VOSA

A VO Spectral Energy Distribution Analyzer. Part 2/2

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IVOA interoperability meeting
Sao Paulo, Oct 21-26, 2012

Model Bayes analysis+

Bestfit
ChaHa1
ChaHa10
ChaHa11
ChaHa12
ChaHa13
ChaHa2
ChaHa3
ChaHa4
ChaHa5
ChaHa6
ChaHa7
ChaHa8
ChaHa9

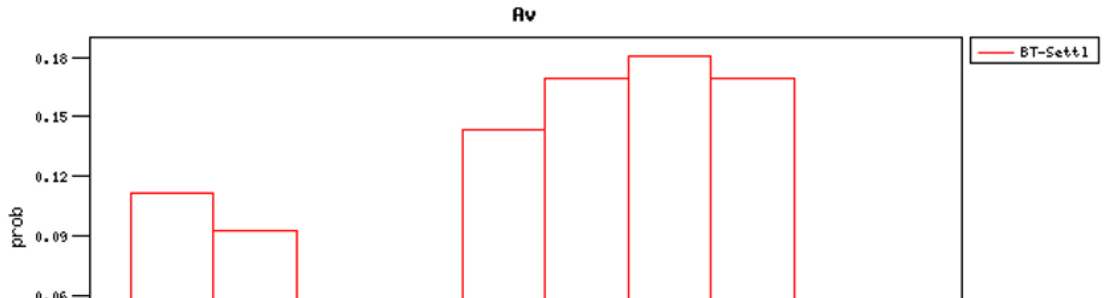
<Prev | Next >

ChaHa11

Here you can see, for each model, the relative probability found for each parameter.
Only those with a probability higher than 1e-4 are shown.

