

Using VOSA to exploit Gaia data

Enrique Solano

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CENTRO DE ASTROBIOLOGÍA
ASOCIADO AL NASA ASTROBIOLOGY INSTITUTE



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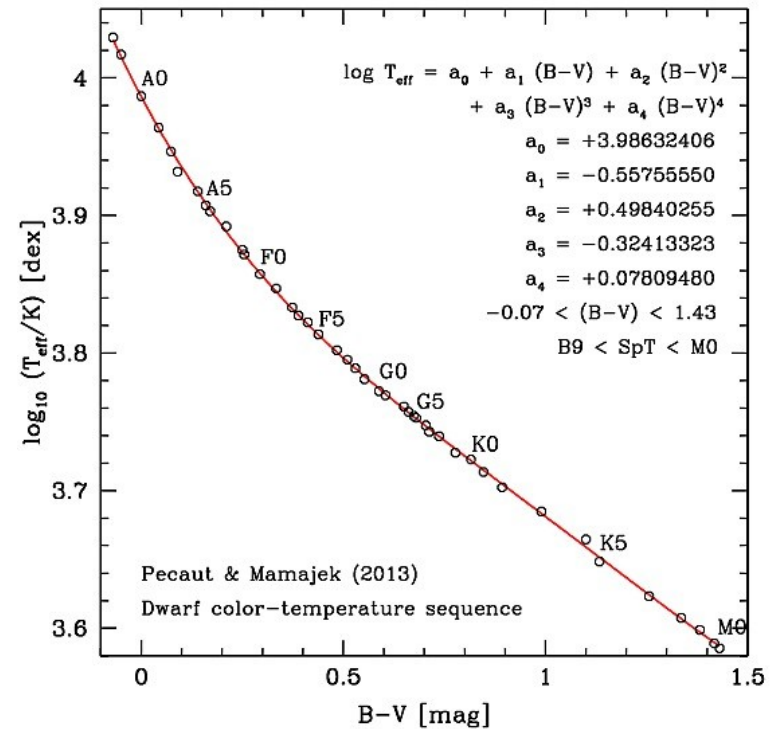
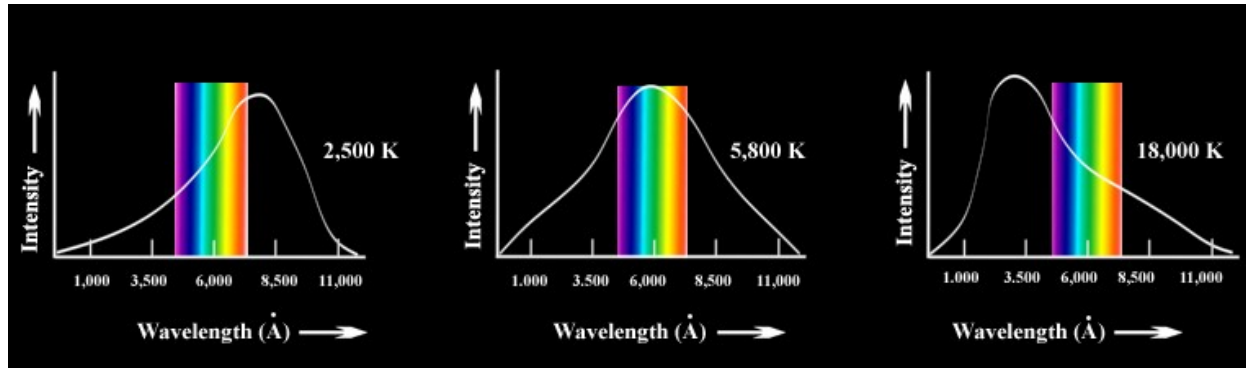


Instituto Nacional de
Técnica Aeroespacial

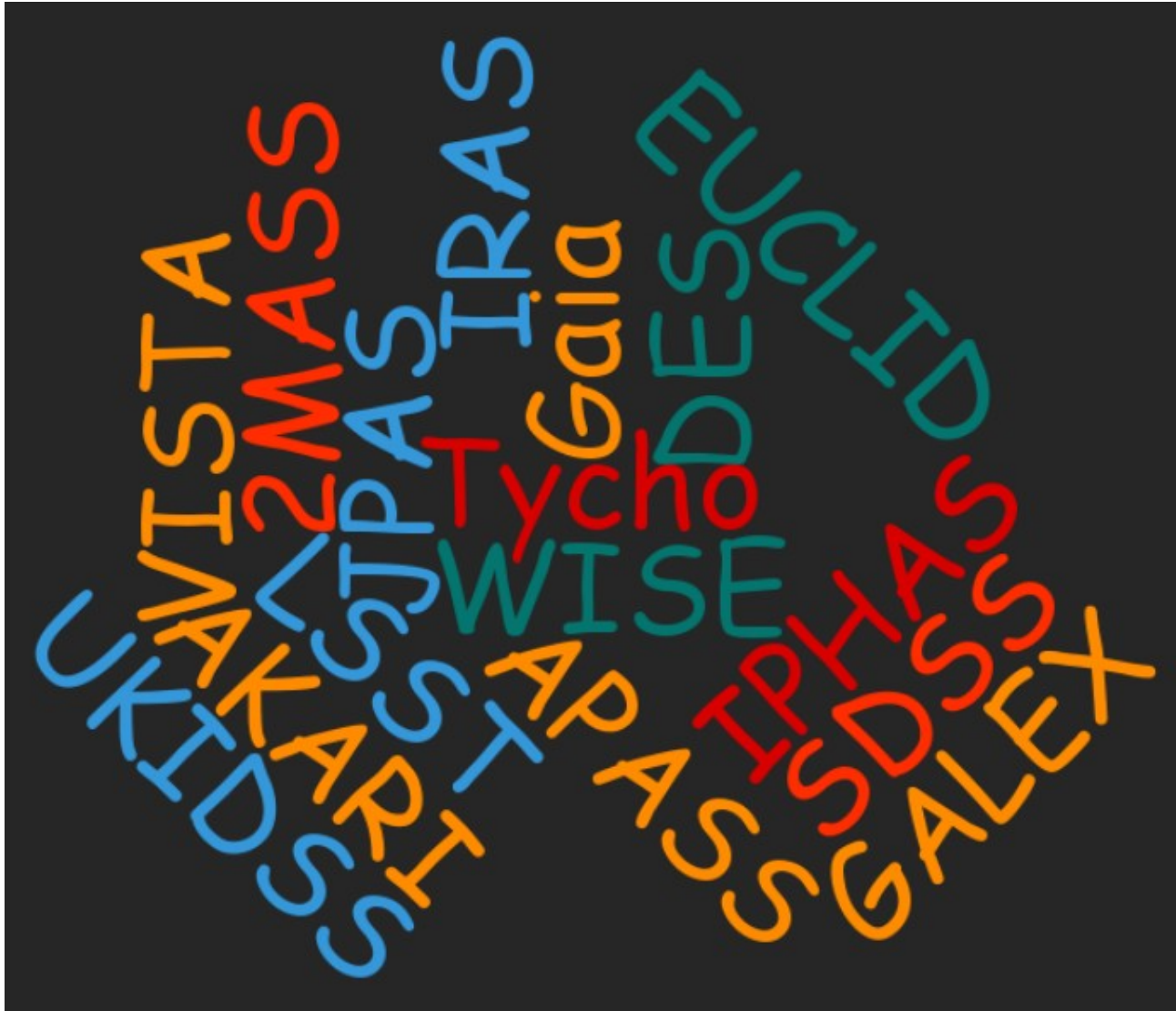
Outline

- Why use Spectral Energy Distributions (SEDs)?
- If you work with SEDs, why use VOSA?
- Example of science cases with Gaia and VOSA.

