AUTOMATIC COMPARISON BETWEEN OBSERVED AND COMPUTED STELLAR SPECTRA WITH TOOLS AND PROTOCOLS FROM THE VIRTUAL OBSERVATORY

A. Lèbre[1], A. Palacios[1], M. Sanguillon[1] and P. Maeght [2]

Abstract. We present - through a *demo* - the VOSPECFLOW application that intends to make easier - with the use of protocols from the Virtual Observatory - the comparison between observed stellar spectra (stored in the TBLegacy archive) and high resolution synthetic spectra (stored in the POLLUX database).

Keywords: Techniques: photometric, Astronomical databases: miscellaneous, Virtual observatory tools

1 Introduction

Synthetic spectra computed over a large spectral range (300 - 1 200 nm) and at high resolution (R = 150 000), such as the ones distributed in the POLLUX database (Palacios et al. 2010) can not be directly nor easily confronted to observational data, such as stellar spectra stored in telescope's archives. Indeed the imprint of the instrument involved to collect the data, as well as some stellar properties such as macroturbulence or surface rotation, have to be taken into account through adequate modifications of the synthetic spectrum to transform it into an optimized simulation of an observed spectrum. Moreover, even if the Virtual Observatory (V.O.) facilitates the access to interoperable data distributed in a somehow homogenized file format (mainly VOTable or FITS format), observed and computed stellar spectra often present different file structures (different number of columns, different units for columns of the same meaning, presence or not of a normalized flux column, ...). Finally, observed and theoretical stellar spectra are generally accessible, within the V.O., through different dedicated protocols, the Simple Stellar Access protocol (SSAP) and the Theoretical Stellar Access Protocol (TSAP), respectively. Each of these protocols involves very specific keywords to request a V.O. compliant service. For example a telescope's archive will be queried through the IDENT and POSITION of a specific star (of often unknown stellar parameters), while theoretical spectra stored in a database will be queried through stellar parameters (Teff, log g, [Fe/H], ...). All of these subtle differences between observed and computed stellar spectra (regarding their structure and storage) really prevent their direct confrontation through any *quicklook* basic tool. For that reason, along the development of the POLLUX database and within the large collaboration OV-GSO (Observatoire Virtuel du Grand Sud Ouest), we have defined the VOSPECFLOW application that we present below.

2 VOSPECFLOW : How it works and what it aims at

The VOSPECFLOW application aims at making easier the comparison between observed and computed stellar spectra. In its present version, it involves observations stored in the TBLegacy archive (`http://tblegacy.bagn.obs-mip.fr/`) and high resolution synthetic spectra stored in the POLLUX database (`http://pollux.graal.univ-montp2.fr/`). Using V.O. protocols and starting from the name of a given star (e.g., HD 232 862), VOSPECFLOW automatically performs successive requests to various services (Fig. 1) such as :

- SIMBAD &VizieR, to retrieve respectively the position informations of the star and its stellar parameters

- TBLegacy, to retrieve - with the position informations obtained from the request addressed to SIMBAD- a list of observations of the star, collected with the Narval spectropolarimeter (Fig. 2)

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[1] LUPM, Université de Montpellier and CNRS, Place E. Bataillon, 34090 Montpellier, France
[2] UPS-OMP, Université de Toulouse and CNRS, 57, Ave. d'Azereix, 65 000 Tarbes, France

- POLLUX, to retrieve - with the stellar parameters obtained from the request addressed to VizieR - a list of synthetic spectra the parameters of which best comply with those of the actual star as returned by VizieR.

