VOSA

A VO Spectral Energy Distribution Analyzer

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IVOA interoperability meeting
Napoli, May 16-20, 2011

VOSA (VO Sed Analyzer)

- a web tool: http://svo.cab.inta-csic.es/theory/vosa/
- designed to automatically determine physical parameters from comparison of observed photometry with collections of theoretical models.
- for several objects at the same time. *(∼ 1000 objects)*
- Much easier using VO tools.

A science case: Collinder 69

The case of the young cluster Collinder 69
(Bayo et al, 2008 A&A 429,277B)

- IRAC photometry for 167 candidate members of C69.
- VO archival data research (multi-wavelength range).
- Four different collections of theoretical models (with TSAP and S3).
- Determination of the best physical parameters for the objects and the association ($T_{\rm eff}$, gravity, mass and age)

Workflow

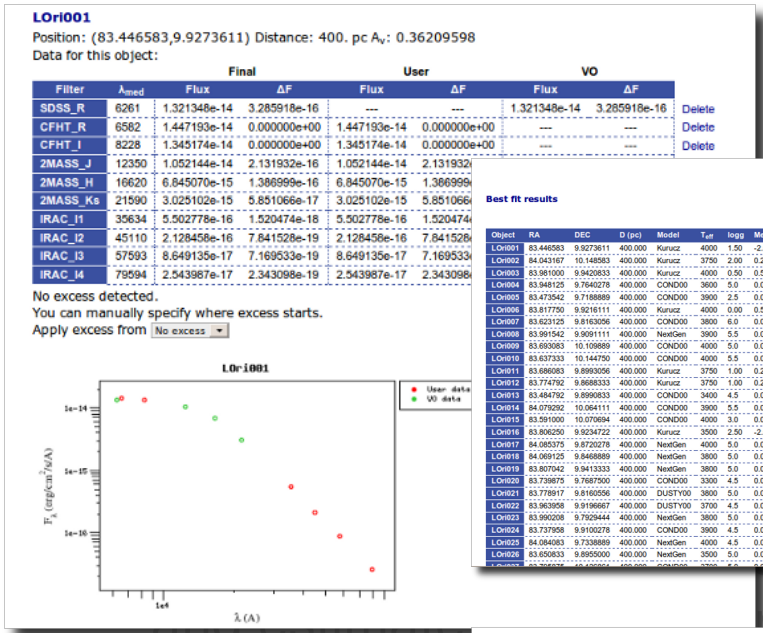
1. **Build object SEDs.**
   - Object properties: name resolution, distance, extinction.
   - User photometry tables + VO catalogs.
2. **Analyze object SEDs.**
   - Fit observed data with theoretical spectra models from the VO and estimate physical parameters for the objects. (Chi-square test + Bayes analysis)
   - Generate a Hertzsprung-Russel diagram using the estimated parameters, obtaining isochrones and evolutionary tracks from the VO (only stars).
3. **Save results** as VOTable, ASCII, png, eps...