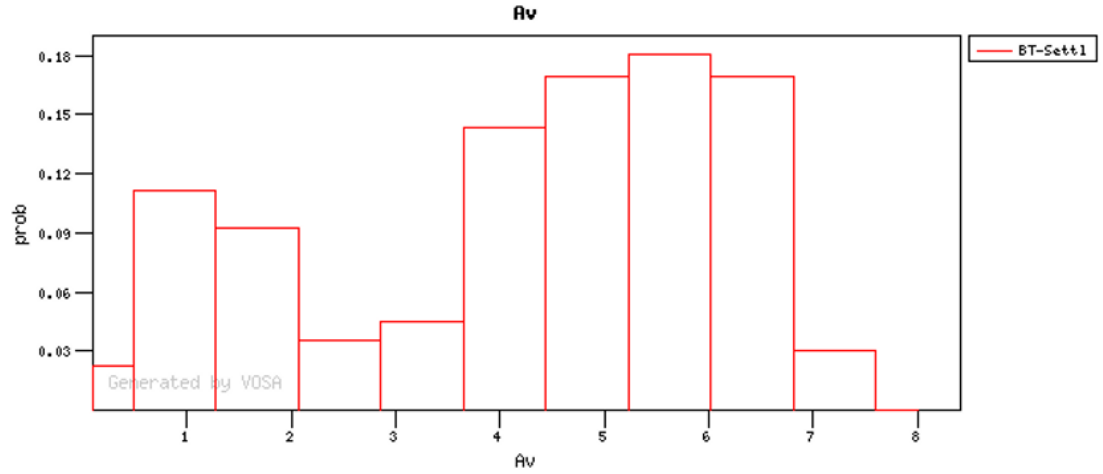
BT-Settl

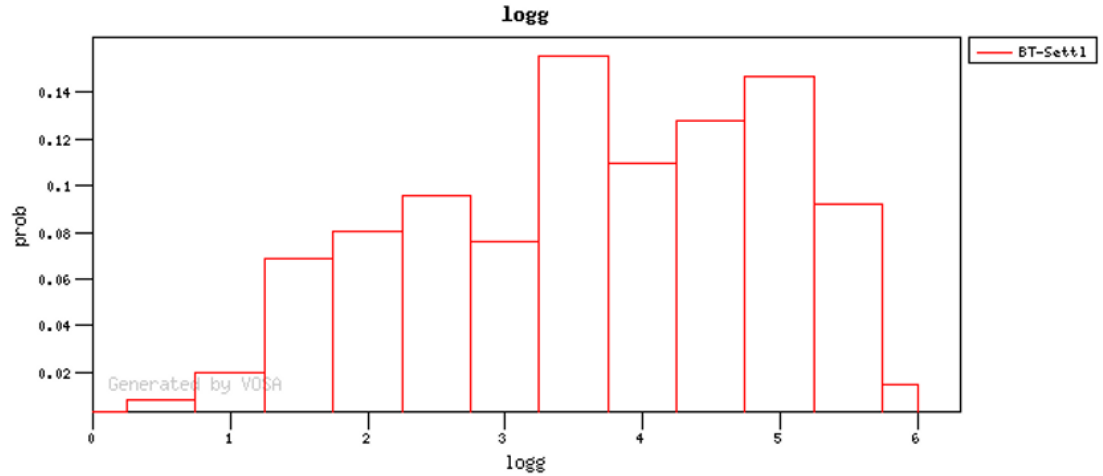
A_v	Probability	logg	Probability	Meta.	Probability	T_{eff}	Probability
0.1	0.022217	0	0.003070	-4	0.201034	2400	0.016414
0.89	0.111355	0.5	0.007963	-3.5	0.249576	2500	0.012273
1.68	0.092246	1	0.019928	-3	0.175828	2600	0.184961
2.47	0.035552	1.5	0.068443	-2.5	0.077275	2700	0.152081
3.26	0.045303	2	0.080602	-2	0.024373	2800	0.127643
4.05	0.143761	2.5	0.095909	-1.5	0.006795	2900	0.102901
4.84	0.169290	3	0.076231	-1	0.020237	3000	0.092399
5.63	0.180556	3.5	0.155589	-0.5	0.046966	3100	0.083539
6.42	0.169251	4	0.109599	0	0.073519	3200	0.092085
7.21	0.030289	4.5	0.128216	0.3	0.058646	3300	0.071022
8	0.000179	5	0.147018	0.5	0.065751	3400	0.039796
		5.5	0.092430			3500	0.018577
		6	0.014912			3600	0.005303
						3700	0.000924

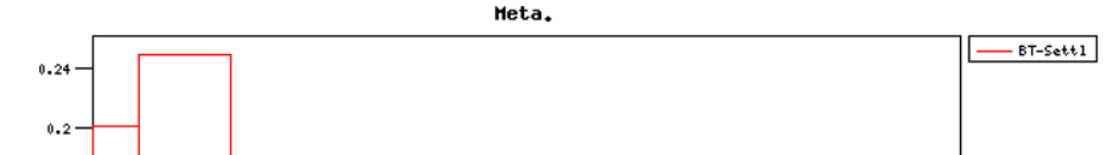


ChaHa9

4.05	0.143761	2.5	0.095909	-1.5	0.006795	2900	0.102901
4.84	0.169290	3	0.076231	-1	0.020237	3000	0.092399
5.63	0.180556	3.5	0.155589	-0.5	0.046966	3100	0.083539
6.42	0.169251	4	0.109599	0	0.073519	3200	0.092085
7.21	0.030289	4.5	0.128216	0.3	0.058646	3300	0.071022
8	0.000179	5	0.147018	0.5	0.065751	3400	0.039796
		5.5	0.092430			3500	0.018577
		6	0.014912			3600	0.005303
						3700	0.000924







VOSA VO SED Analyzer

Template fit

This option allows you to estimate the spectral type for each object comparing its SED with those in template colections obtained from VO services.

Take a look to the corresponding Help Section and Credits Page for more information.