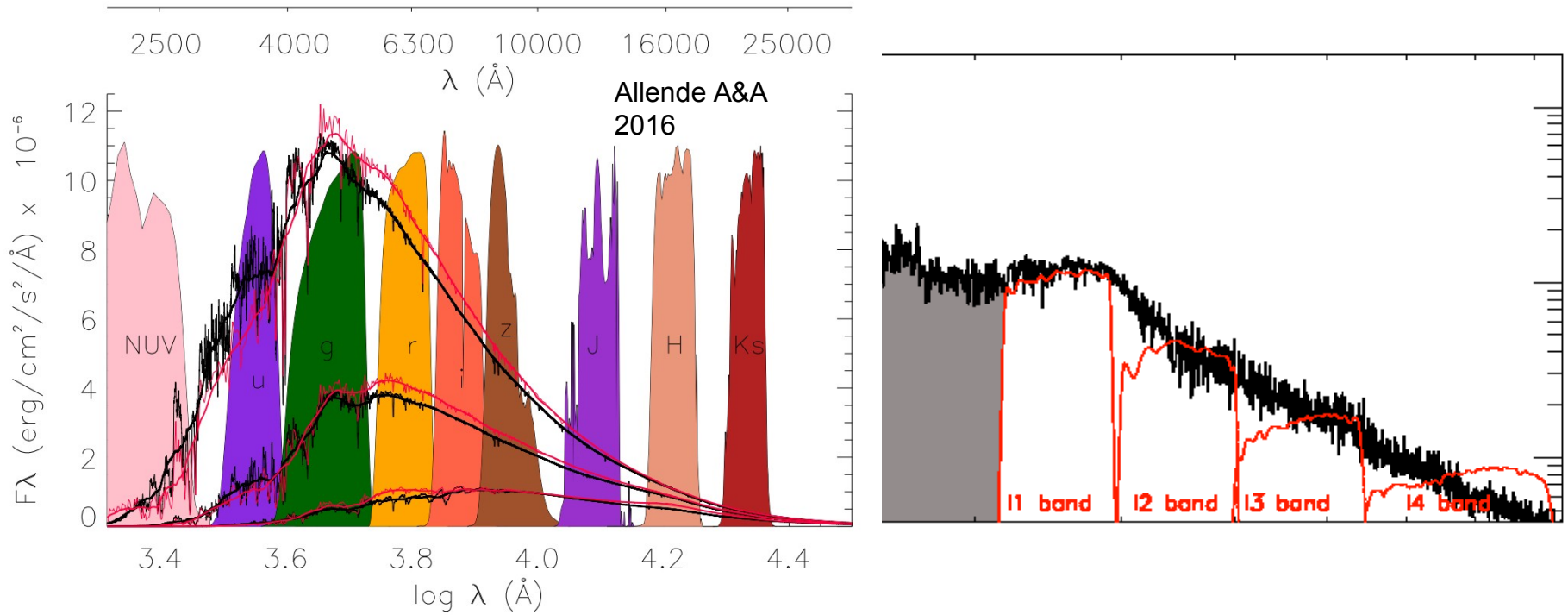
Why SEDs (Spectral Energy Distributions)?



Why SEDs (Spectral Energy Distributions)?



Why SEDs (Spectral Energy Distributions)?



$$F_{Bol} = \int_0^\infty F_\nu d\nu$$

Building SEDs



How to build a Spectral Energy Distribution?

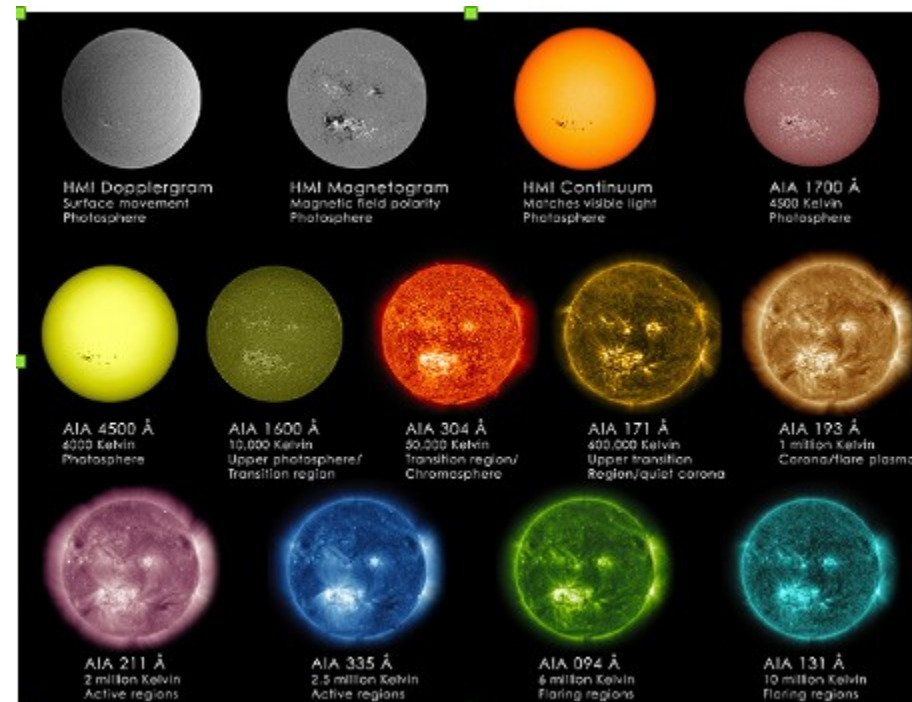
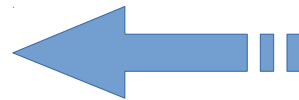
Ingredients



- **Multiwavelength photometry**



Data discovery,
gathering and
manipulation.



Building SEDs

Data discovery
gathering &
manipulation



• Observational data



• Theoretical data

SVD theoretical services VOSA Filters Models Documents data Newsletter Uploads Logout

Theoretical spectra

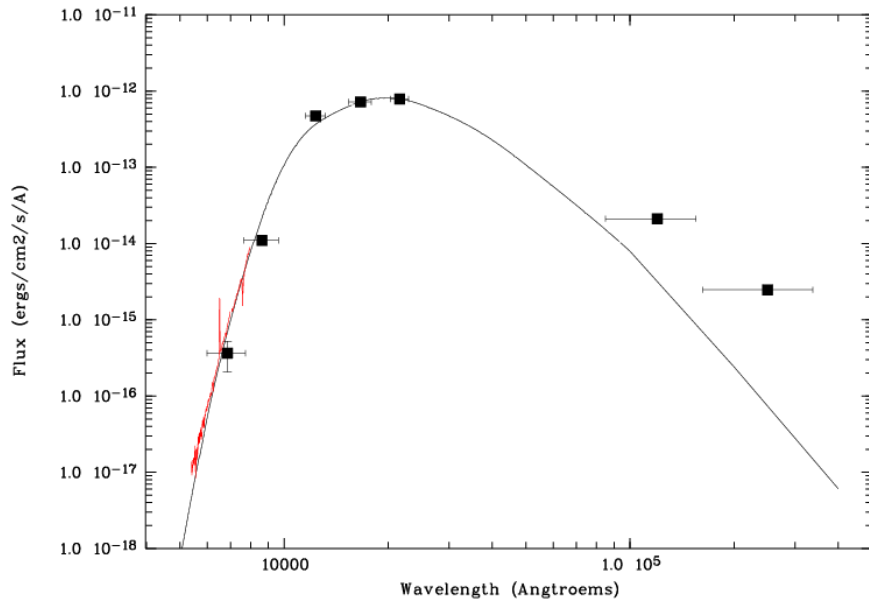
Theoretical Spectra Web Server

Stellar Spectra Models

<p>▶ AMES-Cond 2000</p> <p>The AMES-Cond Model grid of theoretical spectra. (More info)</p>	<p>▶ AMES-L Dusty 2000</p> <p>The AMES-L Dusty Model grid of theoretical spectra (More info)</p>
<p>▶ Black Body flux</p> <p>Black Body flux as calculated in the BT-NextGen model. (More info)</p>	<p>▶ Black Body flux</p> <p>Black Body flux.</p>
<p>▶ BT-COND</p> <p>The BT-COND Model grid of theoretical spectra. (More info)</p>	<p>▶ BT-DUSTY</p> <p>The BT-DUSTY Model grid of theoretical spectra. (More info)</p>
<p>▶ BT-NextGen (AGSS2009)</p> <p>The NextGen Model grid of theoretical spectra; Gas phase only, valid for $T_{\text{eff}} > 2700$ K. Updated opacities. (More info)</p>	<p>▶ BT-NextGen (GNS93)</p> <p>The NextGen Model grid of theoretical spectra; Gas phase only, valid for $T_{\text{eff}} > 2700$ K. Updated opacities. (More info)</p>
<p>▶ BT-Settl</p> <p>The BT-Settl Model grid of theoretical spectra; With a cloud model, valid across the entire parameter range. (More info)</p>	<p>▶ BT-Settl 2014</p> <p>Building the grid. Work in progress (More info)</p>

Building SEDs: Difficulties


- Data Manipulation: From magnitudes to fluxes**



[I/337/gaia](#) [Gaia DR1 \(Gaia Collaboration, 2016\)](#)
[Post annotation](#) [GaiaSource data \(Download Gaia Sc](#)


 [start AladinLite](#)

Full	RA ICRS deg	DE ICRS deg	<Gmag> mag
1	063.4107528711	-89.9888879972	17.965
2	037.5117084305	-89.9858176527	16.664
3	084.7593492719	-89.9781776713	18.553
4	081.5942616579	-89.9832765720	20.472
5	070.9024070024	-89.9715663343	19.829
6	060.8702751299	-89.9781334323	19.492
7	073.1733654732	-89.9817426647	20.019
8	027.3236159503	-89.9767950251	17.006
9	029.9573489468	-89.9759664621	18.649
10	020.0044580076	-89.9836077196	19.202


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GAIA DATA RELEASE DOCUMENTATION



[Gaia Data Release 1 Documentation release D.0](#)

[+] Gaia Data Release 1
Documentation release D.0

- [Introduction to Gaia DR1](#)
- [Full Gaia Data Processing](#)

[5 Photometry](#)

