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1 AIM

POLLUX is a database of stellar spectra developed at the Laboratoire Univers et Particules de Montpellier (LUPM - University of Montpellier - CNRS). Its aim is to provide a comprehensive library of theoretical stellar spectra with a broad coverage of the atmospheric parameters (effective temperature $T_{\text{eff}}$, gravity $\log g$ and metallicity $[\text{Fe/H}]$) as well as spectral types across the Hertzsprung-Russell Diagram.

Since its 6th release, and due to the large imbalance in number and the inconsistency in genre, the POLLUX database collects and presents synthetic spectra computed at high resolution (SSHR data) exclusively. The re-introduction of spectral energy distributions (SED data) will be considered in the future. The SSHR are available for spectral types from O to M and for several metallicities.

POLLUX spectra are expected to be useful to astrophysicists for stellar or galactic applications in several respects:

- abundance determinations
- accurate determination of fundamental properties of stars
- multiwavelength coverage
- test for the current state-of-the-art model atmospheres
- stellar populations synthesis,
- as well as for teaching purposes oriented toward spectroscopy, model atmospheres, etc...

In its 9th version available as of July 2018, POLLUX is made available on-line to the community via a web page (http://pollux.oreme.org) regrouping a documentation, a retrieval interface for the data and an on-line graphic display tool. The web interface allows the convolution of portions of the spectra in the database via the SPECONVOL VO-service (ivo://ov-gso/ssap/speconvol), thus allowing the user to simulate an observation. The data can be retrieved in formats compliant to the Virtual Observatory standards (namely FITS and XML VOTable). The POLLUX database can also be accessed via the VizieR service at Centre de Données de Strasbourg (CDS). It is a registered service of the VO ivo://ov-gso/ssap/pollux.

2 SOURCES FOR THE THEORETICAL DATA

As of July 2018, the database gathers 16803 high resolution synthetic spectra associated to spectral types O to M and to Wolf-Rayet stars.

The high resolution synthetic spectra (hereafter SSHR) are direct products of the best available 1-D models of stellar atmospheres:
• The CMFGEN code (Hillier & Miller, 1998) is used to generate model atmospheres for O, B and Wolf-Rayet stars. Detailed information on this code can be found at the following URL: http://kookaburra.phyast.pitt.edu/hillier/web/CMFGEN.htm

• The MARCS code (Gustafsson et al. 1975, 2003, 2008; Plez et al. 1992) is used for A and F type stars in the range 6000 K to 8000 K, for G-type and cooler stars. Detailed information on this code can be found at the following URL: http://www.marcs.astro.uu.se/

• The ATLAS12 code (Kurucz 2005) is used to generate model atmospheres for A and F stars. Detailed information on this code can be found at the following URL: http://wwwuser.oats.inaf.it/castelli/sources/atlas12.html

Geometric effects are taken into account according to the spectral type and gravity, and the SSHR available in the database are derived from both spherical and plane-parallel models accordingly. The SSHR data sets are derived from the model atmospheres using CMF−FLUX (Hillier & Miller, 1998) and TURBOSPECTRUM (Alvarez & Plez, 1998) spectral synthesis codes for CMFGEN and MARCS models respectively.

The SSHR data sets derived from the ATLAS model atmospheres included in the database since the sixth release are generated using the version SYNSPEC48 of the SYNSPEC code (Hubeny & Lanz 1988-2012).

For the spectra derived from the MARCS model atmospheres with log g < 1 dex and Teff < 5000 K, the atomic linelists are taken from the VALD database (Kupka et al. 2000), and they are complemented by specific molecular linelists (Plez, private communication) for cool stars. For the spectra derived from the MARCS model atmospheres with Teff > 5000 K, computed by P. de Laverny within the framework of the AMBRE project (de Laverny et al. 2012), the atomic linelists are taken from the Opacity Project database (Badnell et al. 2005, Seaton 2005 and references therein), and are complemented by specific molecular linelists. For the spectra derived from the CMFGEN model atmospheres, the atomic linelists are mainly taken from the Opacity Project database (Badnell et al. 2005, Seaton 2005 and references therein), and are occasionally complemented by specific linelists.