First select the template colections that you want to use for the fit

Mark All | Unmark All

Next: Make the fit

- [x] **L and T dwarf data archive**
  L and T dwarf data from Chiu et al. 2006, Golimowski et al. 2004 and Knapp et al. 2004
- [x] **Keck LRIS spectra of late-M, L and T dwarfs**
  These spectra were obtained between 1997 and 1999; they are all flux calibrated and generally span the wavelength range 6000-10,000 A. Spectral types are on the Kirkpatrick et al system as defined in Kirkpatrick et al ApJS, 77, 417 (1991 - for M dwarfs) and Kirkpatrick et al ApJ 519, 802 (1999 - L dwarfs). While not all of these stars are primary spectral standards, they are all bright and should provide an adequate reference sequence. Photometric properties can be derived from the appended postscript files.
- [x] **The NIRSPEC Brown Dwarf Spectroscopic Survey**
  The Brown Dwarf Spectroscopic Survey (BDSS), established in 1998 by Dr. Ian McLean in collaboration with Dr. J. Davy Kirkpatrick at IPAC, is designed to study near-infrared moderate-to-high resolution spectra for a large sample of low-mass stars and sub-stellar mass objects in the M and newly defined L and T dwarf classes.
- [x] **The SpeX Prism Spectral Libraries**
  The SpeX Prism Spectral Libraries

Options for this fit

- [ ] Include model spectrum in fit plots? *(The fit process will be slower, because getting the spectra from the VO can take some time)*

Next: Make the fit

VO SED Analyzer

Files | Objects | VO Phot. | SED | Chi-2 Fit | Bayes Analysis | HR Diag. | Save Results | Log | Help | Logout

Stars and brown dwarfs (Change) **File: prueba** (Info) (Change)

Model Fit | Template fit

Template fit

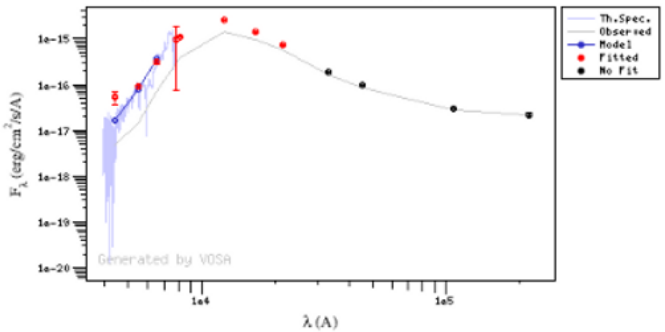
Bestfit
ChaHa1
ChaHa10
ChaHa11
ChaHa12
ChaHa13
ChaHa2
ChaHa3
ChaHa4
ChaHa5
ChaHa6
ChaHa7
ChaHa8
ChaHa9