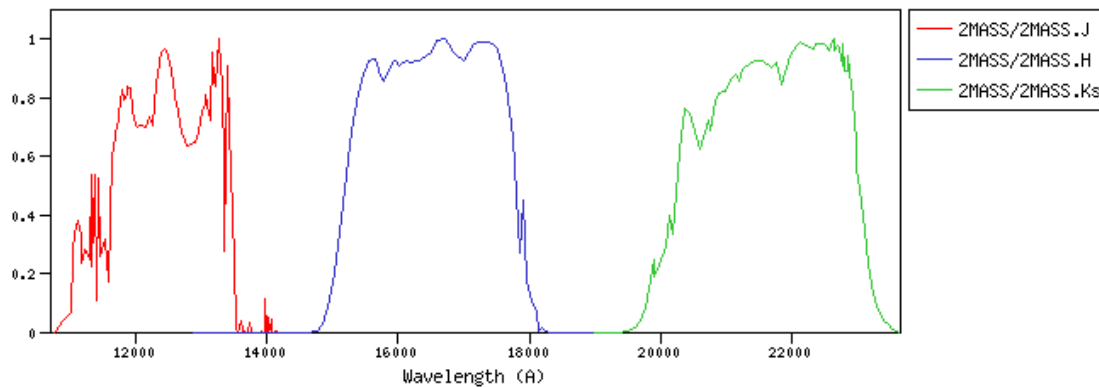
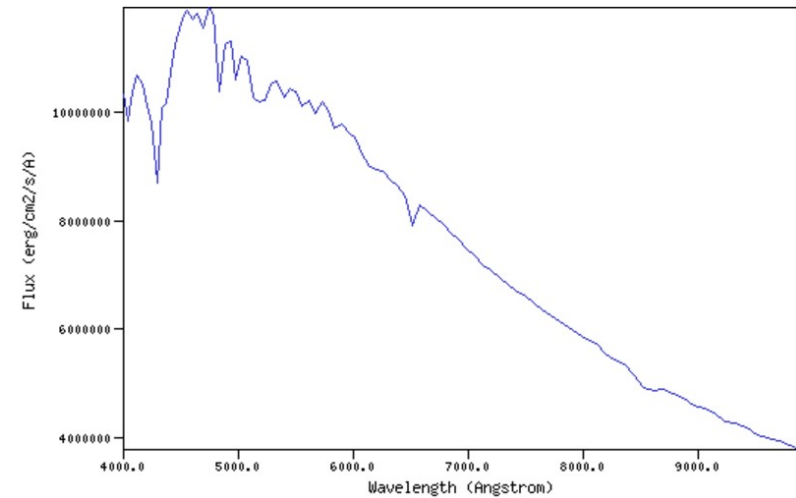
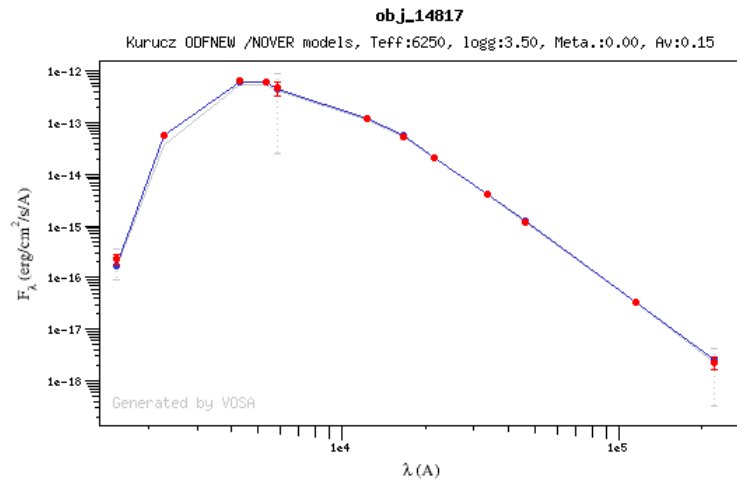
5.3 Calibration models

[5.4 Processing steps](#)

$$m_x = -2.5 \log_{10} \left(\frac{F_x}{F_{x,0}} \right)$$

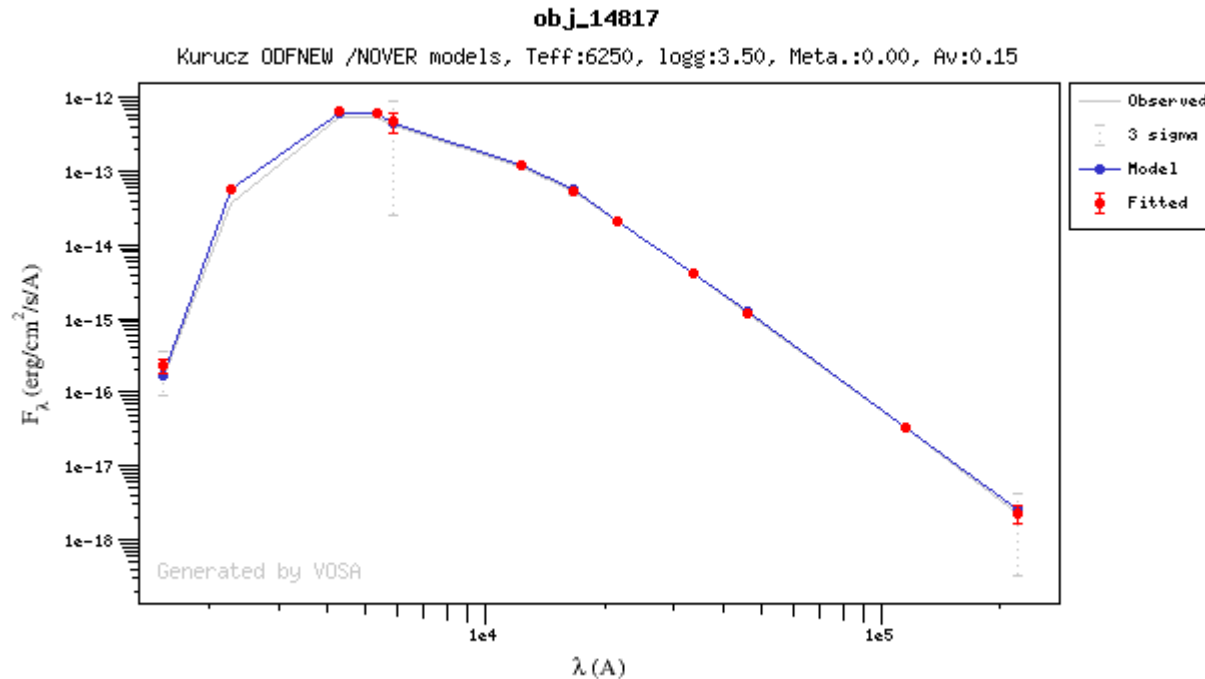
Building SEDs: Difficulties

- **Data Manipulation: From theoretical spectra to synthetic photometry**



Building SEDs: Difficulties

- Data Analysis: Model fitting



Which approach is best? Chi2? Bayes? Others?

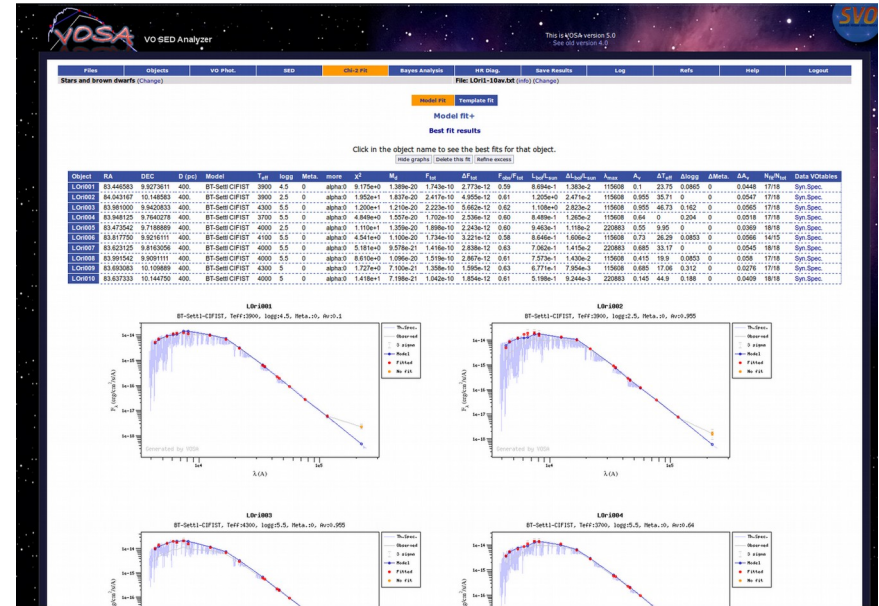
CHALLENGE



Build your favourite SED by hand.

VOSA to the rescue

<http://svo2.cab.inta-csic.es/theory/vosa/>



- Available since 2008.
- More than 800 users.
- More than 1.000.000 objects.

