VOSED: A TOOL FOR THE CHARACTERIZATION OF PROTOPLANETARY DISKS

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ABSTRACT

Theoretical modelling of Spectral Energy Distributions (SEDs) has proved to constitute an invaluable tool for understanding the structure and properties of protoplanetary disks. However, SEDs building requires accessing to a variety of astronomical services providing, in most of the cases, heterogeneous information. Moreover, model fitting demands a tremendous amount of work and time which makes it very inefficient even for modest datasets.

In the framework of the Spanish Virtual Observatory we have developed VOSED[1], a tool that permits to characterize the protoplanetary disks around young stars taking advantage of VO standards and tools. The application allows the user to gather photometric and spectroscopic information, trace the SED, and fit the photospheric and disk contributions following a Bayesian approach.

In this paper the functionalities of VOSED are presented.

Key words: Virtual Observatory; methods: SED fitting.

1. WORKFLOW

We describe here the procedure to perform the fitting of a Spectral Energy Distribution using VOSED. The whole process takes about 2 minutes. A similar work performed manually took several days.

1.1. Input Form

Three main blocks can be distinguished in the VOSED input form:

[1]`http://sdc.laeff.inta.es/vosed`

- Search parameters: the search may be driven by object name or coordinates (given in sexagesimal or decimal degrees).
- Data services: All the SSAP[2] services available from the VO registries are shown for selection. The system also offers the possibility of retrieving photometric information from Vizier[3] catalogues.
- User data: In addition or as an alternative to the data provided by the astronomical services, the user can upload his/her own dataset in FITS, VOTable or ASCII format.

1.2. Data Gathering

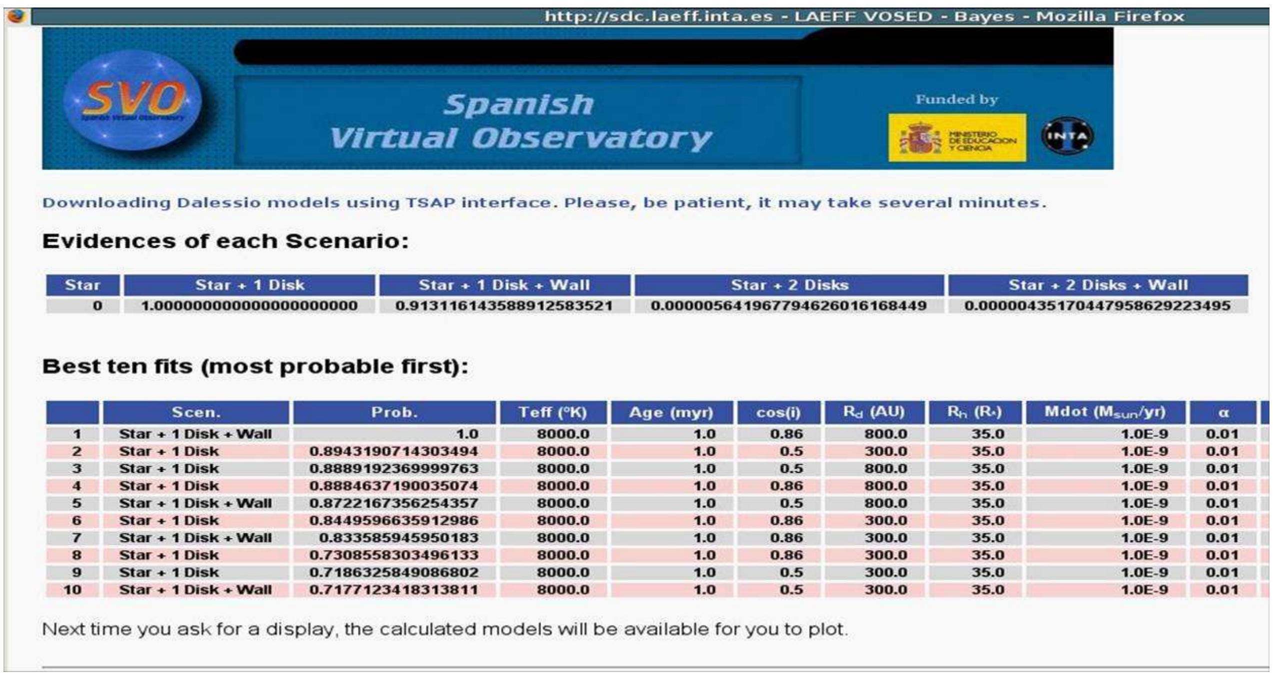
Once the query is submitted, VOSED gathers all the available information and displays the results. If the search has been driven by object name, VOSED queries SIMBAD[4] and shows general information about the object, such as coordinates, type and equivalent names. Below this, a table summarizing the number of products found in the different services is shown. Also, for stellar objects, the system provides information about the fundamental physical parameters (effective temperature, surface gravity, metallicity and E(B-V)), information that, if not provided by the user, is computed automatically from the Strömgren and/or 2MASS photometry. If E(B-V) is known, the observed spectral energy distribution is automatically dereddened.