The linelists used for the high resolution synthetic spectra generated on basis of the ATLAS model atmospheres are the same as those used for the coolest MARCS models (VALD + Plez private communication).

In the 9th version, a new class of spectra is added to the database. These are based on 3D Radiative HydroDynamic simulations of stellar atmospheres performed with the STAGGER code (Magic et al. 2013). These spectra are computed with the OPTIM3D code and result from a disk integration and a temporal average (Chiavassa et al. 2018). These spectra assume zero microturbulence, as this parameter is no
longer needed in 3D RHD simulations, in which velocity fields are self-consistently accounted for. They are available through two collections (see below): medium resolution spectra (constant resolving power of $\lambda/\Delta \lambda = 20\,000$) over a very large spectral range, from 2000 Å to 200 000 Å, and high resolution spectra (constant resolving power of $\lambda/\Delta \lambda = 300\,000$) over the narrow spectral range of the Gaia-RVS, from 8395 to 8905 Å.

- The STAGGER code (Nordlund et al. 2009) is used to generate model atmospheres for F,G and K stars (Magic et al. 2013).

The OPTIM3D spectra use the same molecular and atomic linelists as the last version of the MARCS model atmospheres (see Gustafsson et al. 2008 and Chiavassa et al. 2018).

Useful details on the specific physical parameters used for the calculation of both the model atmospheres and the synthetic spectra data sets are given in an associated ASCII header file (see below). Two new features in the present 9th release of the database are the addition of a specification flag and the introduction of the concept of collection (see §3.1 below). Grids of synthetic spectra are computed so as to give a substantial coverage of the colour-magnitude diagram in terms of effective temperature, gravity, metallicity and chemical composition ($[\alpha/\text{Fe}]$ and CNO nuclei). The coverage provided in the present (nineth) release of the database is described below.

### 3 THE POLLUX DATABASE

The high resolution synthetic spectra (SSHR) are computed from 3000 Å to 12000 Å at high spectral resolution. For the spectra derived from CMFGEN model atmospheres, the resolution is $R = 150\,000$. For those derived from MARCS or ATLAS model atmospheres, the resolution varies within the spectral domain considered, and it is characterised by a constant step in wavelength $\delta \lambda = 0.02$ Å, leading to $R \geq 150\,000$ for these data sets.

Both absolute fluxes and fluxes normalised to the continuum are available.

The typical size of an uncompressed S SHR ASCII file is 5.7 MB (CMFGEN), 15.4 MB (MARCS) or 14 MB (ATLAS).

The new medium resolution synthetic spectra based on 3D RHD simulations are computed from 2000 Å to 120 000 Å with a constant resolving power $R = 30\,000$. Thus for the first time spectra are available not only for the visible domain but also for the infrared and UV spectral domains. The web interface has been modified accordingly as will be explained in §4.

The high resolution OPTIM3D spectra are computed from 8395 Å to 8905 Å with a constant resolving power $R = 300\,000$.

As for the 1D models, the all OPTIM3D spectra (both medium and high resolution) provide both the absolute and the normalised fluxes as a function of wavelength.

The typical size of the three uncompressed medium resolution OPTIM3D ASCII files is 3.3 MB for the entire spectral range, split into 3 files: 2 MB for the infrared part, 1 MB for the visible part and 300 kB.
A header file is attached to each data set. It contains a set of descriptors characterising stellar spectra which are independent of whether the data is observed or synthetic (file structure and curation\(^1\) information). Also included in the header is specific information on the synthetic data (code, input physics, physical parameters characterising the spectrum, ...). This header file constitutes a comprehensive Data Model of the data present in the POLLUX database.

Since the third release, the SSHR files (data + header) may be retrieved in the VO compliant formats XML VOTable, XML binary VOTable and FITS (see below). These versions of the data have been generated via the TOPCAT VO tool (http://www.starlink.ac.uk/topcat/).