Best fit+ results

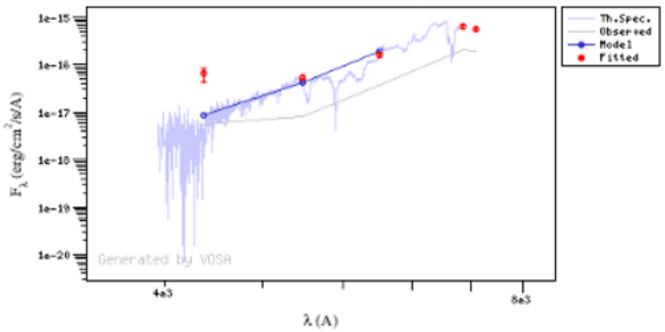
Hide graphs | Delete this fit

Object	RA	DEC	Model	SpTy	more	A_v	χ^2	M_d	λ_{max}	N_{fit}/N_{tot}	Data VOtables
ChaHa1	166.820833	-77.598333	Keck LRIS spectra	L0.5_blue	—	2.0	8.328e+0	2.050e+0	21590	3/12	Spec.
ChaHa10	167.106667	-77.658333	Keck LRIS spectra	L0.5_blue	—	2.0	1.385e+1	1.101e+0	8090	3/5	Spec.
ChaHa11	167.128333	-77.655278	Keck LRIS spectra	L0.5_blue	—	2.0	1.700e+1	7.181e-1	21590	3/8	Spec.
ChaHa12	166.656250	-77.718611	Keck LRIS spectra	L0.5_blue	—	2.0	8.053e+1	3.058e+0	33156	3/12	Spec.
ChaHa13	167.076667	-77.736667	Keck LRIS spectra	L0.5_blue	—	2.0	1.477e+2	1.584e+1	33156	3/12	Spec.
ChaHa2	166.929167	-77.566389	Keck LRIS spectra	L0.5_blue	—	2.0	1.304e+1	5.305e+0	21590	3/12	Spec.
ChaHa3	166.970417	-77.615556	Keck LRIS spectra	L0.5_blue	—	2.0	9.062e+1	7.345e+0	33156	3/12	Spec.
ChaHa4	167.081667	-77.654722	Keck LRIS spectra	L0.5_blue	—	2.0	1.607e+2	1.425e+1	21590	3/12	Spec.
ChaHa5	167.106667	-77.696111	Keck LRIS spectra	L0.5_blue	—	2.0	1.028e+2	9.317e+0	21590	3/8	Spec.
ChaHa6	167.167500	-77.571389	Keck LRIS spectra	L0.5_blue	—	2.0	8.873e+1	5.971e+0	21590	3/13	Spec.
ChaHa7	166.910000	-77.591667	Keck LRIS spectra	L0.5_blue	—	2.0	1.756e+0	8.738e-1	21590	3/12	Spec.
ChaHa8	166.949167	-77.668889	Keck LRIS spectra	L0.5_blue	—	2.0	1.587e+1	3.821e+0	8090	3/4	Spec.
ChaHa9	166.830000	-77.547778	Keck LRIS spectra	L3.5_blue	—	2.0	5.958e+0	1.083e+0	21590	3/12	Spec.

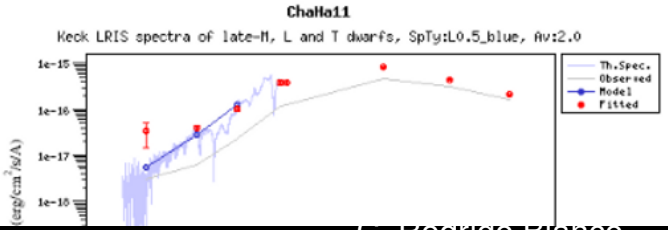
ChaHa1



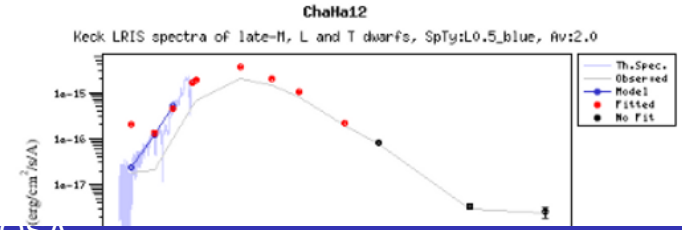
ChaHa10



ChaHa11



ChaHa12



HR diagram (stars)

Hertzsprung-Russel diagram.

- Use the Luminosity and T_{eff} estimated in the fit.
- Obtain isochrones and evolutionary tracks from the VO.
- Interpolate them to estimate values for the Mass and Age of each object.
- (only for stars and brown dwarfs).