VOSA to the rescue

- More than 70 refereed papers

A&A 492, 277-287 (2008)
DOI: 10.1051/0004-6361:200810395

VOSA: virtual observatory SED analyzer

An application to the Collinder 69 open cluster

A. Bayo^{1,2}, C. Rodrigo
Allard³

The first planet detected in the WTS: an inflated hot Jupiter in a 3.35 d orbit around a late F star*

M. Cappetta¹, R. P. Saglia^{1,2}, J. L. Birkby^{3,4}, J. Koppenhoefer^{1,2}, D. J. Pinfield⁵, P. Cruz⁶, G. Kovács³, B. Sipőcz⁵, D. Barrado^{6,7}, B. Nefs⁴, Y. V. Pavlenko⁸, L. I. C. del Burgo^{10,11,12}, E. L. Martín¹³, I. Snellen⁴, J. Barnes⁵, A. Bayo¹⁴, D. A. C. M. C. Gálvez-Ortiz¹³, N. Goulding⁵, C. Haswell⁹, O. Ivanyuk⁸, H. R. Jones⁵, M. N. Lodieu⁷, F. Marocco⁵, D. Mislis³, F. Murgas^{15,16}, R. Napiwotzki⁵, E. Pallé¹¹, L. Sarro Baro¹⁸, E. Solano^{6,19}, P. Steele¹, H. Stoev⁶, R. Tata^{15,16} and J. Zendejas¹⁷

and F.

A&A 556, A144 (2013)

Proper motions of young stars in Chamaeleon II. New kinematical candidate members of Chamaeleon I and II*

Belén López Martí¹, Francisco Jiménez-Esteban^{1,2,3}, Amelia Bayo^{4,5}, David Barrado^{1,6}, Enrique Solano^{1,2}, Hervé Bouy¹ and Carlos Rodríguez^{1,2}

Age determination of the HR8799 planetary system using asteroseismology

A. Moya^{1,4}, P. J. Amado², D. Barrado^{1,3}, A. García Hernández², M. Aberasturi¹, B. Montesinos¹ and F. Aceituno²

A&A 554, A20 (2013)

A&A 560, A92 (2013)

Searching for transits in the Wide Field Camera Transit Survey with difference-imaging light curves

J. Zendejas Dominguez^{1,2}, J. Koppenhoefer^{2,1}, R. P. Saglia^{2,1}, J. L. Birkby³, S. T. Hodgkin⁴, G. Kovács⁴, D. J. Pinfield⁵, B. Sipőcz⁵, D. Barrado^{6,7}, R. Bender^{2,1}, C. del Burgo⁸, M. Cappetta², E. L. Martín⁹, S. V. Nefs³, A. Riffeser¹ and P. Steele²

A Virtual Observatory Census to Address Dwarfs Origins (AVOCADO) I. Science goals, sample selection, and analysis tools

R. Sánchez-Janssen¹, R. Amorín², M. García-Vargas³, J. M. Gomes⁴, M. Huertas-Company⁵, F. Jiménez-Esteban^{6,7,8}, M. Mollá⁹, P. Papaderos⁴, E. Pérez-Montero², C. Rodrigo^{6,7}, J. Sánchez Almeida^{10,11} and E. Solano^{6,7}

The Seven Sisters DANCE

I. Empirical isochrones, luminosity, and mass functions of the Pleiades cluster****

H. Bouy¹, E. Bertin², L. M. Sarro³, D. Barrado¹, E. Moraux⁴, J. Bouvie⁵ and Y. Beletsky⁷

A&A 574, A57 (2015)

The Astrophysical Journal Supplement Series > Volume 216 > Number 2

A GALEX-based Search for the Sparse Young Taurus-Aurigae Star Forming Region

Ana I. Gómez de Castro¹, Javier Lopez-Santiago¹, Fatima López-Martínez¹, Néstor Sánchez², Paolo Manziari³, Manuel Cornide², and Javier Yañez Gestoso¹

HD 85567: A Herbig B[e] star or an interacting B[e] binary?

Resolving HD 85567's circumstellar environment with the VLTI and AMBER***

H. E. Wheelwright, G. Weigelt, A. C. M. de Koter, and M. J. Barlow

A&A 558, A116 (2013)

A&A 566, A103 (2014)

High-resolution imaging of Kepler planet host candidate HD 170582. A comprehensive comparison of different techniques*

J. Lillo-Box, D. Barrado and H. Bouy

Warm debris disks candidates in transiting planets systems

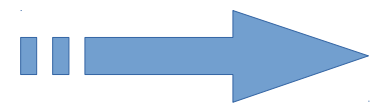
Á. Ribas¹, B. Merín¹, D. R. Ardila² and H. Bouy³

Fundamental parameters of the close interacting binary HD 170582 and its luminous accretion disc

R. E. Mennickent^{1,4}, G. Djurašević², M. Cabezas¹, A. Cséki², J. G. Rosales¹, E. Niemczura³, I. Araya⁴ and M. Curé⁴

and T. Lüttinger³

Why VOSA? Because...



Files	Objects	Build SEDs	Analyse SEDs	HR Diag.	Results	Help
-------	---------	------------	--------------	----------	---------	------

Stars and brown dwarfs (Change)

No file selected (Select/upload a file)

Upload your own data file (max size=500Kb)

It must comply with the [required data format](#)
(A small utility is available to help you to convert an original file in [ascii \(csv\)](#) or [votable](#) to VOSA input format)

File to upload:

Description:

File type:

- Fluxes (erg/cm²/s/A)
- Fluxes (Jy)
- Magnitudes

Create a single object data file

Just write the coordinates (in decimal degrees) of one object that you want to study and we will create a single object data file with the adequate format.
RA and DEC are compulsory.

RA: (deg)

DEC: (deg)

Obj.Name:

Description:

Files that have not been used in the last 3 months have been 'archived' to save disk space. However, if you want to use an archived file, just click the 'Restore' link and it will be available again.

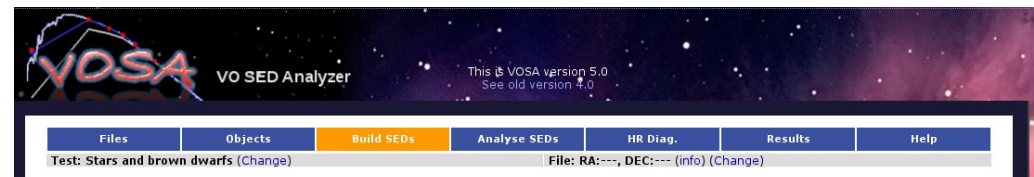
Please, whenever you are done with a file and you do not need it to be archived by us anymore, we would appreciate if you could delete it. VOSA space is large but it has its limits!

Why VOSA? Because...

- **Multiwavelength photometry: observations**

- Given a list of objects, VOSA gathers photometric information & metadata (identifiers, qflags, obs. dates,...) from archives & services using VO protocols (ConeSearch).

- 33 catalogues.
- From the UV to IR.



GAIA DR1

Gaia DR1 contains positions (RA,DEC) and G magnitudes for all sources observed between 25 July 2014 and 16 September 2015 (1142679769 sources). [More Info.](#)

Filters: GAIA/GAIA0.G

Search radius: arcsec

You can apply limits so that magnitudes out of the specified range are not shown

Min mag Max mag

<= GAIA/GAIA0.G <=

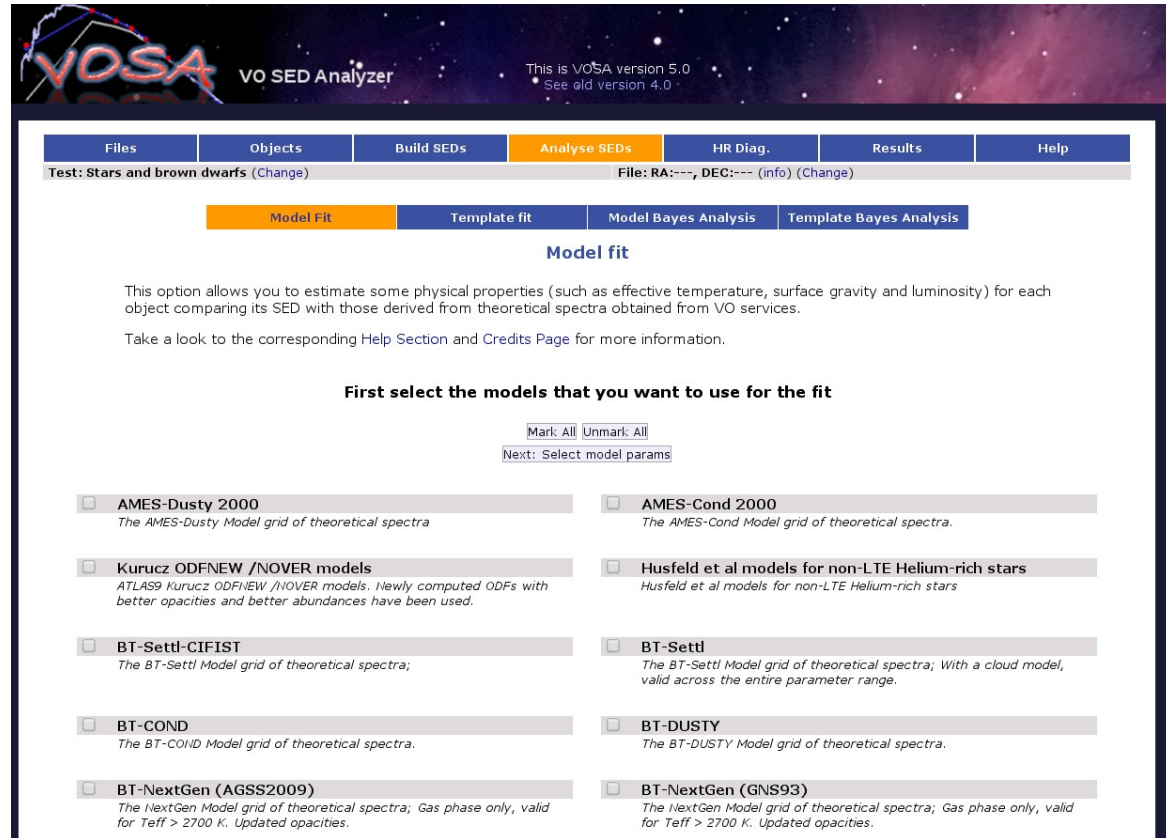
[Hide magnitude limits](#)

- Highly demanded.
- Large area.
- Information on quality.