As an indication, each uncompressed FITS file has a typical size of 3.4 MB (SSHR) for CMFGEN files, 7.0 MB (SSHR) for ATLAS12 files and 7.0 MB (SSHR) for MARCS files.

3.1 Present status (as of July 2018)

In the 9\(^{th}\) POLLUX data release (July 2018),

- the newly available OPTIM3D datasets contain all the spectra presented in Chiavassa et al. (2018).
  They have been computed based on the STAGGER grid of 3D-RHD model atmospheres.

- the medium resolution OPTIM3D spectra are available for 7 different metallicities (\([\text{Fe/H}] = 0.5, 0, -0.5, -1.0, -2.0, -3.0, -4.0 \text{ dex}\)), following the STAGGER grid of model atmospheres. \(\alpha\)-elements are enhanced for subsolar metallicities with \([\alpha/\text{Fe}] = +0.2 \text{ dex for } [\text{Fe/H}] = -0.5 \text{ dex and } [\alpha/\text{Fe}] = +0.2 \text{ dex for lower values of } [\text{Fe/H}]\).

- the high resolution OPTIM3D spectra, computed for the Gaia-RVS spectral domain, are available for 5 different metallicities (\([\text{Fe/H}] = 0.5, 0, -0.5, -1.0, -2.0 \text{ dex}\)), following the STAGGER grid of model atmospheres. \(\alpha\)-elements are enhanced for subsolar metallicities with \([\alpha/\text{Fe}] = +0.2 \text{ dex for } [\text{Fe/H}] = -0.5 \text{ dex and } [\alpha/\text{Fe}] = +0.2 \text{ dex for lower values of } [\text{Fe/H}]\).

The coverage of the colour-magnitude diagram in terms of effective temperature and gravity, provided by the MARCS/TURBOSPECTRUM, ATLAS/SYNSPEC, CMFGEN/CMF−FLUX and STAGGER/OPTIM3D synthetic spectra is shown in Figs. 1 to 3.

The POLLUX database includes solar metallicity data for O to M type stars. Spectra are available in the metallicity range \(-1.0 \text{ dex} \leq [\text{Fe/H}] \leq 1.0 \text{ dex} for A to K type stars with a step of 0.5 dex (for A to F ATLAS12 models) or 0.25 dex (for MARCS models). Spectra at very low metallicity ([Fe/H] = -1.5, -2.0, -2.5, -3.0, -4.0 and -5.0 dex) are available in the spectral type range A to K (MARCS/Turbospectrum models and OPTIM3D models).

Concerning cool and hot stars, 1D SSHR with non-solar C,N,O abundances are also provided.

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\(^{1}\)Curation includes all information concerning the data sets that ensures they are available for discovery and re-use in the future. Number version of the code, data producer, date of production are part of the curation information.
Figure 1: Top: Coverage of the ($T_{\text{eff}}$ - log g) plane by the SSHR associated with CMFGEN (blue and cyan triangles), ATLAS (green dots) and MARCS (red and magenta squares) model atmospheres as of January 2018 for solar metallicity. Superimposed are standard stellar evolution tracks from Schaller et al. (1992). Center: 3-D rendering of the 8th release of the database in the ($T_{\text{eff}}$, log g, [Fe/H]) space. This concerns the High Resolution Synthetic Spectra based on 1-D model atmospheres. Bottom: 3-D rendering for the coverage of the ($T_{\text{eff}}$, log g, [Fe/H]) space by the OPTIM3D spectra based on 3D RHD model atmospheres, and newly available in the 9th release of the database.
Figure 2: Coverage of the \((T_{\text{eff}} - L)\) plane by the SSHR associated with CMFGEN model atmospheres Wolf-Rayet stars as of March 2011. The overplotted tracks are stellar evolution models including rotation from Meynet & Maeder (2003) for different initial masses as labelled (dotted lines for \(M_{\text{ini}} = 85 \, M_{\odot}\), solid lines for \(M_{\text{ini}} = 60 \, M_{\odot}\), dot-dashed lines for \(M_{\text{ini}} = 40 \, M_{\odot}\) and dashed lines for \(M_{\text{ini}} = 25 \, M_{\odot}\)).
Figure 3: Coverage of the ([Fe/H] - [$\alpha$/Fe]) plane by the SSHR associated with MARCS model atmospheres for stars with $T_{\text{eff}} \geq 5000$ K in the 8th release. The red triangles correspond to data flagged with pertinence 1, the black squares to data flagged with pertinence 2 (see text).
A new tag is added to each spectrum, that replaces the pertinence keyword introduced in the 7th version of the database. It allows to describe the detailed specifications of the spectrum that are not clearly seen from the header file, and gives an appreciation of the pertinence. This tag, named "specs", appears in the form of a 8 digit number to be read as follows:

1st digit →  Indicates whether winds have been taken into account for the model atmosphere computation.  
Possible values:
0 = No  
1 = Yes  
9 = Irrelevant

2nd digit →  Indicates whether the chemical composition used for the model atmosphere computation (code1) and for the synthetic spectrum (code2) is identical.  
Possible values:
0 = No  
1 = Yes  
9 = Irrelevant

3rd digit →  Indicates whether clouds have been taken into account for the model atmosphere computation.  
Possible values:
0 = No  
1 = Yes  
9 = Irrelevant

4th digit →  Narrow spectral domain.  
Possible values:
0 = No  
1 = Yes  
9 = Irrelevant

5th digit →  Undefined. Default value = 0

6th digit →  Undefined. Default value = 0

7th digit →  Undefined. Default value = 0

8th digit →  Indicates whether the spectrum should be used under certain restrictions or not.  
Possible values:
1 = All applications
In the case of the present 9th release, the new OPTIM3D SSHR from the Gaia-RVS project, are available only for a narrow portion of the visible domain, and are flagged with pertinence = 2. Some MARCS SSHR from the AMBRE project have inconsistent $[\alpha/Fe]$ valued between the model atmospheres and the synthetic spectra (see de Laverny et al. 2012 for details), and are flagged with pertinence = 2. They are represented as black squares in the Fig 3.

4 HOW TO USE

The POLLUX database is accessible via the URL: http://pollux.oreme.org.

In the 9th release, the interface was already modified to include the Specs keyword and the Collection flag. These changes are described in detail below.

The web page and the database have been elaborated using Plone and Python languages. The web page is designed to be user friendly, and to allow inexperienced users to easily access, visualise and retrieve the data.

The homepage contains a link labelled Access to the Pollux Database that leads to a query page.

4.1 Query Interface - First Page

In this first query page, a first area on the left labelled General Parameters Information contains a query tree allowing to make requests according to:

- the Model Atmosphere the data are based on (1-D MARCS-AMBRE, MARCS-RSG, CMFGEN, CMFGEN-WR, ATLAS or all, and 3-D OPTIM3D-STAGGER, OPTIM3D-RVS or all)
- the Type of Model Atmosphere (plane-parallel, spherical or both for 1-D models, and 3D-RHD for 3-D models).

This first query is hierarchical. The default query concerns all 1-D SSHR excluding Wolf-Rayet data and is shown in Figure 4.

Once the choice of the Data has been made, the user must specify the Spectral Domain. The default is VIS since it is the only domain covered by the 1-D based SSHR. For the 3D OPTIM3D spectra, UV, VIS anr IR are selected by default, and the user may uncheck 3 of these 3 boxes according to the spectral domain he/she is interested in.

The user must specify the Spectrum Parameters. The data type that has been selected via the query tree is recalled on top of the central query block. The possible query depends on the Model Atmosphere Family that has been chosen:

- effective temperature
Figure 4: Pollux General Query Interface.
Figure 5: Pollux Specific Query Interface for Wolf-Rayet Data.
- log g
- mass (irrelevant for data derived from plane-parallel model atmospheres)
- luminosity (irrelevant for data derived from plane-parallel model atmospheres)
- microturbulent velocity
- metallicity [Fe/H]

When selecting the CMFGEN-WR option on the query tree, a specific query form will appear (as shown in Figure 5) in which the parameters that can be queried are different:

- temperature at optical depth $\tau = 20 T^*$
- luminosity
- micro-turbulent velocity
- hydrogen mass fraction $X$
- helium mass fraction $Y$
- metallicity [Fe/H]

The user must either choose an interval or choose an exact value for at least one of the Spectrum Parameters. If the exact value requested is not available in the database, an error message will be returned.

