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ESF-GREAT Workshop: “The UVES analysis of the Gaia-ESO survey: tests, tools, and survey implementation”

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1. Summary

The workshop took place on the 26th and 27th of September at the main auditorium of the ESO Headquarters in Garching, near Munich, Germany. It is part of the preparation work for the Gaia-ESO Survey (P.I.s: Gerry Gilmore & Sofia Randich), with emphasis on the activities of its Working Group (WG) 11.

The Gaia-ESO Survey is a public spectroscopic survey that will observe more than 10^5 stars with the FLAMES multi-object fiber facility at the VLT. Observations will start in Dec. 2011 and last for ~ 5 years for a total of ~ 300 nights. It will produce an unprecedented amount of high-quality data of stars in the main components of the Galaxy (thick and thin disks, halo, and bulge) and in open clusters of different ages (from young associations to old clusters).

Working group 11 (co-coordinators: Andreas Korn & Rodolfo Smiljanic) deals with the analysis of high-resolution UVES spectra of FGK-type stars. The WG11 will deliver the atmospheric parameters (effective temperature – T_{eff} , surface gravity – $\log g$, microturbulent velocity – ξ , and metallicity – $[\text{Fe}/\text{H}]$) and elemental abundances of these stars.

The Survey is a large-scale test of the ability of the community to handle large spectroscopic data sets. The data to be collected put new demands on all the teams involved in the analysis and the codes used. In particular, to safeguard homogeneity of results, we need to agree on a common methodology.

In this two-days workshop the groups involved in the UVES analysis had a chance to discuss a number of topics: the current status of the survey; the management structure of the WG; results of performance tests; issues and limitations of the available codes, model atmospheres, and line lists; the methodology; future tests of the analysis; and some science topics.

The workshop was a successful and important step towards preparing to deal with the survey data. As a result of the workshop, all groups have now a better understanding of the challenges involved in organizing the UVES analysis. The presentations and discussions allowed decisions regarding very important steps that have to be concluded before the survey commences (by Dec. 2011). These decisions include new tests and comparisons, and definition of line lists and codes. Work on these issues is underway.

2. Scientific content and discussions

The activities of WG11 bring together about 17 groups, with ~ 66 people from more than 20 institutes across Europe, and in Chile and the USA. The workshop had 40 participants, with representatives from most of these groups.

The workshop consisted of discussions and presentations that were divided in five sections, described below.

2.1 Project status & review

The first day started with talks giving an overview of the survey activities, the WG11 activities, and the activities of the individual nodes.

Sofia Randich, one the Survey PIs, first gave an overview of the most recent developments regarding the survey. This included news about the Survey Management and Implementation plans, the publication and documentation policy, new membership and plans for early science.

Next, Rodolfo Smiljanic gave an overview of the recent activities of the WG11. This included details about the groups that are part of WG11, the data that will be obtained, the coordination team, how analysis is envisioned, and open questions to be discussed during the meeting.

In the last, but most extensive part of the session, those representing the groups involved on the analysis were given an opportunity to present the activities of their groups. They were asked to include information about the man-power available at the group, the methodology usually adopted in their analysis, and updates on the progress and difficulties they encountered during the test analysis that the groups were required to undertake.

2.2 Technology

The first half of the first afternoon was divided in two main discussions. One about how to (sub)structure the activities and tasks within WG11. A substructure answers the needs of the groups for input auxiliary data for implementing the analysis (such as model atmospheres, line lists, and synthetic spectra) and to improve communication and division of responsibilities within the WG. This discussion was conducted with the participation of the coordinators of WG10 (Alejandra Recio Blanco & Carlos Allende Prieto – Analysis of Giraffe spectra of FGK-type stars). Many of these decisions have to be taken in agreement between WG10 and WG11 to ensure homogeneity and consistency of the analysis.

The other was a more general discussion, lead by Andreas Korn, about "technological" issues that need to be decided and the actual steps that need

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to be taken for the analysis implementation. As previously agreed, the whole survey will rely on MARCS model atmospheres. Various nodes reported problem with data access via the web interface and the interpolation routine provided on the MARCS site. These reports gave vital feedback to the coordinators and have to be addressed before the survey commences.

2.3 Methodology

The second half of the first afternoon was dedicated to presentations and a discussions about the analysis methodology. Not just the individual methodologies adopted by each of the groups, but also the hoe the survey analysis should be structured and the steps that will lead to the catalogue for data release.

The first presentation was given by Elena Pancino. She coordinates WG5 (Calibrators & Standards). The WG5 is in charge of selecting of objects for calibrating the survey data. This includes well-known and studied objects, stars with fundamental parameters, and stars in common with large surveys. The purpose is to create standards in terms of astrophysical parameters and abundance ratios that all adopted methodologies should reproduce.

This was followed by a presentation by Patrick François, coordinator of WG15 (Survey Parameter Homogenization). This WG is in charge of ensuring homogenization of the results provided by the five WGs responsible for spectrum analysis. In addition to WG10 and WG11 mentioned above: WG12 – Pre-main-sequence spectrum analysis; WG13 – OBA stars spectrum analysis; WG14 – Non-standard objects spectrum analysis. An overview of the tasks of this WG was given (including definition of output formats, information that should be added to the data, definition of formats, etc...).