- **Multiwavelength photometry: models**

- 23 collections of theoretical spectra.
- VO protocols to handle theoretical models in a standard way.
- From O stars to brown dwarfs.
- From giants to white dwarfs.



VO SA VO SED Analyzer

This is VO SA version 5.0
See old version 4.0

Files Objects Build SEDs **Analyse SEDs** HR Diag. Results Help

Test: Stars and brown dwarfs (Change) File: RA:---, DEC:--- (info) (Change)

Model Fit Template fit Model Bayes Analysis Template Bayes Analysis

Model fit

This option allows you to estimate some physical properties (such as effective temperature, surface gravity and luminosity) for each object comparing its SED with those derived from theoretical spectra obtained from VO services.

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

First select the models that you want to use for the fit

Mark: All Unmark: All

Next: Select model params


<input type="checkbox"/> AMES-Dusty 2000 <i>The AMES-Dusty Model grid of theoretical spectra</i>	<input type="checkbox"/> AMES-Cond 2000 <i>The AMES-Cond Model grid of theoretical spectra.</i>
<input type="checkbox"/> Kurucz ODFNEW /NOVER models <i>ATLAS9 Kurucz ODFNEW /NOVER models. Newly computed ODFs with better opacities and better abundances have been used.</i>	<input type="checkbox"/> Husfeld et al models for non-LTE Helium-rich stars <i>Husfeld et al models for non-LTE Helium-rich stars</i>
<input type="checkbox"/> BT-Settl-CIFIST <i>The BT-Settl Model grid of theoretical spectra;</i>	<input type="checkbox"/> BT-Settl <i>The BT-Settl Model grid of theoretical spectra; With a cloud model, valid across the entire parameter range.</i>
<input type="checkbox"/> BT-COND <i>The BT-COND Model grid of theoretical spectra.</i>	<input type="checkbox"/> BT-DUSTY <i>The BT-DUSTY Model grid of theoretical spectra.</i>
<input type="checkbox"/> BT-NextGen (AGSS2009) <i>The NextGen Model grid of theoretical spectra; Gas phase only, valid for $T_{\text{eff}} > 2700$ K. Updated opacities.</i>	<input type="checkbox"/> BT-NextGen (GNS93) <i>The NextGen Model grid of theoretical spectra; Gas phase only, valid for $T_{\text{eff}} > 2700$ K. Updated opacities.</i>

Why VOSA? Because...

- From magnitudes to fluxes and from theoretical spectra to synthetic photometry.


- VOSA takes advantage of the Filter Profile Service to get the needed information (i.e. zeropoints and other filter properties to, for instance, estimate flux overlapping).

- Photometric systems described following the VO Photometric Data Model.



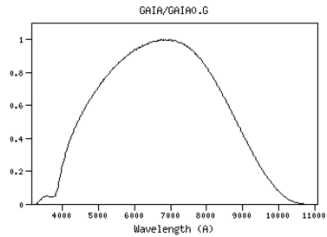
Filter Profile Service

An experiment about filter standardization in the VO

Funded by 

VO Service Browse Search
AuthId:esm@iaeff.inta Passw:*** Login Register

GAIA/GAIA0.G

<p>Filter Description</p> <p>Filter ID (?): GAIA/GAIA0.G Description (?): GAIA G filter pre release Phot.System (?): GAIA Detector.Type (?): Energy counter Band Name (?): ----- Obs. Facility (?): GAIA Instrument (?): GAIA Comments (?): -----</p>	<p>Mathematical properties</p> <table border="1" style="width: 100%; border-collapse: collapse; font-size: small;"> <thead> <tr> <th>Property</th> <th>Calculated</th> <th>Specified</th> <th>Unit</th> </tr> </thead> <tbody> <tr><td>λ_{mean} (?):</td><td>6735.42</td><td>-----</td><td>(Angstrom)</td></tr> <tr><td>λ_{cen} (?):</td><td>6631.79</td><td>-----</td><td>(Angstrom)</td></tr> <tr><td>λ_{eff} (?):</td><td>5857.56</td><td>-----</td><td>(Angstrom)</td></tr> <tr><td>λ_{peak} (?):</td><td>7010.00</td><td>-----</td><td>(Angstrom)</td></tr> <tr><td>λ_{pivot} (?):</td><td>6573.25</td><td>-----</td><td>(Angstrom)</td></tr> <tr><td>λ_{phot} (?):</td><td>6153.86</td><td>-----</td><td>(Angstrom)</td></tr> <tr><td>λ_{min} (?):</td><td>3321.39</td><td>-----</td><td>(Angstrom)</td></tr> <tr><td>λ_{max} (?):</td><td>10514.70</td><td>-----</td><td>(Angstrom)</td></tr> <tr><td>W_{eff} (?):</td><td>4203.60</td><td>-----</td><td>(Angstrom)</td></tr> <tr><td>FWHM (?):</td><td>4396.69</td><td>-----</td><td>(Angstrom)</td></tr> <tr><td>A_f/A_v (?):</td><td>0.94</td><td>-----</td><td>()</td></tr> </tbody> </table>	Property	Calculated	Specified	Unit	λ_{mean} (?):	6735.42	-----	(Angstrom)	λ_{cen} (?):	6631.79	-----	(Angstrom)	λ_{eff} (?):	5857.56	-----	(Angstrom)	λ_{peak} (?):	7010.00	-----	(Angstrom)	λ_{pivot} (?):	6573.25	-----	(Angstrom)	λ_{phot} (?):	6153.86	-----	(Angstrom)	λ_{min} (?):	3321.39	-----	(Angstrom)	λ_{max} (?):	10514.70	-----	(Angstrom)	W_{eff} (?):	4203.60	-----	(Angstrom)	FWHM (?):	4396.69	-----	(Angstrom)	A_f/A_v (?):	0.94	-----	()
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<p>Transmission curve</p>  <p style="font-size: x-small;">Data file: ascii, VOTable</p>	<p>Calibration properties</p> <p>Vega System</p> <table border="1" style="width: 100%; border-collapse: collapse; font-size: x-small;"> <thead> <tr> <th>Property</th> <th>Specified</th> <th>Calculated</th> <th>Unit</th> </tr> </thead> <tbody> <tr><td>Zero Point (?):</td><td>-----</td><td>2.500e-9</td><td>(erg/cm2/s/A)</td></tr> <tr><td></td><td>-----</td><td>2861.30</td><td>(Jy)</td></tr> </tbody> </table> <p>ZP Type (?): Pogson PhotCal ID (?): GAIA/GAIA0.G/Vega</p> <p>AB System</p> <table border="1" style="width: 100%; border-collapse: collapse; font-size: x-small;"> <thead> <tr> <th>Property</th> <th>Specified</th> <th>Calculated</th> <th>Unit</th> </tr> </thead> <tbody> <tr><td>Zero Point (?):</td><td>-----</td><td>3.173e-9</td><td>(erg/cm2/s/A)</td></tr> <tr><td></td><td>-----</td><td>3631.00</td><td>(Jy)</td></tr> </tbody> </table> <p>ZP Type (?): Pogson PhotCal ID (?): GAIA/GAIA0.G/AB</p> <p>ST System</p> <table border="1" style="width: 100%; border-collapse: collapse; font-size: x-small;"> <thead> <tr> <th>Property</th> <th>Specified</th> <th>Calculated</th> <th>Unit</th> </tr> </thead> <tbody> <tr><td>Zero Point (?):</td><td>-----</td><td>3.631e-9</td><td>(erg/cm2/s/A)</td></tr> <tr><td></td><td>-----</td><td>4155.64</td><td>(Jy)</td></tr> </tbody> </table> <p>ZP Type (?): Pogson PhotCal ID (?): GAIA/GAIA0.G/ST</p>	Property	Specified	Calculated	Unit	Zero Point (?):	-----	2.500e-9	(erg/cm2/s/A)		-----	2861.30	(Jy)	Property	Specified	Calculated	Unit	Zero Point (?):	-----	3.173e-9	(erg/cm2/s/A)		-----	3631.00	(Jy)	Property	Specified	Calculated	Unit	Zero Point (?):	-----	3.631e-9	(erg/cm2/s/A)		-----	4155.64	(Jy)												
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Why VOSA? Because...