Then, onto a limited portion (10 nm large) of a synthetic spectrum selected among the proposed POLLUX spectra, VOSPECFLOW allows the user to perform - *on the fly* - up to three successive convolutions so as to mimic the instrumental profile, macroturbulent and rotational effects (Fig. 3). This aims at transforming the synthetic spectrum into an optimized simulation of an observation. To take into account the stellar properties, macroturbulence and surface rotation effects can be introduced respectively with a radial-tangent profile and with a rotational profile, the width of these functions being macroturbulent veocity and vsini, respectively. Then, the instrumental profile can be applied through a gaussian function with a fixed full width half maximum. The result of these operations as well as the initial spectra retrieved from TBLegacy or POLLUX can be visualized within a dedicated graphic interface (Fig. 4), these data being temporarily stored in a VOSPECFLOW space.
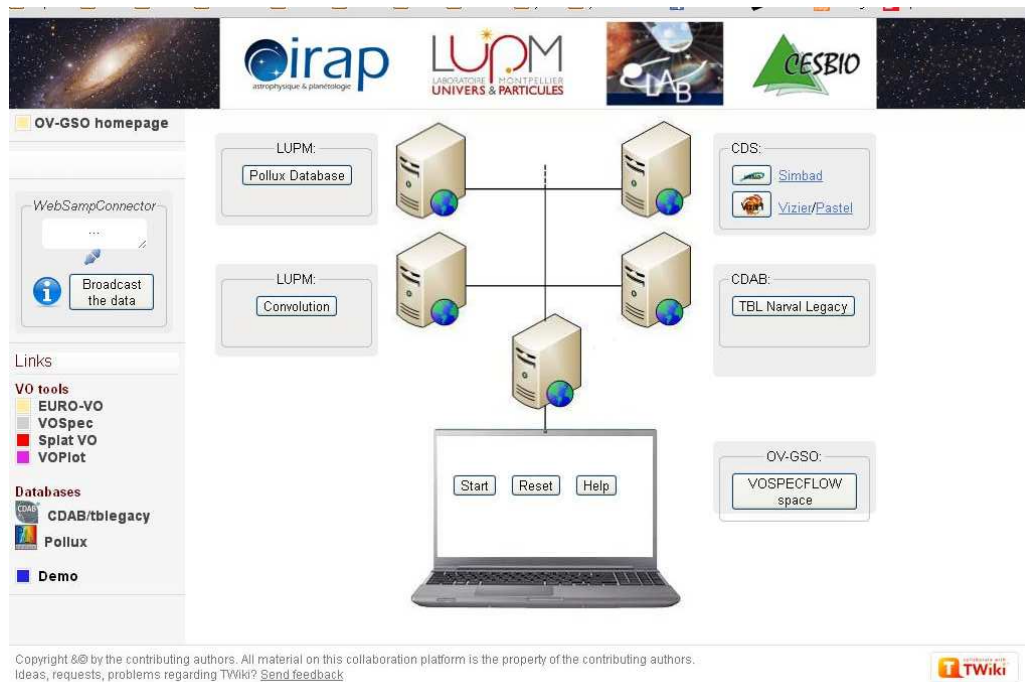

Fig. 1. VOSPECFLOW global view. In the central panel, the different remoted services are indicated (SIMBAD and VizieR at CDS ; TBLegacy at CDAB ; POLLUX at LUPM). The SAMP connexion to VO tools (such as VOspec) is located on the right side and allows broadcast (to other V.O. services / tools) of data temporarily stored in the space VOSPECFLOW at OV-GSO

3   VOSPECFLOW and other V.O. tools

On the left side of VOSPECFLOW main page, a WebSAMPConnector is present (see Fig. 1). When connected, this client toolkit enables our VOSPECFLOW service to interoperate and communicate with VO softwares and to perform, for example, data transfer. At that stage, into any V.O. tool, such as VOSpec, it is thus possible to broadcast any of the data that the user has been storing in the VOSPECFLOW space, such as the portion of synthetic spectrum resulting from convolution operations. Then the visualization and further spectral analysis can be performed directly through the selected V.O. tool (Fig. 5).