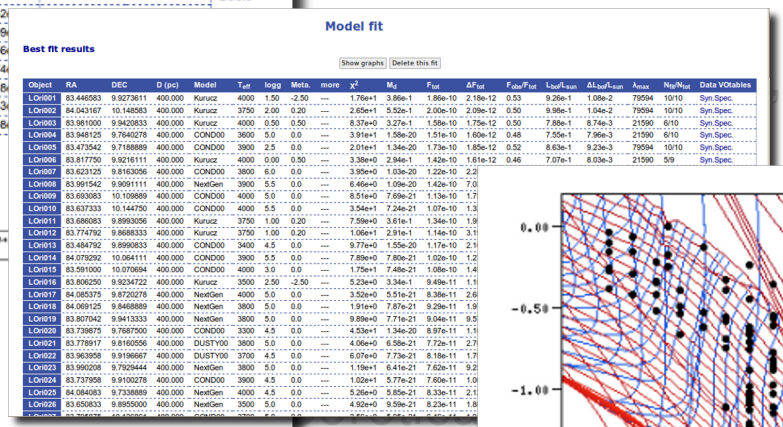
Workflow

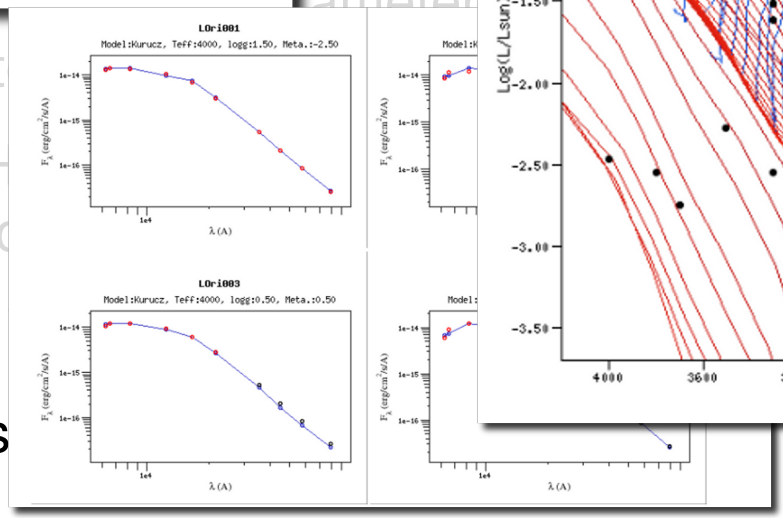
1

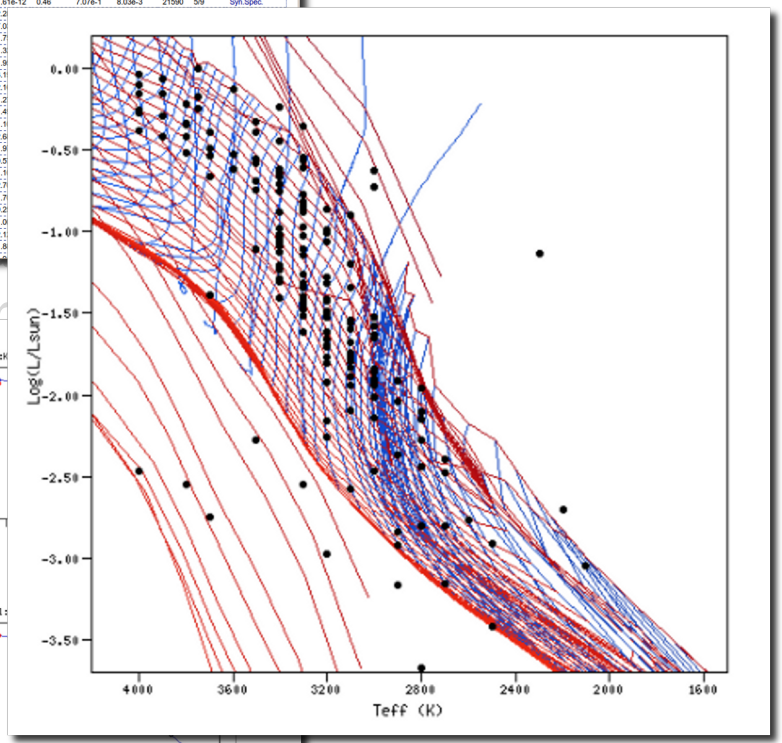
2

3









extinction.

(Chi-square t

- Generate a H
  parameters,
  the VO (only

Save results as

Two different workflows

Theoretical model services | Documents | Models | Services

VOSA: VO Sed Analyzer

VO SED Analyzer

Services: VOSA Filters TSAP S3if | crb@laeff.inta.es Users Models Uploads LogOut

VOSA

VOSA allows to analyze both stellar and galactic data but, given that the physics involved is not the same, there are some important differences between both cases.

Please, select first what type of objects you want to work with in this session.