HR Diagram

Models

Plot | Mark All | Unmark All

- BT-Settl t:0.00100
- BT-Settl t:0.00200
- BT-Settl t:0.00300
- BT-Settl t:0.00400
- BT-Settl t:0.00500
- BT-Settl t:0.00600
- BT-Settl t:0.00700
- BT-Settl t:0.00800
- BT-Settl t:0.00900
- BT-Settl t:0.01000
- BT-Settl t:0.02000
- BT-Settl t:0.03000
- BT-Settl t:0.04000
- BT-Settl t:0.05000
- BT-Settl t:0.06000
- BT-Settl t:0.07000
- BT-Settl t:0.08000
- BT-Settl t:0.09000
- BT-Settl t:0.10000
- BT-Settl t:0.12000
- BT-Settl t:0.15000
- BT-Settl t:0.20000
- BT-Settl t:0.30000
- BT-Settl t:0.40000
- BT-Settl t:0.50000
- BT-Settl t:0.60000
- BT-Settl t:0.70000
- BT-Settl t:0.80000
- BT-Settl t:0.90000
- BT-Settl t:1.00000
- BT-Settl t:2.00000
- BT-Settl t:3.00000
- BT-Settl t:4.00000
- BT-Settl t:5.00000
- BT-Settl t:6.00000
- BT-Settl t:7.00000
- BT-Settl t:8.00000
- BT-Settl t:9.00000
- BT-Settl

Objects

Show | Show All | Show None

	Obj	Model	teff	logL	t		m	
☑	ChaHa1	BT-Settl	2600	-1.7020	---	[4]	---	[4]
☑	ChaHa10	BT-Settl	3700	-1.1072	0.0399		0.6170	[1]
☑	ChaHa11	BT-Settl	2700	-2.2118	0.0060		0.030:0.040	[3]
☑	ChaHa12	BT-Settl	2600	-1.6419	---	[4]	---	[4]
☑	ChaHa13	BT-Settl	2800	-1.1568	---	[4]	---	[4]
☑	ChaHa2	BT-Settl	3200	-0.9318	0.0020		0.2131	
☑	ChaHa3	BT-Settl	2800	-1.2858	---	[4]	---	[4]
☑	ChaHa4	BT-Settl	2800	-1.1741	---	[4]	---	[4]
☑	ChaHa5	BT-Settl	2900	-1.0110	---	[4]	---	[4]
☑	ChaHa6	BT-Settl	2800	-1.1185	---	[4]	---	[4]
☑	ChaHa7	BT-Settl	2500	-1.8149	---	[4]	---	[4]
☑	ChaHa9	BT-Settl	3200	-1.1662	0.0039		0.2008	

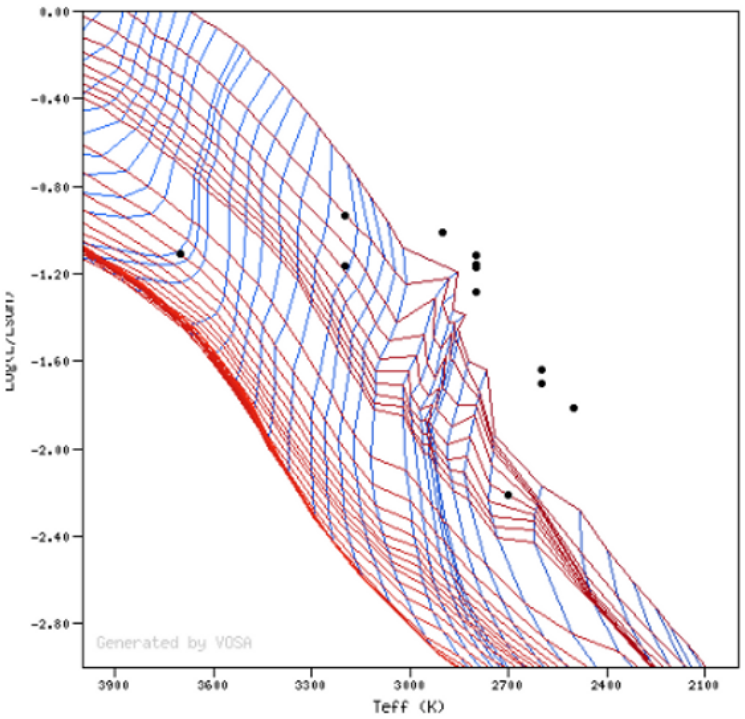
[1] The distance to one of the closer curves has been estimated as the one to the closest point in the curve

[3] Only a range of values can be estimated

[4] The point lies outside the area covered by the isochrones

X ∈ 2000 - 4000 Flip: ☑ Plot

Y ∈ -3 - 0 Flip: ☐



More information.