4   Conclusions

The application VOSPECFLOW mainly offers facilities like access to data, transformation of a high resolution synthetic spectrum into an optimized simulation of observation, *quicklook* graphic display. However in its present
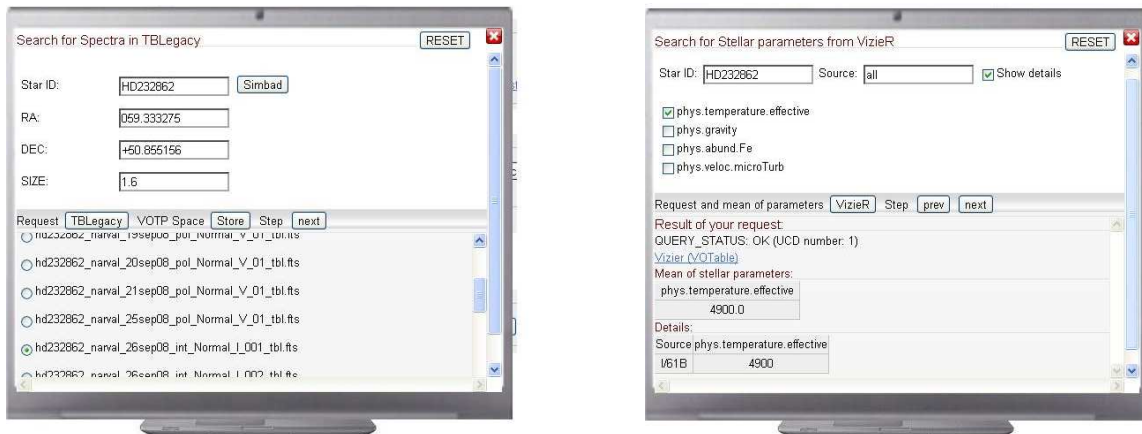
Fig. 2. Left: Request to SIMBAD, to retrieve position informations : RA and DEC. From them, request to TBLegacy to retrieve observations of HD 232 862. **Right:** Request to VizieR, to retrieve stellar parameters from various catalogs.
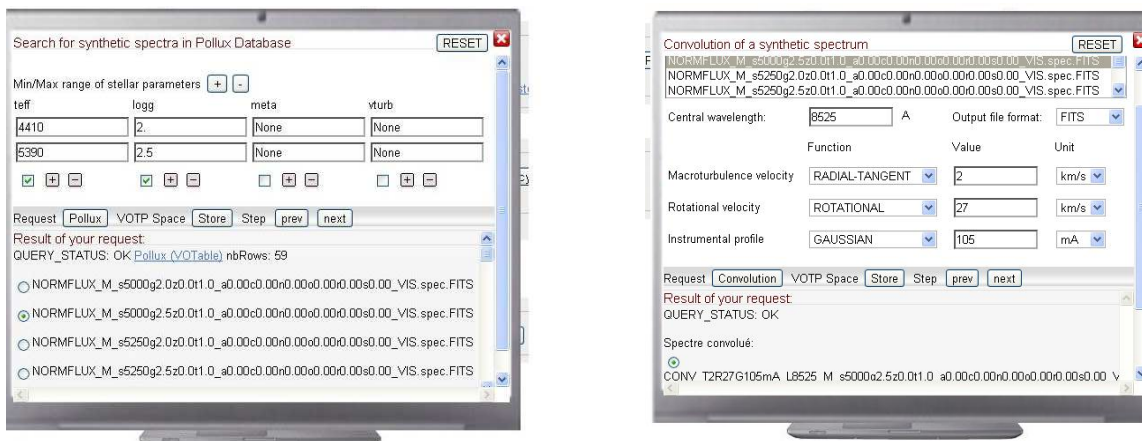

Fig. 3. Left: From stellar parameters retrieved from VizieR, request to POLLUX, to retrieve synthetic spectra with nearest values for parameters (Teff, log g, [Fe/H]). **Right:** Convolution operations applied to a theoretical POLLUX spectrum so as to turn it into an optimized simulation of an observation.
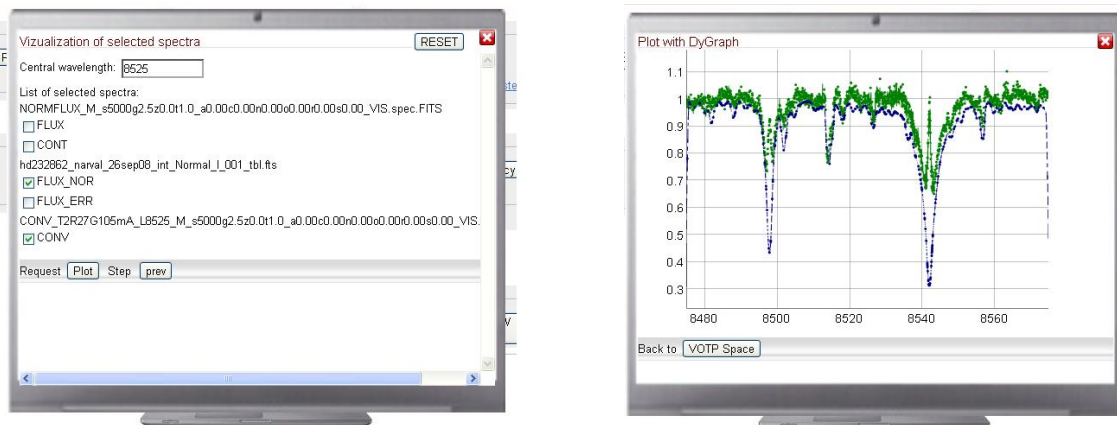