Stars and brown dwarfs

Galaxies

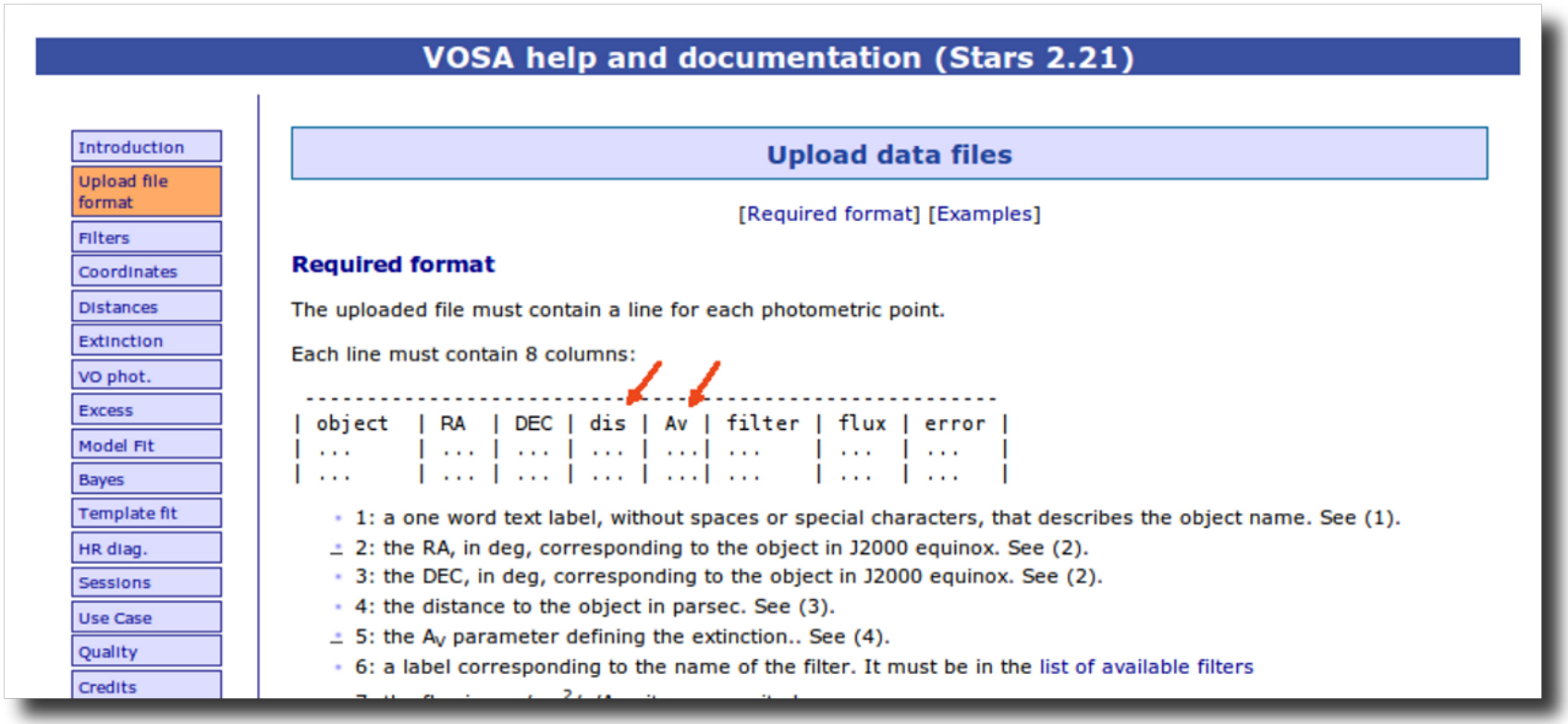
Improving VOSA

We often receive suggestions and/or requests to improve the tool in different aspects from several sources

- Euro-VO Science Advisory Commitee.
- VO schools feedback.
- VOSA users.
- Scientific projects with special needs.

Object properties

The user can specify, in the input file, some important object properties:



New: object properties

More and better information about object properties:

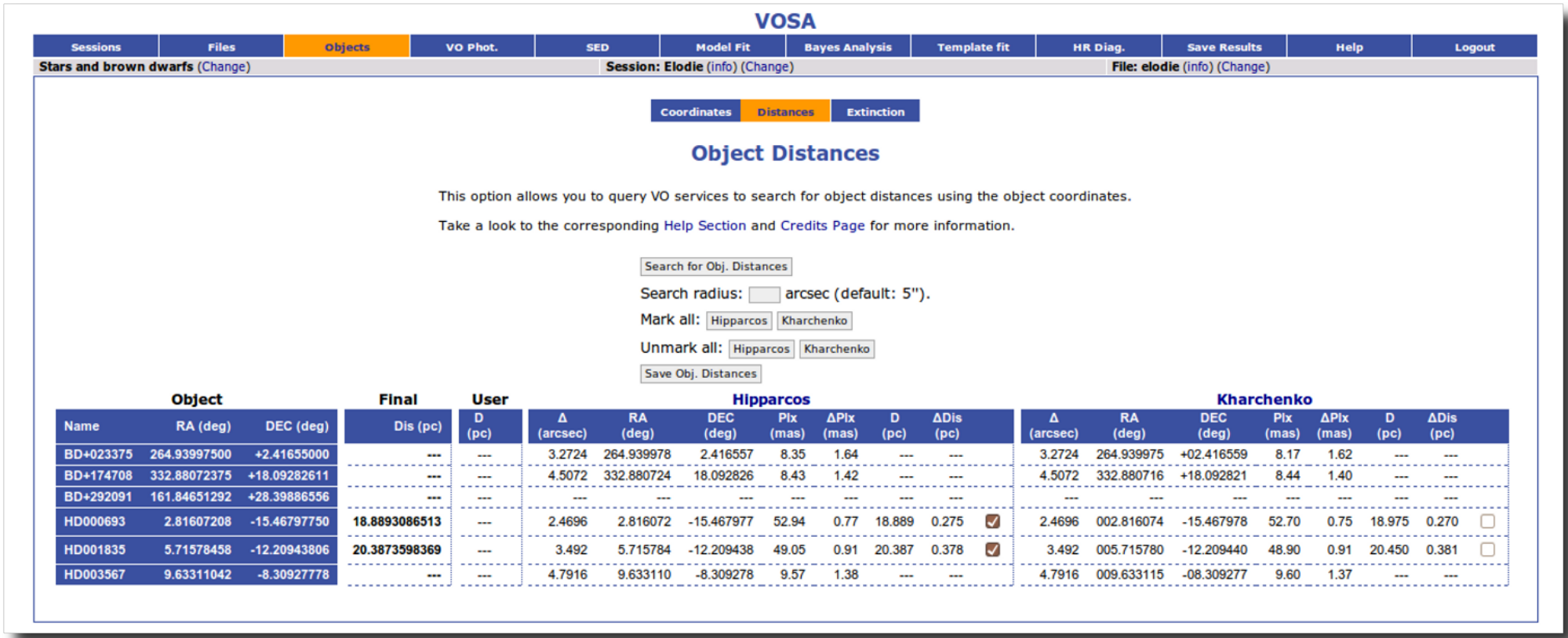
- More flexibility with object names.
  - Names with spaces, like the one for the variable star R Aql, can be used now just as R_Aql.
- Object distance from VO catalogues.
- Object extinction properties (R_V, E(B-V),A_V) from VO catalogues.

(SAC, VO schools, users)

Object properties: Distance

The object distance is important to

- calculate bolometric luminosities in the model fit.
- build the HR diagram to infer masses and ages.