- And many more things...
- Parameters of interest (e.g. distances, extinction).

Object			Final		User		Gaia TGAS							
Name	RA (deg)	DEC (deg)	Dis (pc)	Δ Dis (pc)	D (pc)	Δ Dis (pc)	Δ (arcsec)	RA (deg)	DEC (deg)	Plx (mas)	Δ Plx (mas)	D (pc)	Δ Dis (pc)	
AK_Pic	99.501523980	-61.533387245	21.295	0.367	21.295	0.367	---	---	---	---	---	---	---	
BD-034778	301.205833	-2.655556	66.907	2.836	66.907	2.836	1.4874278531513	301.20577672353807	-2.6559653324222907	14.946160262675168	0.633445535189698	66.907	2.836	
CP-681894	200.53125	-69.636667	98.892	3.477	98.892	3.477	0.62841099688041	200.53096654040246	-69.63681101855927	10.112062527326222	0.35555658147693964	98.892	3.477	
EG_Cha	129.234167	-78.946111	102.264	6.427	102.26	6.427	0.86741015893762	129.23358291137242	-78.94589766116239	9.77865609415897	0.6145318505980452	102.264	6.427	
HD_217379	345.116473141	-26.311887527	32.009	0.277	32.009	0.277	2.978832064554	345.1170290328832	-26.31254811756945	31.241380996286175	0.2701321530637279	32.009	0.277	

UBV Photometry of O & B Stars in Vela (Denoyelle 1977)



The Spatial Distribution of Young Stars in Vela
Info in catalogue: E(B-V)
More info
Search radius: 5 arcsec

SAI Open Clusters Catalog (Glushkova+, 2009)



Automated search for star clusters in large multiband surveys. II. Discovery and investigation of open clusters in the Galactic plane
Info in catalogue: E(B-V)
More info
Search radius: 5 arcsec

Stellar Spectrophotometric Atlas



Stellar Spectrophotometric Atlas
Info in catalogue: A_V
More info
Search radius: 5 arcsec

Photometric Catalog of Northern Bright Galaxies (Kodaira+ 1992)



Photometric Catalog of Northern Bright Galaxies
Info in catalogue: A_V
More info
Search radius: 5 arcsec

Optically visible open clusters and Candidates (Dias+ 2002-2010)



New catalog of optically visible open clusters and candidates (V3.0)
Info in catalogue: E(B-V)
More info
Search radius: 5 arcsec

Guarinos, 1992



Interstellar matter in the Galactic Disk (Guarinos J., 1992)
Info in catalogue: A_V
More info
Search radius: 5 arcsec

6dF galaxy survey final redshift release (Jones+, 2009)



6dF galaxy survey final redshift release (Jones+, 2009)
Info in catalogue: A_V
More info
Search radius: 5 arcsec

Reddening and extinction at high galactic latitude (Larson+, 2005)



Reddening and the extinction law at high galactic latitude.
Info in catalogue: E(B-V)
More info
Search radius: 5 arcsec

RR Lyrae Metallicities (Layden 1994)



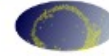
RR Lyrae data II. The Metallicities and Kinematics of Local RR Lyrae
Info in catalogue: A_V
More info
Search radius: 5 arcsec

UV Interstellar Extinction (Savage+ 1985)



A Catalogue of UV Interstellar Extinction Excesses for 1415 stars
Info in catalogue: E(B-V)
More info
Search radius: 5 arcsec

The R_V extinction factor, Morales+, 2006



The R_V extinction factor
Info in catalogue: E(B-V), R_V
Search radius: 5 arcsec

Kainulainen+ 2009



Info in catalogue: A_V
Search radius: 5 arcsec

STELIB: A library of stellar spectra at R~2000 (Le Borgne+, 2003)



STELIB: A library of stellar spectra at R~2000
Info in catalogue: A_V
More info
Search radius: 5 arcsec

Extinction map. Morales+, 2006



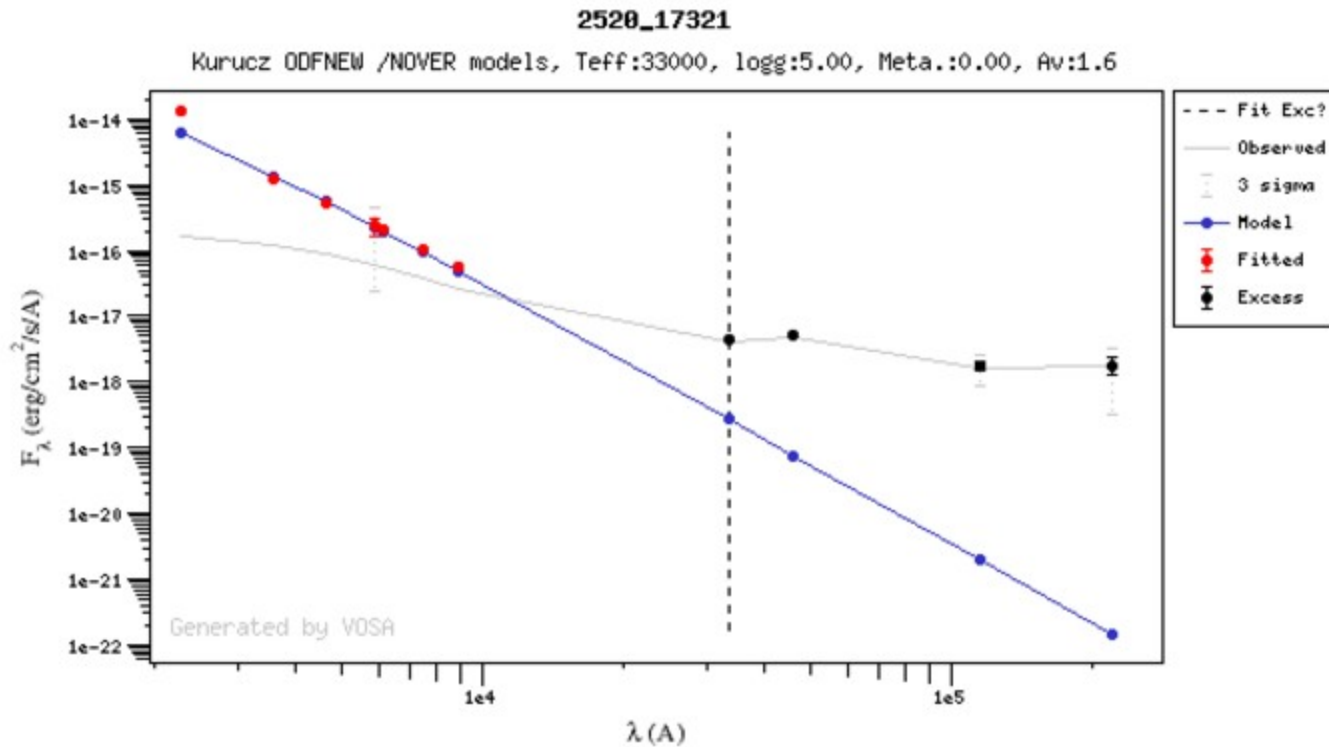
Extinction map.
Info in catalogue: E(B-V), R_V , A_V
Search radius: 5 arcsec