A second optional query block is also available, which enables the user to choose data sets with Specific Abundances. The set of searchable abundances depends on the data queried. For ATLAS, CMFGEN and MARCS, queries can be made on Carbon, Nitrogen, Oxygen, $\alpha$, $r$- and $s$- elements in terms of [X/Fe]. For CMFGEN-WR data, the searchable abundances are Carbon, Nitrogen and Oxygen in terms of mass fractions $X_C$, $X_N$ and $X_O$. For the OPTIM3D data, the searchable abundances are $\alpha$ elements in terms of [X/Fe].

A final block indicates the Cart Status, and allows to empty the cart.

Once the mandatory fields have been specified, the user may retrieve the result of his/her request by clicking on the Search button.

In the case that the user clicks on Search immediately as he/she enters this first query page, the result would be the listing of all the entries in the database.

### 4.2 Result of Request - Second Page

The result of the request consists of a table (dispatched on several pages if needed) containing 4 main parts: Convolution, Display, Data Characteristics and Cart.
4.2.1 Convolution and Display

Columns are ordered as follows:

1. Tick boxes to select up to five spectra to be convolved when clicking on the "convolution" button placed above the table, left to the "new search" button. A red checked box at the bottom of this column allows to uncheck all previously selected items;

2. Tick boxes to select up to three spectra to be overplotted (raw or normalised to the continuum) on the same graph when clicking on the icon in the header of the column. A red checked box at the bottom of this column allows to uncheck all previously selected items;

3. Clickable icon allowing the graphical display of the individual spectrum in a pop-up window;

Figure 6: Pollux Result of Request for O to M type stars models.
4. Clickable icon allowing the graphical display of the individual spectrum normalised to the continuum if relevant in a pop-up window;

5. Clickable icon allowing the display of the ASCII header file in a pop-up window.

The graphical tool that allows the visualisation of the spectra integrates a pointer and different zoom facilities. Instructions for use are displayed in the lower part of the pop-up window. An animated help opening as a pop-up window when clicking on the i sign also shows how to use the tool. The image displayed in this window can be saved in a png format.

4.2.2 General Data Characteristics

Columns 5 to 21 of the table present the data characteristics

5. Specs (Specifications of the SSHR, see § 3.1)

6. SpecRange (Spectral domain, UV : 200 nm to 300 nm; VIS 300nm to 1200 nm; IR 1200 nm to 20000 nm)

7. Collection (subset to which the SSHR belongs. See below)

8. Model (atmosphere family)

9. Type (of model atmosphere)
10. $T_{\text{eff}}$
11. log g
12. $M / M_\odot$
13. log $L / L_\odot$

14. micro-turbulent velocity
15. [Fe/H]
16. [$\alpha$-elements/H]
17. [C/H]
18. [O/H]
19. [N/H]
20. [$r$-elements/H]
21. [$s$-elements/H]

Clicking on the label of these columns will sort the data in the table in decreasing or increasing values of the selected parameter.

As of the 9th release, the notion of Collection is introduced. This allows the user to select clearly identified subsets of spectra. All but the ATLAS models may be classified into collections:

- **AMBRE** corresponds to the SSHR based on 1-D MARCS model atmospheres computed within the AMBRE project (de Laverny et al. 2012),
- **RSG** corresponds to the SSHR based on 1-D MARCS model atmospheres representing the spectra of Red SuperGiant stars,
- **WR** corresponds to the SSHR based on 1-D CMFGEN model atmospheres representing Wolf-Rayet stars,
- **STAGGER** corresponds to the SSHR computed based on the STAGGER grid of 3D RHD model atmospheres, available at medium resolution in the UV, VIS and IR spectral domains (Chiavassa et al. 2018),
- **RVS** corresponds to the SSHR computed based on the STAGGER grid of 3D RHD model atmospheres, available at high resolution in the restricted spectral domain of the Gaia-RVS instrument (Chiavassa et al. 2018).
4.2.3 Data Characteristics for Wolf-Rayet data