VOSA

Sessions | Files | Objects | VO Phot. | SED | Model Fit | Bayes Analysis | Template fit | HR Diag. | Save Results | Help | Logout

Stars and brown dwarfs (Change) — **Session: Elodie** (info) (Change) — **File: elodie** (info) (Change)

Coordinates | Distances | Extinction

Object Distances

This option allows you to query VO services to search for object distances using the object coordinates.

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

Search for Obj. Distances

Search radius: arcsec (default: 5").

Mark all: Hipparcos Kharchenko

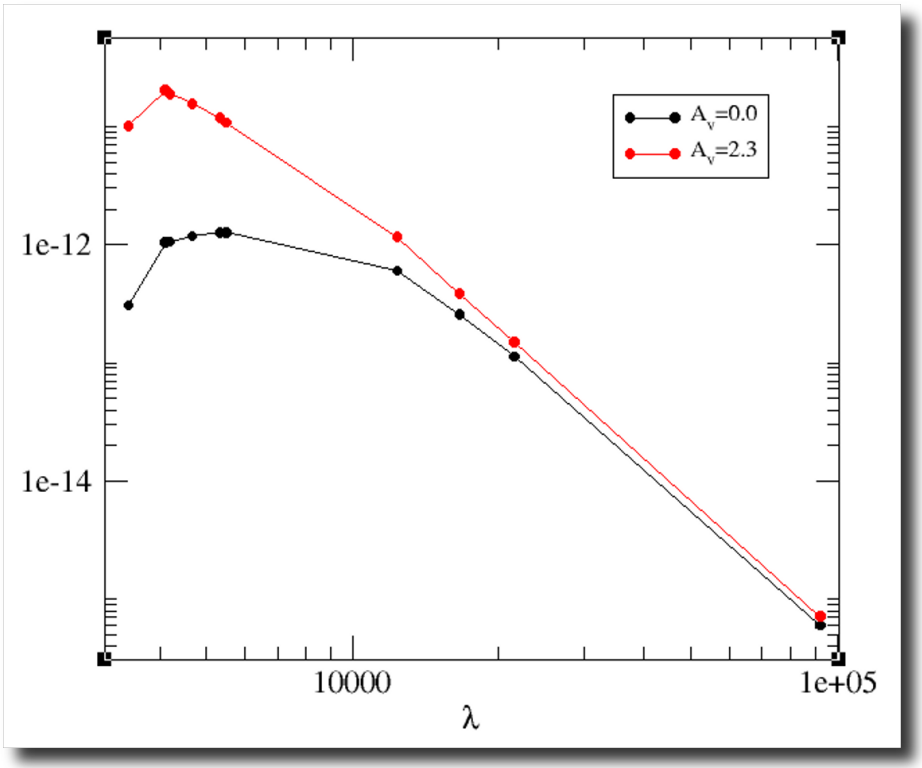
Unmark all: Hipparcos Kharchenko

Save Obj. Distances

Object			Final	User	Hipparcos								Kharchenko							
Name	RA (deg)	DEC (deg)	Dis (pc)	D (pc)	Δ (arcsec)	RA (deg)	DEC (deg)	Plx (mas)	ΔPlx (mas)	D (pc)	ΔDis (pc)		Δ (arcsec)	RA (deg)	DEC (deg)	Plx (mas)	ΔPlx (mas)	D (pc)	ΔDis (pc)	
BD+023375	264.93997500	+2.41655000	---	---	3.2724	264.939978	2.416557	8.35	1.64	---	---		3.2724	264.939975	+02.416559	8.17	1.62	---	---	
BD+174708	332.88072375	+18.09282611	---	---	4.5072	332.880724	18.092826	8.43	1.42	---	---		4.5072	332.880716	+18.092821	8.44	1.40	---	---	
BD+292091	161.84651292	+28.39886556	---	---	---	---	---	---	---	---	---		---	---	---	---	---	---	---	
HD000693	2.81607208	-15.46797750	18.8893086513	---	2.4696	2.816072	-15.467977	52.94	0.77	18.889	0.275	☑	2.4696	002.816074	-15.467978	52.70	0.75	18.975	0.270	☐
HD001835	5.71578458	-12.20943806	20.3873598369	---	3.492	5.715784	-12.209438	49.05	0.91	20.387	0.378	☑	3.492	005.715780	-12.209440	48.90	0.91	20.450	0.381	☐
HD003567	9.63311042	-8.30927778	---	---	4.7916	9.633110	-8.309278	9.57	1.38	---	---		4.7916	009.633115	-08.309277	9.60	1.37	---	---	

Object properties: Extinction

Having the right value for the extinction is very important because it changes the SED, specially for hot objects.



Object properties: Extinction

VOSA

Sessions | Files | Objects | VO Phot. | SED | Model Fit | Bayes Analysis | Template fit | HR Diag. | Save Results | Help | Logout

Stars and brown dwarfs (Change) **Session: Extinction** (info) (Change) **File: test** (info) (Change)

Coordinates | Distances | Extinction

Extinction properties

This option allows you to query VO services to search for the extinction properties of these objects using the object coordinates.

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

Search for Extinction properties

Search radius: [ ] arcsec (default: 5").