Next was a talk by Caroline Soubiran on “The external calibration of Gaia’s radial velocities and astrophysical parameters”. This covered the important topic on how calibration for the Gaia satellite data is envisioned. For optimal exploration of the survey data a synergy between the Survey and Gaia calibration is very important.

After the talks, a second discussion session lead again by Andreas Korn was conducted. Here, more information was given on the S/N results to prepare for a decision on Day 2. The discussion also addressed issues related to common line lists and common methodology in general. It became clear that several groups consider the overhead associated with adopting a fully consistent methodology too costly. The nodes should rather conduct tests on standard stars in order to show that their methodology produces meaningful results that are, at least in principle, compatible with what others are doing.

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2.4 Tests

As part of the planning for analyzing the survey data, a number of tests have been and will be conducted. The morning of the second day was dedicated to discuss these tests, their results and difficulties. Given the necessary synergy between WG10 and WG11, some time was allocated to allow WG10 to report on their tests.

Two presentations were given about the tests that are being done for the Giraffe analysis by Alejandra Recio Blanco & Luca Sbordone. These tests have the objective of refining the choice of set-ups to be used during the observations, understand the influence of S/N on the atmospheric parameters determination, and evaluate which individual abundances can be determined, in each type of star, as a function of S/N. They reported on the progress and problems encountered in preparing realistic synthetic spectra to fulfil these aims. The testing was underway and results not yet available.

The results of tests being conducted for the UVES analysis were reported by Rodolfo Smiljanic. The tests consisted on the analysis of synthetic spectra of 50 different stars with three levels of S/N ($S/N = 40, 70, 100$). The objective was to compare the group's methodologies in a controlled test, with specified and common input data. We also aimed to understand the effect of S/N on the derived parameters and abundances. No significant dependency with S/N was found, but it was concluded this is likely an artifact since the noise included in the spectra was not realistic. Some level of scatter between the results of different groups was also found. This shows that additional steps have to be taken in order to guarantee the homogeneity of the results.

The presentations were followed by an open discussion session about the current and future tests. The importance of calibrators and standards was stressed. It was agreed that a new test, on a selected set of standard stars should be conducted. All groups should use this test to validate their methodology with a set of stars that have well known and fundamental parameters.

2.5 Science

Finally, the last session during the afternoon of the second day was dedicated to presentations on a few of the scientific topics of the survey.

The first presentation was given by Rosine Lallement on "ISM line diagnostics". She remarked that a few spectral features from the interstellar medium will be present in the UVES spectra. They can be used to study the properties of gas and dust in the Milky Way, not just as a side product of the survey but also as one of its results.

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The second presentation was given by Sophie Van Eck on the “Analysis of peculiar stars”. A number of peculiar stars (e.g. stars enriched in s-process elements) will likely be observed by the survey. This presentation discussed what kinds of peculiar stars can be expected and raised the question of how to deal with their analysis.

A last presentation was given by Alex Lobel, about the analysis of hot stars. The analysis of hot stars is mainly a concern of another WG. Nevertheless, many of the issues regarding the structuring of their analysis are in common with the issues faced by WG11. Thus, a discussion to compare experiences and solutions is useful for both sides. In addition, the issue of the analysis of A-type stars was also discussed. Some effort is necessary from both WGs to identify experts on their analysis.

The last discussion session of the workshop was lead by Andreas Korn on what is the S/N required to fulfill the scientific objectives of the survey. It was agreed that the observations should aim to obtain spectra with a minimum of $S/N = 40-50$.

3. Results and impact

The workshop was successful in bringing together the community interested in the Gaia-ESO survey and the exploration of its results. The survey will obtain UVES spectra of about 5000 stars (among field and cluster stars). The challenge we face is to optimize the resources and man-power available, organizing an analysis that will produce results with added value that can be directly used by the community, without the need to reanalyze the data.

The meeting allowed a first in-depth discussion of issues related to Gaia-ESO survey preparation and implementation. This is practically the first time that abundance-analysis teams across Europe decide to work together, while retaining some autonomy in the way the analysis is performed. The Gaia-ESO Survey is the very first survey to attempt such a division of labour. Issues related to methodology were identified that will need to be addresses in the coming months leading up to the first observations. Not surprisingly, some tension also surfaced at the meeting. It is fair to claim that the Gaia-ESO Survey is as much a sociological experiment as it is a scientific one.

It was finally decided that regular meetings along the same line of this workshop are going to be very useful also during the survey. They will allow to bring together the community to discuss the survey development and any issue encountered during its execution. It is currently foreseen that the next meeting will take place some time around March/April 2012. This time, we aim for a

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joint Giraffe/UVES meeting. By this time, the first few observing runs of the survey will be finished and data analysis will be ongoing. This meeting will allow a first overview of the real data and decisions on how the results will be prepared for the first release of advanced data products, currently foreseen for mid-2013.