Columns 5 to 18 of the table present the data characteristics

5. **Specs** (Specificities of the SSHR)
6. **SpecRange** (Spectral domain)
7. **Collection** (subset to which the SSHR belongs)
8. **Model** (atmosphere family)
9. **Type** (of model atmosphere)
10. $T^*$
11. $\log L/L_\odot$
12. micro-turbulent velocity
13. $X$
14. $T$
15. [Fe/H]
16. $X_C$ (carbon mass fraction)
17. $X_O$ (oxygen mass fraction)
18. $X_N$ (nitrogen mass fraction)

Clicking on the label of these columns will sort the data in the table in decreasing or increasing values of the selected parameter.

4.2.4 Cart

The last two columns of the table allow

- to directly download a **gzipped tar archive** `name_of_file.flat.tgz` containing the pair spectrum + associated header in Flat Table ASCII format
- to select various rows and fill a cart with the data that the user wishes to download.

The nomenclature used for the file names is as shown in Fig. 8 and 9.

The last row of the table allows on the left to uncheck the selected spectra for overplot by clicking on the **red cross** on the left, to proceed to the retrieval page by clicking on the **View Cart** icon, or to uncheck the selected spectra for retrieval by clicking on the **Empty Cart** icon on the right. It
also indicates the number of selected spectra with respect to the total number of spectra associated to the query.

Figure 8: Name nomenclature for the CMFGEN (upper line), MARCS or ATLAS (central line) and OPTIM3D (lower line) files. The spectra will be given the extension .spec and the associated headers will have .spec.txt.
4.3 Convolution - Third Page

This page is loaded and includes the convolution parameters for all the spectra (up to five) that have been selected for convolution on the Result of Query page.

The interface provided here, and shown in Figure 8 allows the query of the SPECFLOW VO service based on a Fortran code that implements a number of convolution functions used to model the instrumental profile, the macroturbulence and the rotational broadening of spectral lines.

The user can choose to include one to three of the following convolution parameters:

- The convolution service: SPECONVOL (labelled OV-GSO (LUPM)) is the only spectral convolution service registered in the VO registry, and is as such the only choice available as of now;
- Macroturbulence velocity can be specified in km.s\(^{-1}\). It is modeled by a radial tangential anisotropic profile as described in Gray (2005, pp 433), and describes the lines broadening due to convection;
- Rotational velocity of the star can be specified in km.s\(^{-1}\). It is modeled by a ”rotation” profile as described in Gray (2005, pp 434-436), and describes the lines broadening due stellar rotation;
- The simulated signature of an instrumental profile can be specified in m\(\AA\) (default unit) or in km.s\(^{-1}\). It is modeled by a gaussian profile and describes the line broadening due to the instrumental design.
The convolution parameters are applied to a spectral window centered at a chosen central wavelength that can be specified in units Å, and of limited width to be chosen between 100 Å and 500 Å.

The convolved portion of spectra can also be translated according to the radial velocity that can be specified in units of km.s⁻¹.

These parameters are sent to the SPECONVOL service when clicking on the apply button and the user is redirected after a short time to the next page which is similar to the Result of Request page but now includes the initially selected spectra and the associated convolved portions.

The original spectrum and the convolved portion can be overplotted using the graphical tool within the interface as illustrated in Figure 11.

The selection of the spectra to be added to the cart is done by clicking on the last column (see previous section).

Figure 10: Interface to the SPECONV convolution service.
4.4 Cart and Retrieval - Third or Fourth (if convolution) Page

The last page is a table listing the data stored in the cart. It is shown here on Figure 12.

On the left, a tree allows to obtain information on the different retrieval formats available and to choose a format. The archive can either be a tar file or a zip file. By default, the retrieval format is a tgz zipped tar archive containing the spectra in Flat Table format and the header file in ASCII format.