Mark all: User | Dias | Kodaira | Jones | Larson | Savage | Rowan-Robinson | LeBorgne | Glushkova | Morales | Guarinos | Layden

Unmark all: User | Dias | Kodaira | Jones | Larson | Savage | Rowan-Robinson | LeBorgne | Glushkova | Morales | Guarinos | Layden

Add default user values, Rv: 3.2 E(B-V): [ ] Add

Save Extinction properties

Object			Final	User			VO Data						
Name	RA (deg)	DEC (deg)	Av	Rv	E(B-V)	Av	Δ (arcsec)	RA (deg)	DEC (deg)	Rv	E(B-V)	Av	Source
prueba1	83.79	9.94	---	3.2									
prueba10	267.025	1.300	1.184	3.2			0	267.025	+1.300	---	0.370	---	Dias+, 2002-2010 (?)
prueba11	263.102	7.062	0.31	3.2			1.44	263.102	+7.062	---	---	0.31	Kodaira+, 1992 (?)
prueba12	264.875	-0.327	0.77	3.2			0.9	264.87525	-0.32700	---	---	0.77	Jones+, 2009 (?)
prueba13	260.688	-3.731	2.432	3.2			2.1204	260.68823	-03.73154	---	0.76	---	Larson+, 2005 (?)
prueba14	332.600	18.80	---	3.2									
prueba15	340.357	23.847	0.352	3.2			1.44	340.357	+23.847	---	0.11	---	Savage+, 1985 (?)
prueba16	154.280	-59.52	---	3.2									
prueba17	33.439	-3.703	0.50	3.2			2.1096	033.439579	-03.702900	---	---	0.50	Rowan-Robinson+, 2008 (?)
prueba18	300.275	27.7535	0.00	3.2			0.2412	300.27504	+27.75356	---	---	0.00	Le Borgne+, 2000 (?)
prueba2	264.82	3.56	---	3.2									
prueba20	312.4692	41.255	2.848	3.2			0	312.4692	+41.2550	---	0.89	---	Glushkova+, 2009 (?)
prueba21	317.508	15.517	0.5	3.2		0.5	1.656	317.508	+15.517	---	0.100	---	Dias+, 2002-2010 (?)
prueba22	330.171	17.739	0.17	3.2			1.44	330.171	+17.739	---	---	0.17	Kodaira+, 1992 (?)

More catalogues with VO photometry.

(It's not just querying the catalogues. We need the filters, zero points, the synthetic photometry for all the theoretical models and a careful correspondence with the catalogue data)

- AKARI FIS/IRC
- GLIMPSE
- IRAS
- MSX
- $\sim$ 20 catalogues.

Request by Euro-VO SAC to extend queries to IR photometric catalogues

New: More collections of theoretical spectra

More collections of theoretical spectra.

- Hot stars:
  - *TLUSTY OSTAR2002+BSTAR2006 Grid*
  - *Husfeld et al non-LTE models for Helium-rich stars.*

(scientific projects)

Model fit

- Better plots.
  - Option to include the theoretical spectra together with the photometry in the fit plots.
- Bayes analysis of parameter space.
  - A different approach to estimate the best values for the physical parameters, assigning probabilities to the different possible values.

(Users + Scientific projects)

Chi-square fitting (galaxies)

VOSA

Objects | VO Phot. | SED | Model Fit | Bayes Analysis | Save Results | Help | Logout

Galaxies 3.3 (Change) **Session:** (info) (Change) **File: a** (info) (Change)

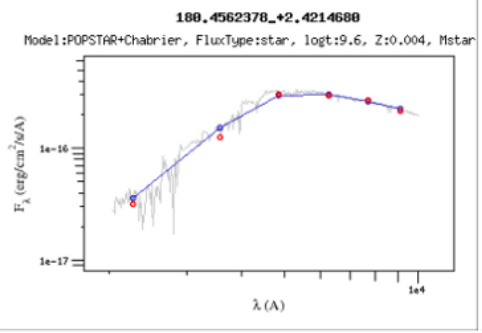
Model fit

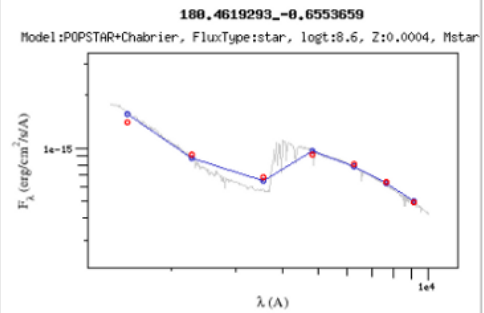
Bestfit
180.4562378_+2.4214680
180.4619293_-0.6553659
180.6196442_+2.2885530
180.6363373_+1.7487876
180.9663849_+1.8360813
181.1261597_+1.6840036
181.1450500_+1.8423587
181.1934052_+2.0052178
181.3663635_+1.8613694
186.5941010_-1.2550402
191.4905853_+1.2980399
192.9112244_+1.6708190

