meeting allowed to coordinate the work of people that belong to different analysis nodes. One example is the work on the atomic line-lists, that has involved people from Vilnius, Munich, Arcetri and Nice during the last two months and produced a new version of the clean line-list at the beginning of June.

In conclusion, the Nice meeting has had a crucial impact on the activities of the Gaia-ESO data analysis. The conclusion and discussions of the meeting were reported on the Gaia-ESO newsletter of May and the Steering Committee has recently agreed that the first scientific meeting of the project will be hosted by Nice, at the end of the year.

## IV. Final meeting programme

### DATES and PLACE

The meeting took place at the Observatoire de la Cote d'Azur (Nice, France) on 18th-19th April 2012.

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**SOC:** A. Recio-Blanco (OCA, France), V. Hill (OCA, France), C. Allende Prieto (IAC, Spain), R. Smiljanic (ESO, Germany), A. Korn (Uppsala Obs., Sweden), P. de Laverny (OCA, France)

**LOC:** V. Hill, P. de Laverny, A. Recio-Blanco, S. Goletto, S. Rousset

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### **AGENDA:**

#### **WEDNESDAY 18th April**

**9:30** Welcome and introduction (A. Recio-Blanco)

**9:35** Project Status by the P.Is ([G. Gilmore & S. Randich](#))

#### **10:15 Session 1: Pipeline processing of raw data**

- Observations (T. Bensby, 15min):
- Clusters target selection ([A. Bragaglia](#), 15 min):
- Field target selection ([C. Babusiaux](#), 15 min):

**11: 00** *Coffee break* (20 min)

- Pipeline for GIRAFFE raw data ([J. Lewis](#), 15 min)
- Pipeline for UVES raw data ([G. Sacco](#), 15 min)
- Radial and rotational velocities and Spectral classification ([S. Koposov](#), 25 min)
- Calibration ([E. Pancino](#), 15 min)

**12:30** Lunch at OCA

#### **14:00 Session 2: Auxiliary data for GIRAFFE and UVES**

- Stellar atmospheres ([B. Edvardsson](#), 15 min)
- Line list compilation ([S. Mikolaitis](#), 15 min)
- Synthetic spectra grids ([P. de Laverny](#), 15 min)
- Bench-mark stars ([C. Soubiran](#), 15 min)

#### **15:00 Session 3: Spectrum analysis of GIRAFFE FGK stars**

- Spectrum analysis procedure and the status of the first GIRAFFE data processing ([A. Recio-Blanco & C. Allende Prieto](#), 25 min)

**15:25** *Coffee break* (20 min)

- Node's presentations: the representative of each spectrum analysis node will present the advancement of the work and the eventual problems encountered. (15 min per node presentation):
  - - LUMBA ([K. Lind](#))

- - EPINARBO ([L. Magrini](#))
- - Brussels ([T. Masseron](#))
- - Catania ([A. Frasca](#))
- - Vilnius (G. Tautvaišienė)
- - Nice ([A. Recio-Blanco](#))

- Discussion

**19:00** End of the first day

**THURSDAY 19th April**

**9:30 Session 4: Spectrum analysis of UVES FGK stars**

- Spectrum analysis procedure and the status of the first UVES data processing (A. Korn & R. Smiljanic, 25 min)
- The representative of each spectrum analysis node will present the advancement of the work and the eventual problems encountered (15 min per node presentation, and a coffee break).

- IAC-AIP ([M. Steffen](#))

- - LUMBA ([G. Ruchti](#))
- - EPINARBO ([L. Magrini](#))
- - Catania ([A. Frasca](#))
- - Liège ([T. Morel](#))
- - Porto ([S. Sousa](#))
- - Madrid ([J. González Hernández](#))
- - Heidelberg ([L. Sbordone](#))
- - Bologna ([A. Mucciarelli](#))
- - Brussels ([T. Masseron](#))
- - Nice ([C. Worley](#))

- Discussion

**12:30** Lunch at OCA

**14:00** Session 5: Analysis strategy for the first data release

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- [Discussion](#) and [final conclusions](#) (A. Recio-Blanco and everybody)
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- Presentation by the leader of the Survey Parameter Homogenization WG15 (P. François, 30 min)
  - Spectrum analysis for AEGIS ([A. Casey](#), 20 min)

**16:30** End of the meeting