Fig. 4. Left: Selection of (portion of) spectra to be visualized. **Right:** Convolution operations applied to a theoretical POLLUX spectrum so as to turn it into an optimized simulation of an observation.

form, this tool should be used with caution. In particular, it is not designed to produce scientific results such as determination of precise stellar parameters or measurement of chemical abundances. Only diagnostics onto stellar parameters (i.e., determination of a range of values) or qualitative information onto the presence/absence of any element into a stellar atmosphere can be inferred from the use of VOSPECFLOW that is mainly designed to help the user well upstream of a more complete and classical analysis of the spectra.

The first version of VOSPECFLOW presented here relies only on the TBLegacy archive and on the POLLUX database, being respectively observational and theoretical data providing V.O. services. Its extension toward other V.O. services, such as other telescope's archives or computed spectra distributed from V.O. compliant databases is foreseen.

VOSPECFLOW will be opened to the community at the beginning of the year 2013, and the information of its url will be spread through SF2A communication channel. Besides, the module allowing convolution operations onto a synthetic spectrum will be implemented in the POLLUX website before the end of 2012.

References

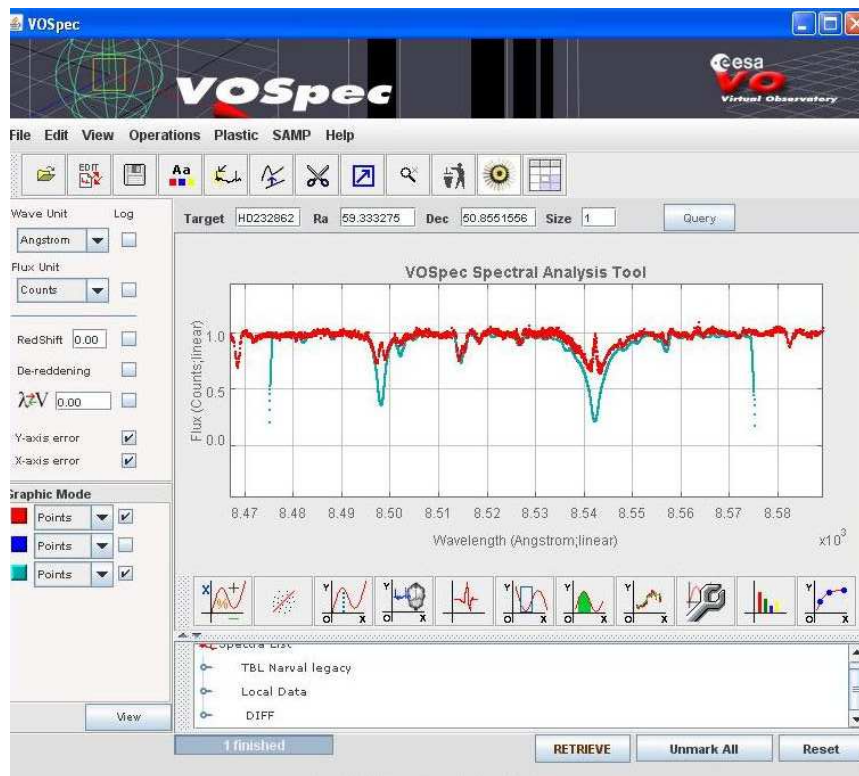Palacios, A., Gebran, M., Josselin, E., et al. 2010, A&A 516, A13

Fig. 5. Final visualization through VOSpec, using the broadcast data through the SAMP protocol.