Best fit results

Hide graphs | Delete this fit

Object	RA	DEC	D (pc)	Model	FluxType	logt	Z	χ^2	M_d	F_{tot}	ΔF_{tot}	F_{obs}/F_{tot}	L_{bol}/L_{sun}	$\Delta L_{bol}/L_{sun}$	Mass/M_{sun}	M_{star}	Data VOtables
180.4562378_+2.4214680	180.45623780	2.42146800	10.0	POPSTAR+Chabrier	star	9.6	0.004	6.89e+0	1.17e-45	3.21e-12	7.96e-15	0.14	1.00e-5	2.48e-8	1.40e-5	0.43	Syn.Spec.
180.4619293_-0.6553659	180.46192930	-0.65536590	10.0	POPSTAR+Chabrier	star	8.6	0.0004	1.55e+1	3.25e-46	9.82e-12	4.62e-14	0.18	3.06e-5	1.44e-7	3.89e-6	0.594	Syn.Spec.
180.6196442_+2.2885530	180.61964420	2.28855300	10.0	POPSTAR+Chabrier	total	10.18	0.004	1.28e+1	4.14e-45	3.68e-12	9.26e-14	0.26	1.15e-5	2.89e-7	4.95e-5	0.342	Syn.Spec.
180.6363373_+1.7487876	180.63633730	1.74878760	10.0	POPSTAR+Chabrier	star	9.3	0.02	4.47e+0	1.39e-45	5.19e-12	6.63e-15	0.13	1.62e-5	2.07e-8	1.67e-5	0.493	Syn.Spec.
180.9663849_+1.8360813	180.96638490	1.83608130	10.0	POPSTAR+Chabrier	total	10.08	0.004	3.30e+0	3.11e-45	3.69e-12	5.96e-15	0.13	1.15e-5	1.86e-8	3.72e-5	0.357	Syn.Spec.
181.1261597_+1.6840036	181.12615970	1.68400360	10.0	POPSTAR+Chabrier	star	8.6	0.0001	3.30e+1	1.19e-46	4.01e-12	9.53e-15	0.13	1.25e-5	2.97e-8	1.42e-6	0.587	Syn.Spec.
181.1450500_+1.8423587	181.14505000	1.84235870	10.0	POPSTAR+Chabrier	total	10.14	0.008	2.26e+0	5.81e-45	5.88e-12	2.74e-13	0.35	1.83e-5	8.55e-7	6.95e-5	0.36	Syn.Spec.
181.1934052_+2.0052178	181.19340520	2.00521780	10.0	POPSTAR+Chabrier	total	9.95	0.008	2.45e+0	7.47e-45	9.85e-12	2.62e-13	0.30	3.07e-5	8.18e-7	8.94e-5	0.389	Syn.Spec.
181.3663635_+1.8613694	181.36636350	1.86136940	10.0	POPSTAR+Chabrier	total	8.9	0.0004	1.07e+1	1.79e-46	3.08e-12	3.09e-14	0.18	9.61e-6	9.62e-8	2.15e-6	0.542	Syn.Spec.
186.5941010_-1.2550402	186.59410100	-1.25504020	10.0	POPSTAR+Chabrier	star	7.7	0.02	6.97e+1	1.16e-46	1.12e-11	7.17e-14	0.20	3.49e-5	2.23e-7	1.39e-6	0.751	Syn.Spec.
191.4905853_+1.2980399	191.49058530	1.29803990	10.0	POPSTAR+Chabrier	total	8.3	0.0004	2.56e+1	9.28e-47	4.15e-12	1.32e-13	0.24	1.29e-5	4.10e-7	1.11e-6	0.648	Syn.Spec.
192.9112244_+1.6708190	192.91122440	1.67081900	10.0	POPSTAR+Chabrier	total	8.7	0.0004	7.18e+0	2.46e-46	5.51e-12	3.97e-14	0.18	1.72e-5	1.24e-7	2.94e-6	0.576	Syn.Spec.





Bayes analysis (galaxies)

VOSA

Objects | VO Phot. | SED | Model Fit | Bayes Analysis | Save Results | Help | Logout

Galaxies 3.3 (Change) **Session:** (info) (Change) **File: a** (info) (Change)

Model Bayes analysis

Bestfit

- 180.4562378_+2.4214680
- 180.4619293_-0.6553659
- 180.6196442_+2.2885530
- 180.6363373_+1.7487876
- 180.9663849_+1.8360813
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- 181.3663635_+1.8613694
- 186.5941010_-1.2550402
- 191.4905853_+1.2980399
- 192.9112244_+1.6708190

180.4562378_+2.4214680

Here you can see, for each model, the relative probability found for each parameter.
Only those with a probability higher than 1e-5 are shown.