The available formats are:

1. Flat Table: the spectrum and the header are provided in two distinct ASCII files;
2. XML VOTable: the header and the spectrum data are provided in the same single ASCII file in pure XML format;
3. XML Binary VOTable: the header file is written in pure XML format at the beginning of the file. The spectrum is provided in the form of a votable-binary-inline binary element containing base64-encoded data following the XML header;
4. FITS: the fits file is written consisting of two HDUs (Header + Data Units): a primary one (required by the FITS standard), and a single extension of type BINTABLE containing the table data.

Files in format XML VOTable, XML Binary VOTable and FITS have been generated using the GNU-GPL TOPCAT tool http://www.starlink.ac.uk/topcat/.
The main table of the retrieval page contains the list of the selected data. In the head of this table, the **File Format** and **File Type** are recalled. Buttons **download** and **go back to previous form** are also located in this region.

Below, the columns are ordered as follows:

1. select or unselect the file which will actually be included in the archive to be downloaded.
2. icon to remove the data set from the cart.
3. file name (as explicitly described in Figure 6).
4. type of data (High Resolution Synthetic Spectrum) with a suffix specific for the selected format.
5. size of the compressed archive file that will be retrieved.

At the end of the table, the total size of the archive is given.

### 5 VO COMPLIANT DATABASE

The data provided in the POLLUX database have been made compliant to the Virtual Observatory standards. POLLUX is accessible via the Simple Spectra Access Protocol Version 1.04, the.
This means in particular that all the relevant characteristics of the data appearing in the query forms described above have an associated UCD+1 (Unified Content Descriptors, Version 1+, see http://www.ivoa.net/Documents/latest/UCD.html) that allows for interoperability within the VO.

The POLLUX database is registered in the NVO registry as a service providing theoretical spectra. The query to the registry allows POLLUX data to be visible through VO tools such as VOSpec (http://esavo.esa.int/vospec/) and Aladin (http://aladin.u-strasbg.fr/).

Since the 7th release, POLLUX can be used through the VO within the framework of Science Cases. In particular, we have developed the science case SPECFLOW (http://bass2000.bagn.obs-mip.fr/vospecflow/index.php) that combines interrogation of Vizier and Simbad CDS services, the observational databases TBLegacy and Polarbase, the POLLUX database and the spectral convolution service SPECONVOL registered in the VO (ivo://ov-gso/ssap/speconvol) and included in the POLLUX web interface as described above.

6 FUTURE DEVELOPMENTS

6.1 Additional data at low metallicities

The archive will be completed with more data sets derived from ATLAS12 model atmospheres at lower metallicity ([Fe/H] = -0.5).

Additional data with non-solar CNO abundances will also be made available for cool stars.

6.2 Additional data related to B-type

We have started a discussion with the providers of TLUSTY spectra (http://nova.astro.umd.edu/) to add in the POLLUX database the files provided in their webpage in order to increase the coverage of the log $g$, $T_{\text{eff}}$ plane in the B- and O-type domain. Their incorporation into the database will constitute a new release in the near future.

6.3 Additional data from PHOENIX model atmospheres

The PHOENIX high-resolution spectra computed by F. Allard @ CRAL-Lyon (France; Allard et al. 2012) will be available in the next release of the POLLUX database. These data, computed with the PHOENIX code, include a state-of-the-art treatment of the molecules and dust in cool stellar atmospheres, and will be available for the UV and the IR in addition to the visible domain.

6.4 Extension of the database to IR

Considering the new generation of spectrographs that are being built, a new effort to provide theoretical data in the IR domain should be done and we are working on this aspect in order to be able to provide the community with well described ans VO-compliant IR high resolution synthetic spectra.
6.5 (Re-)Introduction of SEDs

The introduction of spectral energy distributions (SED data) will be considered in the future.

7 CREDITS

The POLLUX database is described at length as of its third release, in a Palacios et al. (2010). When using POLLUX data for scientific publication, please quote:


and mention the following sentence:

This research was achieved using the POLLUX database (http://pollux.oreme.org/), operated at LUPM (Université de Montpellier - CNRS, France) with the support of the PNPS and INSU.

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