Finally, a detailed list with the spectra and catalogue sources that match the search criteria is shown. The system allows the user to select the spectra and the flux calibrated photometric values that will form the SED, plot or download them and/or launch the model fitting tool.

[2]`http://ivoa.net/Documents/latest/SSA.html`
[3]`http://vizier.u-strasbg.fr/viz-bin/VizieR`
[4]`http://simbad.u-strasbg.fr/simbad/`

1.3. The fitting approach: Bayesian Analysis

If the model fitting option has been enabled, VOSED retrieves the synthetic spectra from the SVO Theoretical Model web server using the TSAP protocol[5]. The Bayesian approach implemented in the system allows to quantitatively analyse the data in terms of the evidence of models of different complexity (up to four different scenarios have been considered: no disk, single disk, truncated disk and truncated and not-truncated disk with two sets of grains of different size distribution). Once the fitting process is finished, the results are shown in two blocks. In the first of them, the total evidences of each scenario are presented whereas in a second block the ten models that best fit (regardless the scenario) are displayed ranked by probability (Figure 1). At this stage, the user has the possibility of downloading the models or overplotting them to the observational SED.


http://sdc.laeff.inta.es - LAEFF VOSED - Bayes - Mozilla Firefox

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Downloading Dalessio models using TSAP interface. Please, be patient, it may take several minutes.

Evidences of each Scenario:

Star	Star + 1 Disk	Star + 1 Disk + Wall	Star + 2 Disks	Star + 2 Disks + Wall
0	1.0000000000000000000000	0.913116143588912583521	0.00000564196779462601616849	0.0000043517044795862922349 5

Best ten fits (most probable first):

	Scen.	Prob.	Teff (°K)	Age (myr)	cos(i)	R_d (AU)	R_h (R_*)	Mdot (M_{sun}/yr)	α
1	Star + 1 Disk + Wall	1.0	8000.0	1.0	0.86	800.0	35.0	1.0E-9	0.01
2	Star + 1 Disk	0.8943190714303494	8000.0	1.0	0.5	300.0	35.0	1.0E-9	0.01
3	Star + 1 Disk	0.8889192369999763	8000.0	1.0	0.5	800.0	35.0	1.0E-9	0.01
4	Star + 1 Disk	0.8884637190035074	8000.0	1.0	0.86	800.0	35.0	1.0E-9	0.01
5	Star + 1 Disk + Wall	0.8722167356254357	8000.0	1.0	0.5	800.0	35.0	1.0E-9	0.01
6	Star + 1 Disk	0.8449596635912986	8000.0	1.0	0.86	300.0	35.0	1.0E-9	0.01
7	Star + 1 Disk + Wall	0.833585945950183	8000.0	1.0	0.86	300.0	35.0	1.0E-9	0.01
8	Star + 1 Disk	0.7308558303496133	8000.0	1.0	0.86	300.0	35.0	1.0E-9	0.01
9	Star + 1 Disk	0.7186325849086802	8000.0	1.0	0.5	300.0	35.0	1.0E-9	0.01
10	Star + 1 Disk + Wall	0.7177123418313811	8000.0	1.0	0.5	300.0	35.0	1.0E-9	0.01

Next time you ask for a display, the calculated models will be available for you to plot.

Figure 1. Results from a fitting.

2. FUTURE WORK

VOSED is a tool under continuous development and new features are being implemented. Among them, we highlight the following ones:

- New, improved theoretical models.
- Grid densification and implementation of interpolation algorithms.
- Implementation of other fitting methodologies (e.g χ^2-minimization).
- Efficient handling of large observational datasets from projects like Spitzer, SDSS and UKIDSS.

[5] http://ivoa.net/internal/IVOA/IvoaTheory/

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