POPSTAR with Chabrier (2003) IMF

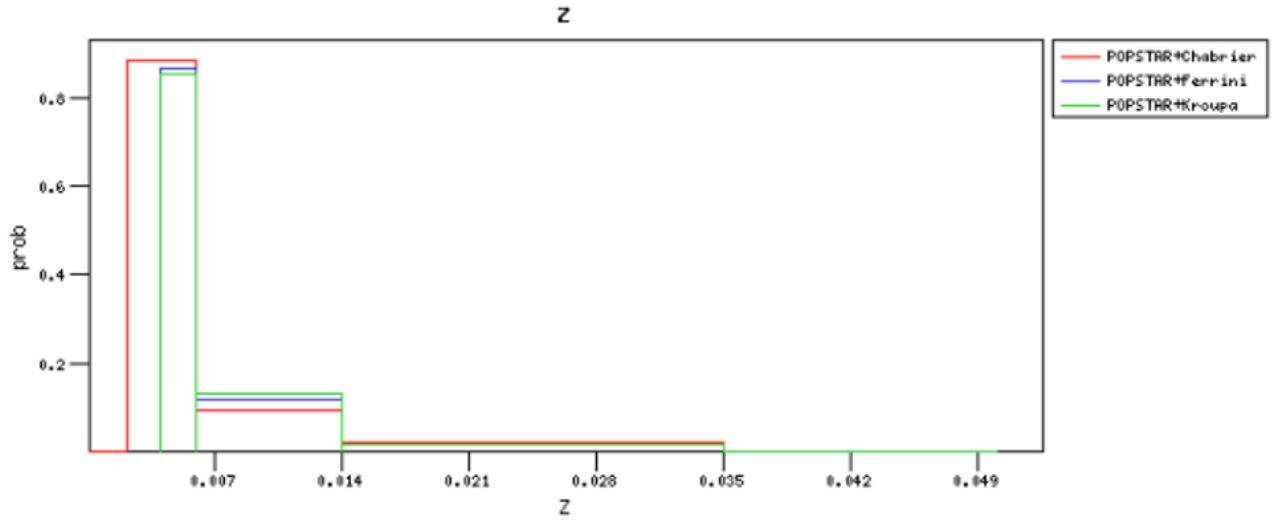
Z	Probability	logt	Probability	FluxType	Probability
0.0001	0.000015	9	0.000023	star	0.505013
0.004	0.884214	9.18	0.018425	total	0.494987
0.008	0.093201	9.3	0.061476		
0.02	0.022547	9.4	0.019093		
0.05	0.000023	9.48	0.235115		
		9.54	0.108777		
		9.6	0.254404		
		9.65	0.229294		
		9.7	0.057177		
		9.74	0.011729		
		9.78	0.003759		
		9.81	0.000705		
		9.95	0.000013		

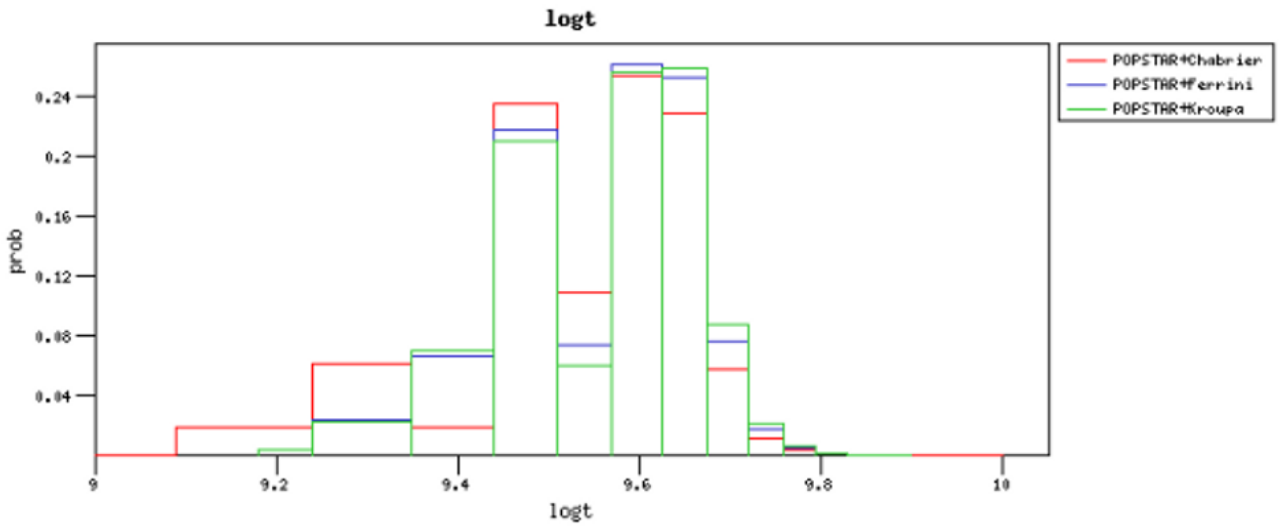
POPSTAR with Ferrini, Penco, Palla (1990) IMF

Z	Probability	logt	Probability	FluxType	Probability
0.004	0.866549	9.18	0.003859	star	0.504502
0.008	0.118153	9.3	0.023899	total	0.495498
0.02	0.015293	9.4	0.066321		
		9.48	0.217824		
		9.54	0.073461		
		9.6	0.261642		
		9.65	0.252956		
		9.7	0.076216		

Bayes analysis (galaxies)

9.7	0.087332
9.74	0.020737
9.78	0.006796
9.81	0.001332
9.85	0.000017





VOSA in action

- VOSA has been important for some scientific projects.
  - At least 2 papers in 2011.
- Presented and used in SVO and Euro-VO schools.
  - 4 schools in 2010-2011.