SWIRE Photometric Redshift Catalogue

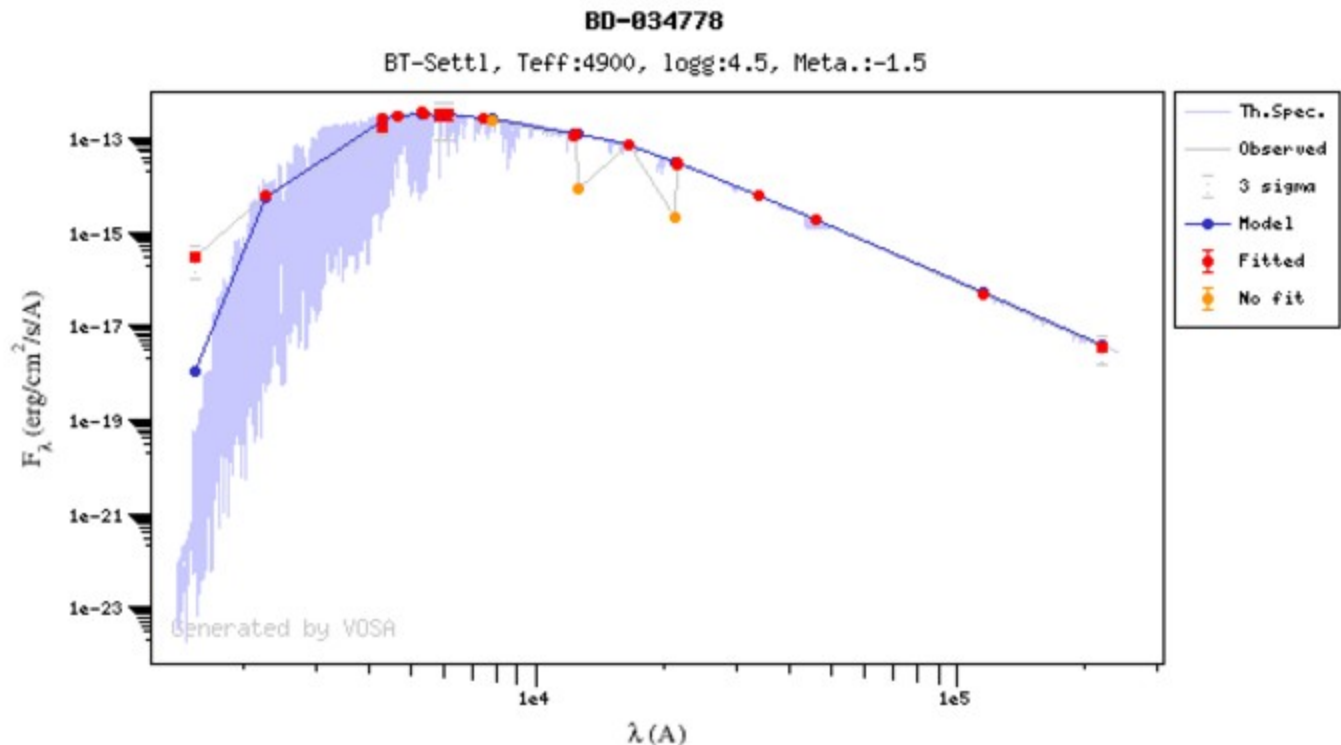


Photometric redshifts in the SWIRE Survey.
Info in catalogue: A_V
More info
Search radius: 5 arcsec

- And many more things...
 - Identification of IR excess




- **And many more things...**
 - **Identification of bad photometric points (not considered in the fit)**

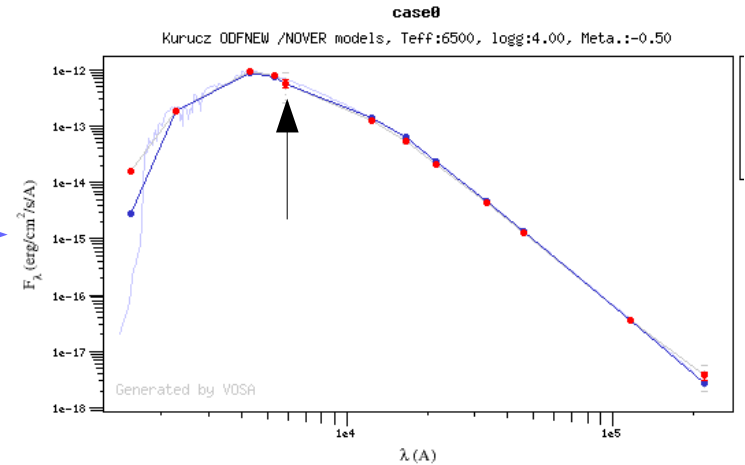


Science case #1: Determination of physical parameters

[I/337/gaia](#) [Gaia DR1 \(Gaia Collaboration, 2016\)](#)
[Post annotation](#) [GaiaSource data \(Download Gaia Source Catalogue\)](#)

 start AladinLite

<i>Full</i>	<u>RA_ICRS</u>	<u>DE_ICRS</u>	<u><Gmag></u>
	<u>deg</u>	<u>deg</u>	<u>mag</u>
<u>1</u>	063.4107528711	-89.9888879972	17.965
<u>2</u>	037.5117084305	-89.9858176527	16.664
<u>3</u>	084.7593492719	-89.9781776713	18.553

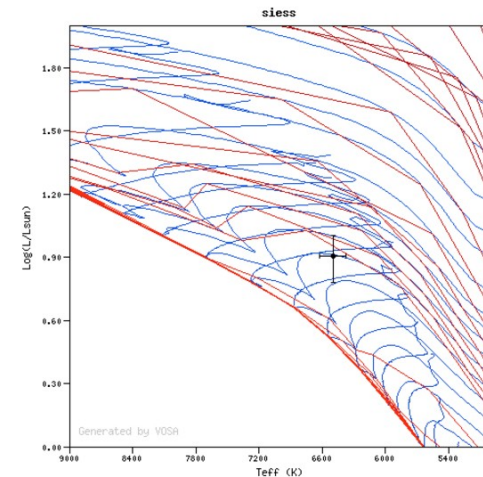


Objects						
Object	Model	T _{eff}	LogL	Age	Mass	
case0	siess	6500 (6375,6625)	0.9087 (0.7817,1.0067)	0.0102 (0.0090,2.0403)	[1]	1.5997 (1.4995,1.7141)

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

Gaia TGAS

RA (deg)	DEC (deg)	Plx (mas)	ΔPlx (mas)
301.8466189871131	-42.070408408686404	4.367777320347275	0.3432906180577608



Science case #1: Disk characterization

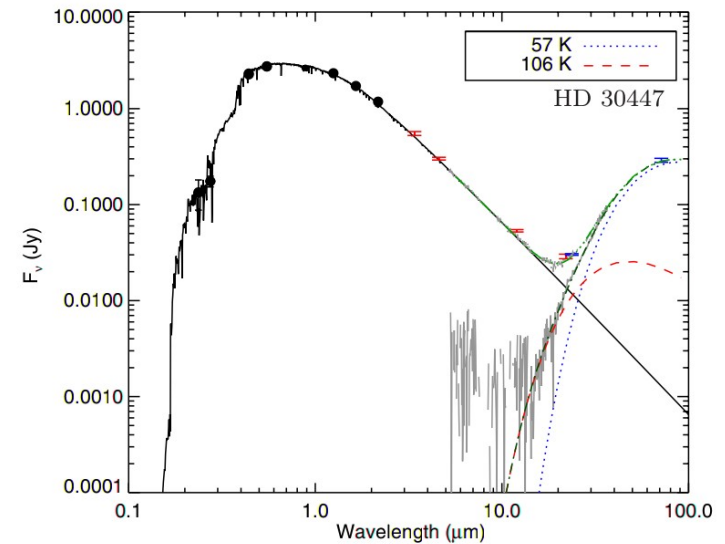
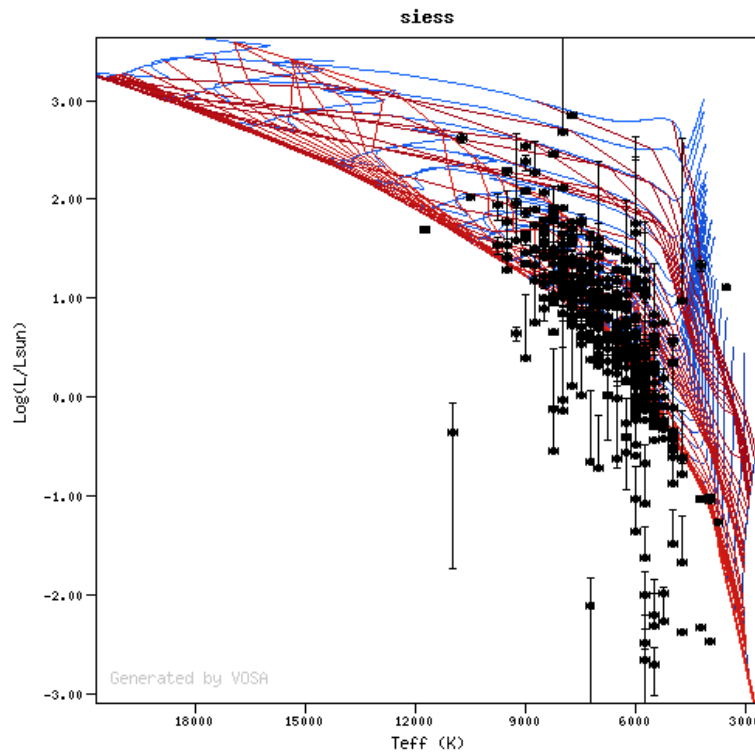
THE ASTROPHYSICAL JOURNAL SUPPLEMENT SERIES, 211:25 (22pp), 2014 April
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doi:10.1088/0067-0049/211/2/25

THE *SPITZER* INFRARED SPECTROGRAPH DEBRIS DISK CATALOG. I. CONTINUUM ANALYSIS OF UNRESOLVED TARGETS

CHRISTINE H. CHEN¹, TUSHAR MITTAL², MARC KUCHNER³, WILLIAM J. FORREST⁴, CAREY M. LISSE⁵, P. MANOJ⁶,
BENJAMIN A. SARGENT⁷, AND DAN M. WATSON⁴

