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COMMUNICATE WITH FLAGS!

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Abstract. The Gaia-ESO survey (GES) is a spectroscopic survey designed to complement the Gaia astrometric mission with radial velocities and chemical abundances. Within Gaia-ESO, a dozen analysis nodes collaborate to derive atmospheric parameters and chemical abundances applying different methods on the same input spectra. During the progressive data releases, experience has proven that an efficient system of flags is needed to ease the communication between nodes during the analysis phase and to ease technical/analysis issue reporting. Flags are also of great use to the homogenization working group to provide a single set of results per GES source since physical quantities derived by the nodes (and their associated errors) are hard to combine. Finally, the flag system allows the identification of objects exhibiting specific spectral features or belonging to specific stellar classes. Here we describe the Gaia-ESO flag dictionary and emphasize its usefulness for the consortium and end-user.

Keywords: surveys, methods: data analysis, techniques: spectroscopic

1 Introduction

The Gaia-ESO survey (Gilmore et al. 2012; Randich et al. 2013) is one of the on-going large spectroscopic surveys, aiming at providing the community with precise radial velocities and chemical abundances for 10^5 stars. Two different spectrographs are being used, UVES (high resolution, $R \sim 47\,000$) and GIRAFFE (medium resolution, $R \sim 20\,000$), thanks to the FLAMES facility at ESO/VLT. Two UVES setups and eight GIRAFFE setups are used to cover different spectral domains. The fifth internal data release (iDR5) comprises the data obtained from the start of the observation campaign, on December 31st 2011 until January 1st 2016. About 400 000 individual spectra have been recorded for more than 80 000 unique targets. Among those targets, 38 000 FGK stars have been observed with the GIRAFFE multifibre spectrograph while more than 2000 have been observed with UVES. About ten analysis nodes work on these GIRAFFE and UVES subsamples and apply different analysis techniques to the same input. It means that up to ten sets of results might be provided per star and they will have to be folded into a single result. Experience has proven that physical quantities and their errors are hard to average and this is why a sophisticated system of flags has been set up.

2 The flag system

A flag of the GES dictionary has a very flexible syntax which allows various information to be reported. It comprises five dash-separated elements, *PPPPP-WW-NN-SS-X*, reporting various information:

1. *PPPPP*: a prefix (integer) coding for an issue. The prefix codes for specific issues or classes of issues that are frequently encountered during the analysis or the prefix highlights interesting stellar properties. Table 1 lists some of the most used prefixes;
2. *WW*: the ID (integer) of the working group the node belongs to;
3. *NN*: the ID (integer) of the node (within a working group) raising the flag;

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Category	Sub-category	Prefix ID	Prefix description
TECH	Data reduction	10 100	Saturated spectrum
		10 103	Suspicious or bad co-addition of exposures
		10 104	Suspicious or bad spectrum normalisation
		10 105	Incomplete spectrum (missing wavelengths)
	Data analysis	10 302	Code convergence issue: one of more convergence criteria (node-specific) could not be fulfilled. Criteria to be described using the suffix
		10 309	Photometric gravity (instead of spectroscopic gravity)
		10 311	No parameters because too few Fe I lines
		10 317	Incomplete/missing set of parameters because of mass loss / wind determination problems. Conditions to be described using the suffix
		10 320	Incomplete/missing set of parameters because of suspected multiple stellar system
PECULI		20 020	Spectroscopic binary SB2
		25 000	Hα emission profile
REMARK		30 200	CEMP-r

Table 1. Some of the most used prefixes. For instance, the description of the prefix 10 302 has a broad meaning on purpose: the analysis nodes have the freedom to use as many suffixes as they need to specify the method-dependent conditions triggering their flags built with this prefix. The prefixes are sorted into three main categories TECH (technical flags), PECULI and REMARK (stellar properties or classification flags), themselves organised in sub-categories.

4. *SS*: a suffix (integer) that can be used to forward a node-specific comment. If the prefix description is precise enough, the default suffix (00) can be used. On the other hand, if the prefix description was intentionally kept general, then it is mandatory for the node to use one or more non-nil suffixes to provide the missing information (e.g., the temperature range where the prefix applies);
5. *X*: a confidence flag (letter) indicating how probable the flag apply to the current object (from A, most probable, to C, least probable).