VOSA in action

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Astronomy & Astrophysics

A search for new hot subdwarf stars by means of Virtual Observatory tools

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ABSTRACT

Context. Recent massive sky surveys in different bandwidths are providing new opportunities to modern astronomy. The Virtual Observatory (VO) provides the adequate framework to handle the huge amount of information available and filter out data according

VOSA in action

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Astronomy & Astrophysics

Identification of blue high proper motion objects in the Tycho-2 and 2MASS catalogues using Virtual Observatory tools

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ABSTRACT

Aims. With available Virtual Observatory tools, we looked for new bright blue high proper motion objects in the entire sky: white dwarfs, hot subdwarfs, runaway OB stars, and early-type stars in nearby young moving groups.
Methods. We performed an all-sky cross-match between the optical Tycho-2 and near-infrared 2MASS catalogues with Aladin, and selected objects with proper motions $\mu > 50\,\mathrm{mas\,yr^{-1}}$ and colours $V_T - K_s < -0.5$ mag with TOPCAT. We also collected multi-wavelength photometry, constructed the spectral energy distributions and estimated effective temperatures from fits to atmospheric models with VOSA for the most interesting targets.
Results. We assembled a sample of 32 bright blue high proper motion objects, including ten sdO/B subdwarfs, nine DA white dwarfs, five young early-type stars (two of which are runaway stars), two blue horizontal branch stars, one star with poor information, and five objects reported for the first time in this work. These last five objects have magnitudes $B_T \approx 11.0$–11.6 mag, effective temperatures $T_{\mathrm{eff}} \approx 24\,000$–$30\,000$ K, and are located in the region of known white dwarfs and hot subdwarfs in a reduced proper motion-colour diagram. We confirmed the hot subdwarf nature of one of the new objects, Albus 5, with public far-ultraviolet spectroscopic data

VOSA in action

- VOSA has been important for some scientific projects.
  - At least 2 papers in 2011.
- Presented and used in SVO and Euro-VO schools.
  - 4 schools in 2010-2011.

VOSA in action

EURO VO ICE International Cooperation Empowerment Inc.

Jump Search Edit Attach

Tags: create new tag, view all tags

Collinder 69: From SED fitting to Age estimation using VOSA

- **Title:** ***From SED fitting to Age estimation using VOSA***
- **Tools to be used**: VOSA http://svo.cab.inta-csic.es/theory/vosa
- **Use Case #1:** Collinder 69 candidate members. Determination of physical parameters.
  - **Data for Use Case #1:** A subset of the objects studied in Bayo, A. et al. (2008, A&A 492..277B). vosa_usecase1.txt

- **Step 1.-** Go to http://svo.cab.inta-csic.es/theory/vosa.
- **Step 2.-** To use VOSA you need to be registered. Click on "Register" and fill in the fields (email, name and passwd).
- **Step 3.-** VOSA can be used to study stellar and extragalactic data. For this use case, click on "Stars and brown dwarfs".
- **Step 4.-** Cut and paste in a file the list of objects in "VOSA format" included in vosa_usecase1.txt
- **Step 5.-** Upload the file in VOSA (tab Files). Give a description and do not forget to select "magnitudes" as file type. Then, click "Upload".
- **Step 6.-** In the new window, click on the corresponding radio button and then on "Select".
- **Step 7.-** Click on "Objects" (next tag). You will see a table with three columns: The name of our objects (first column in the input file), the coordinates provides by the user (second and thrid column of the input file) and a third column where the coordinates provided by Sesame will appear once we click on "Search for obj. coordinates". As our object identifiers are meningless (LOri001, LOri002,...) we will not use the Sesame capabilities.
- **Step8.-** We skip the "Distances" and "Extinction" tags as the VO services consulted by VOSA do not provide any information for our list of objects.
- **Step9.-** With the next tag "VO Phot" we can complement our "user photometry" with photometry found in a number of VO services. For this use case we select only 2MASS and CMC-14. Do not forget to click on "Save VO photometry" once the results are displayed. Once this is done, a summary table with the VO photometry (in flux units) will appear.
- **Step10.-** The next tag ("SED") gives us the possibility of checking the SED before the model fitting. User data are plotted in red and VO data in green. Bad photometric points can be removed cliking on "Delete". If VOSA detects an infrared excess, the photometric points are drawn in black and are not considered in the fitting process. The user can manually overrride it and specify a new limit in the "Apply excess from" panel. Do not make any modification to what VOSA shows in this page.
- **Step11.-** In the next tag ("Model Fit"), different grids of theoretical models are displayed. They cover different ranges of physical parameters. For this case, we select the "Nextgen", "Dusty","Cond" and "Kurucz" set of models. Click on "Select model params".
- **Step12.-** In this window, we can refine the range of physical parameters that will be used for the fit. We will make the following assumption:
  - Nextgen: Teff: 2500-6000K; logg: 3.5-4.5
  - Dusty: Teff: 1800-2500K; logg: 3.5-4.5
  - COND: Teff: 100-1800K; logg: 3.5-4.5
  - Kurucz: Teff: 3500-6000K; logg: 3.5-4.5; met: 0

Work in progress

Adding new functionalities when needed for scientific projects.

- More filters.
- Other theoretical models.
- k-correction: taking into account the effect of red-shift in the photometry (galaxies).
- Global search of object properties (extinction, distance, redshift) in VO catalogues.
- VO photometry: search by quality flag.
- ...

THANK YOU!