- **Log** of all the work done.
  - VO services consulted, fit made, fit undone, models used, etc since the file was uploaded.
  - Web visualization and downloadable file.
- **References**
  - Description of all the references for external services, models, etc used to obtain the results for a user file.
  - Bibtex file with the bibtex entries for those references.
- **Online help**

Activity Log

Here you can see a log with a summary of all the activity already performed with this file.

Last operations are shown first

2012/10/22 19:54:11 HR diagram generated

Model parameter values used for the diagram:
BT-Settl Isochrones and Evolutionary Tracks
Isochrones
t_min = 0.00100
t_max = 12.00000
Ev. tracks
m_min = 0.001
m_max = 1.400

2012/10/22 19:53:41 Previous HR diagram results are not valid anymore. They have been deleted

2012/10/22 19:50:58 HR diagram generated

Model parameter values used for the diagram:
BT-Settl Isochrones and Evolutionary Tracks
Isochrones
t_min = 0.00100
t_max = 12.00000
Ev. tracks
m_min = 0.001
m_max = 1.400

2012/06/13 09:58:41 Model fit+ executed

Parameter values used for the fit:
Kurucz ODFNEW /NOVER models
teff_min = 3500
teff_max = 50000
logg_min = 3.00
logg_max = 5.00
meta_min = 0.00
meta_max = 0.00
BT-Settl
teff_min = 400
teff_max = 70000
logg_min = 3
logg_max = 5
meta_min = 0
meta_max = 0

2012/06/13 09:57:00 Previous model fit+ results are not valid anymore. They have been deleted

2012/06/13 09:49:27 Previous model fit+ results are not valid anymore. They have been deleted

2012/06/09 05:52:52 Model fit+ executed

Parameter values used for the fit:
Kurucz ODFNEW /NOVER models
teff_min = 3500
teff_max = 50000

News: References

refs.dat (~/.cache/.fr-FxeA84/vosa_results_74/info) - gedit

File Edit View Search Tools Documents Help

Open Save Undo

refs.dat

```
If your research benefits from the use of VOSA, we would appreciate if you could include the corresponding reference
in your publication. Note also that VOSA makes use of models, VO services, etc that should be referenced too if they
are relevant to your final results. Here you have a list of all the services that have been used for obtaining the
results for this particular file. Please, take that into account. The refs.bibtex.bib file includes all the bibtex
entries corresponding to the information below

VOSA
------------------------------------------------------
 * VOSA
   - Acknowledgement : This publication makes use of VOSA, developed under the Spanish Virtual Observatory project
supported from the Spanish MICINN through grant AyA2008-02156.
   - 2008A&A...492..277B : Bayo et al 2008, A&A, 492, 277B


Dereddening
------------------------------------------------------
 * For dereddening the SEDs we make use of the extinction law by Fitzpatrick (1999) improved by Indebetouw et al
(2005) in the infrared.
   - 1999PASP..111...63F : Fitzpatrick, E.; 1999, PASP, 111, 63
   - 2005ApJ...619..931I : Indebetouw et al, 2005, ApJ 619, 931


VO photometry
------------------------------------------------------
 * 2MASS All-Sky Point Source Catalog
   - Acknowledgement : This publication makes use of data products from the Two Micron All Sky Survey, which is a
joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/California Institute
of Technology, funded by the National Aeronautics and Space Administration and the National Science Foundation.
   - 2000A&AS..143...23O : Ochsenbein et al 2000, A&AS 143, 221

 * DENIS Catalogue
   - 2000A&AS..143...23O : Ochsenbein et al 2000, A&AS 143, 221

 * Galaxy Evolution Explorer [GALEX]
   - Please, check the GALEX web page: http://galex.stsci.edu

 * WISE catalogue
```