3 Concluding remarks

For iDR5, more than 1.2 million flags have been raised, especially those concerning the data analysis. The node-to-node agreement is acceptable. For instance, the prefix 10 302 coding for a convergence issue for the stellar parameters has been raised for 14 000 stars and at least two nodes have raised this flag in 60 % of cases. Figure 1 shows an example illustrating how the flags can be used to fix issues. This spectrum was marked as broken in iDR5 thanks to a flag. Looking at the individual exposures showed that four of them needed to be removed from the co-addition. The bottom spectrum shows that the iDR6 version of this spectrum is now usable for the analysis.

A flag system is mandatory when the amount of astronomical data is not human-sized anymore. They allow the reporting of issues or highlighting of peculiarities throughout the data processing. Flags have to be assigned and used in an automatic way by the pipelines. The Gaia-ESO survey is a good laboratory to test and deploy such flagging techniques: it is a large survey where automated procedures are the rule but its size (10^5 stars, $< 10^6$ spectra) still allows manual mining of a representative fraction of the data, which is advantageous to perform a posteriori checks and control that the pipelines work as intended.

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References

Gilmore, G., Randich, S., Asplund, M., et al. 2012, The Messenger, 147, 25

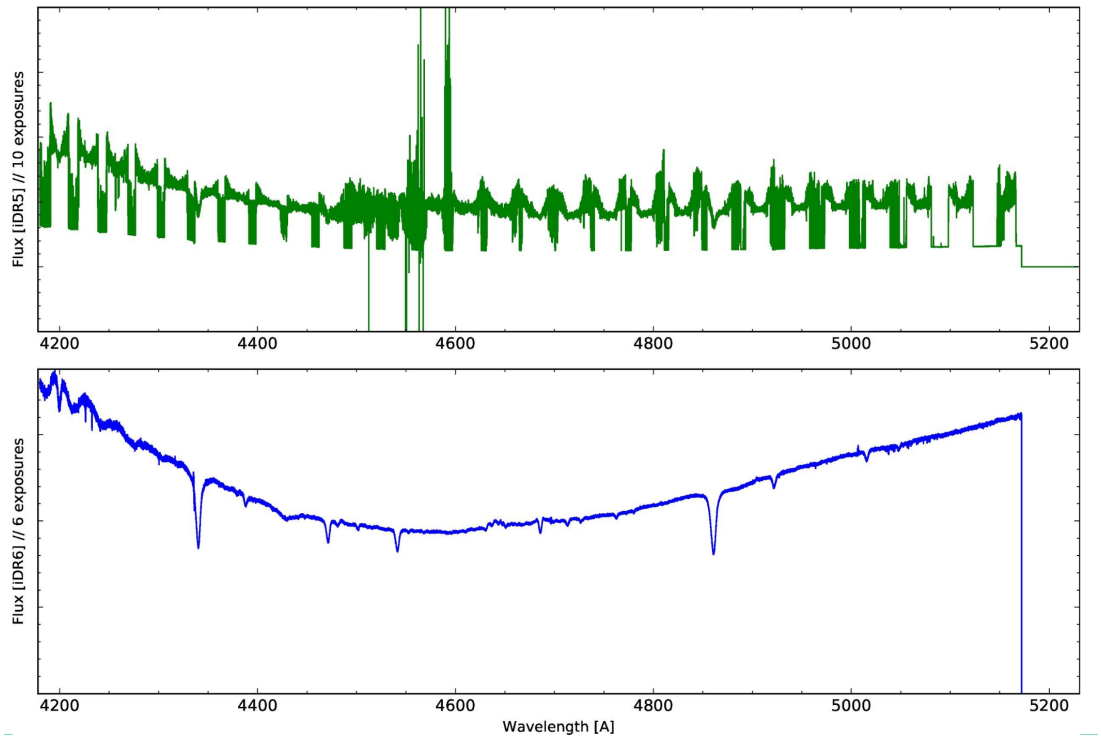

Fig. 1. **Top:** Co-added iDR5 spectrum of a given star, reported as being broken. **Bottom:** Co-added iDR6 spectrum obtained after removing four of the ten exposures. Thanks to the flag it was possible to fix the issue and recover the spectrum of this star.

Randich, S., Gilmore, G., & Gaia-ESO Consortium. 2013, The Messenger, 154, 47