References

refs.bibtex.bib (~/.cache/.fr-XUW4rS/vosa_results_74/info) - gedit

File Edit View Search Tools Documents Help

Open Save Undo

refs.dat refs.bibtex.bib

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@ARTICLE{2008A&A...492..277B,
   author = {{Bayo}, A. and {Rodrigo}, C. and {Barrado Y Navascu{\'e}s}, D. and
        {Solano}, E. and {Guti{\'e}rrez}, R. and {Morales-Calder{\'o}n}, M. and
        {Allard}, F.},
    title = "{VOSA: virtual observatory SED analyzer. An application to the Collinder 69 open cluster}",
  journal = {\aap},
archivePrefix = "arXiv",
   eprint = {0808.0270},
 keywords = {astronomical data bases: miscellaneous, stars: formation, stars: circumstellar matter, stars: low-mass,
brown dwarfs , stars: Hertzsprung-Russell (HR) and C-M diagrams, Galaxy: open clusters and associations: individual:
Collinder 69},
     year = 2008,
    month = dec,
   volume = 492,
    pages = {277-287},
      doi = {10.1051/0004-6361:200810395},
   adsurl = {http://adsabs.harvard.edu/abs/2008A%26A...492..277B},
  adsnote = {Provided by the SAO/NASA Astrophysics Data System}
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@ARTICLE{1999PASP..111...63F,
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    title = "{Correcting for the Effects of Interstellar Extinction}",
  journal = {\pasp},
   eprint = {arXiv:astro-ph/9809387},
 keywords = {ISM: DUST, EXTINCTION},
     year = 1999,
    month = jan,
   volume = 111,
    pages = {63-75},
      doi = {10.1086/316293},
   adsurl = {http://adsabs.harvard.edu/abs/1999PASP..111...63F},
  adsnote = {Provided by the SAO/NASA Astrophysics Data System}
}
```

Model Fit

[Fit] [Best Fit] [Extinction fit] [Reduced chi-square] [Errors] [Excess] [Synthetic photometry] [Bolometric Luminosity]

One of the main analysis options of this application is the *Model fit*.

Here the observed SED for each object is compared to the synthetic photometry for several theoretical models using a chi-square test. This gives an estimation of the physical properties of the given object.

If you provide a range for the visual extinction (A_V), this fitting will also consider it as a fit parameter, as explained below.

Fit

When a fitting process is started you can choose among a list of theoretical spectra models available in the VO. Only those that are checked will be used for the fit.

In the next step the application uses the TSAP protocol (SSAP for theoretical spectra) for asking the model servers which parameters are available to perform a search. According to that, a form is built for each model so that you can choose the ranges of parameters that you want to use for the fit. Take into account that:

- The fitting process implies queries to VO services, data sent through the network, a lot of calculations (some done by the services themselves and some done by the application)... That means that it could take a long time to get the final results (seconds for only an object or half an hour for around 100 depending also on the load of the services).
- Using more models and wider ranges of parameters will imply a longer time for the fitting (specially if your file contains many objects) so be ready for a long waiting time in the next step.
- In some cases, the whole range of parameters offered by the models are not right for your objects. For instance, if you know, for whatever physical reasons, that your objects have small temperatures, choose only small temperatures in the forms to optimize the process.
- The response time has roughly linear dependence on the number of objects in the file (twice number of objects means twice waiting time). Thus, you could prefer splitting your input file in different ones (according to physical properties, pertenence to a group or other reasons) better than doing all the work in an only data file.
- If you decide to fit the extinction too (giving a range for A_V) this will also increase the fitting time. Take into account that 20 different values of A_V are considered for each object/model combination. Although this won't imply a fitting time 20 times larger, it also enlarges the calculation time.

Once the fit has been finished, you can see a list with the best fit for each object and, optionally, a simple plot of these fits.

Besides that, for each particular object, you can also see a list with the best 5 fits for each model and, then, ordered by χ^2.

- Link to a VOtable with the **synthetic spectra** corresponding to the best fit.

Extinction fit

If a range for the visual extinction (A_V) is given, it will also be considered a fit parameter.

You can provide this range for each object in two different ways:

- In the input file (10th column). See Upload file format section for more info.
- In the "Objects: extinction" tab.

If you don't provide a range for A_V, the default value provided by you (also in the input file or the Extinction tab) will be used.

If you provide a range, like for instance A_V:0.5/5.5, the fit service will compare each particular file of the model with the observed SED dereddened using 20 different values for A_V in that range. Then the best fit models will be returned by the service with the best corresponding value of A_V.

Reduced chi-square

The fit process minimizes the value of $\mathbf{X_r^2}$ defined as:

$$\chi_r^2 = \frac{1}{N - n_p} \sum_{i=1}^{N} \left\{ \frac{(Y_{o,i} - M_d\, Y_{m,i})^2}{\sigma_{o,i}^2} \right\}$$

Where:

N: Number of photometric points.

n_p: Number of fitted parameters for the model.
($N-n_p$ are the degrees of freedom associated to the chi-square test)

Y_o: observed flux.

σ_o: observational error in the flux.

Y_m: theoretical flux predicted by the model.

M_d: Multiplicative dilution factor, defined as:

$$M_d = \left(\frac{R}{D}\right)^2$$

being R the object radius and D the distance between the object and the observer.
It is calculated as a result of the fit too.

Observational errors

Save results

Save results.

- VOTable, ASCII
- PNG, EPS and grace files for the images available.
- Download as tar file.

Save Results

Please, select what you want to retrieve.

Mark All | Unmark All | Retrieve

Object SED

	dat	xml	png	eps
Photometry (Observed)	☐	☐	☐	☐

Model Fit+

	dat	xml	png	eps
Best Fit+ Results	☐	☐		
Fit+ parameters info	☐			
Photometry (Obs+Model fit+)	☐	☐	☐	☐

Bayes Analysis+

	dat	xml	png	eps
Best Model Bayes Results	☐	☐		
Bayes parameters info	☐			
Object Model Bayes analysis results	☐	☐	☐	☐

Template Fit

	dat	xml
Template fit	☐	☐
Template Fit parameters info	☐	

Template Bayes Analysis+

	dat	xml
Best Template Bayes Results	☐	☐
Template Bayes parameters info	☐	
Object Template Bayes analysis results	☐	☐

HR diagram

	dat	xml	png	eps
HR diagram	☐	☐	☐	☐

Log File

	dat
Activity log	☐

If your research benefits from the use of VOSA, please remember to include the appropiate references in your publication.

The main reference for VOSA is:

> *Bayo, A., Rodrigo, C., Barrado y Navascues, D., Solano, E., Gutierrez, R., Morales-Calderon, M., Allard, F. 2008, A&A 492,277B.*

We would also appreciate if you include the following acknowledgement in any published material that makes use of VOSA:

> *This publication makes use of VOSA, developed under the Spanish Virtual Observatory project supported from the Spanish MICINN through grant AyA2008-02156.*

VOSA uses also external services, theoretical models and science inputs from other sources that you might want to cite or acknowledge as well.

When you download your results two aditional files are included:

- info/refs.dat : with a description of all references for the services that have been used in this file.
- info/refs.bibtex.bib : with the bibtex entries corresponding to all those references.

Please, read the info/refs.dat file and take it into account.

THANK YOU!