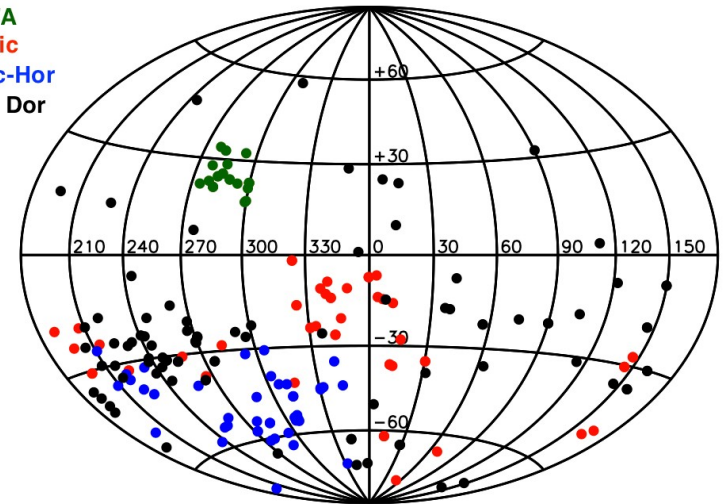
- Detailed characterization of the photospheric component
- Disk evolution with age



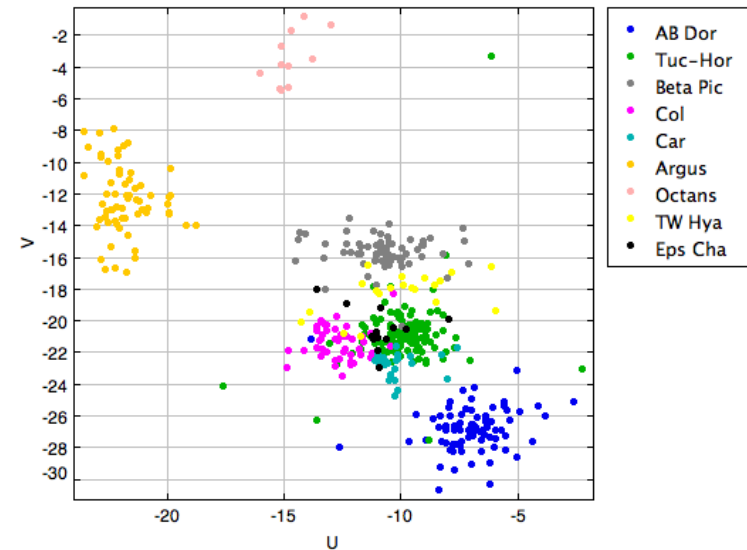
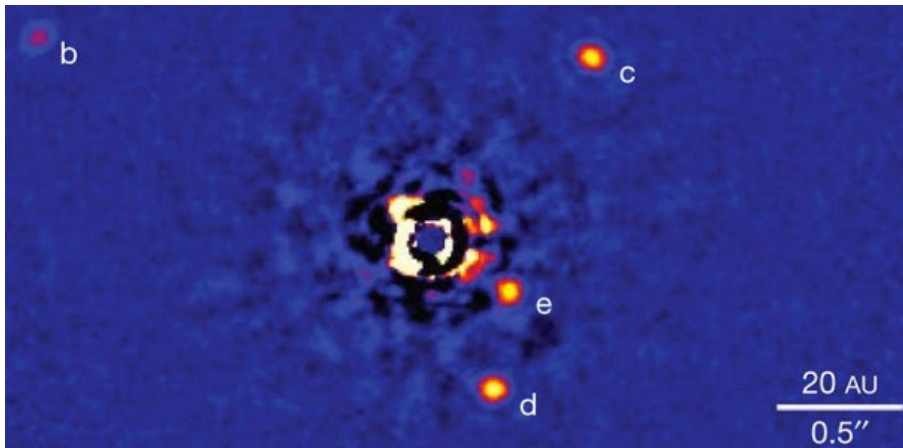
Science case #2: Stellar associations



TWA
 β Pic
Tuc-Hor
AB Dor



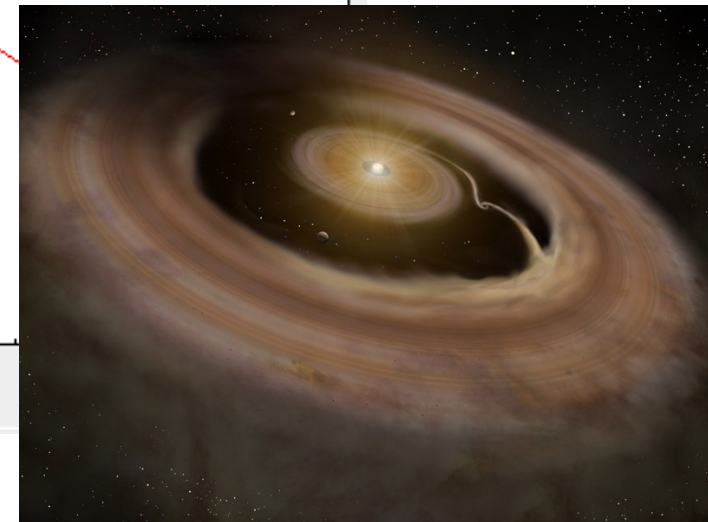
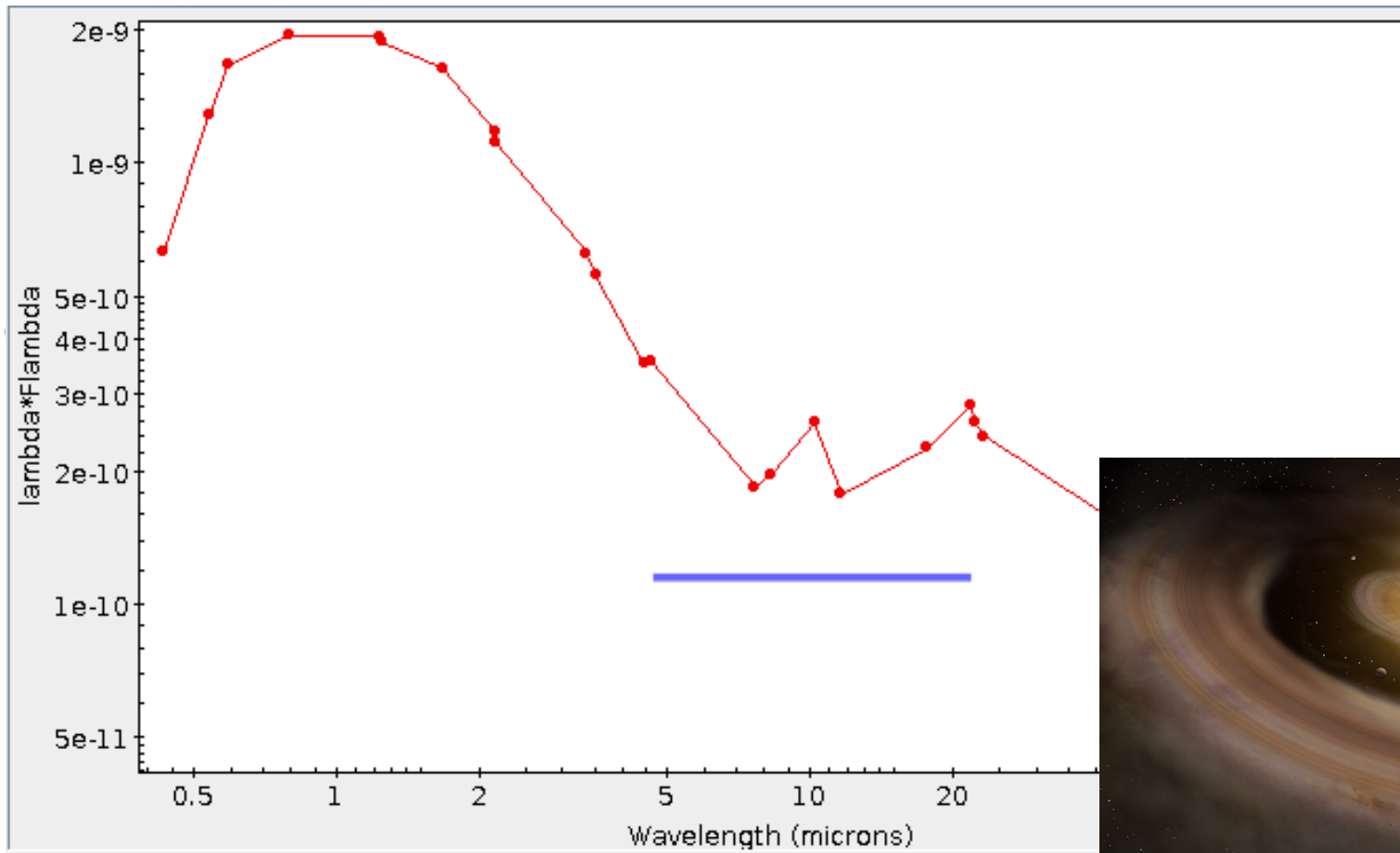
- < 150 pc
- 5 – 100 My



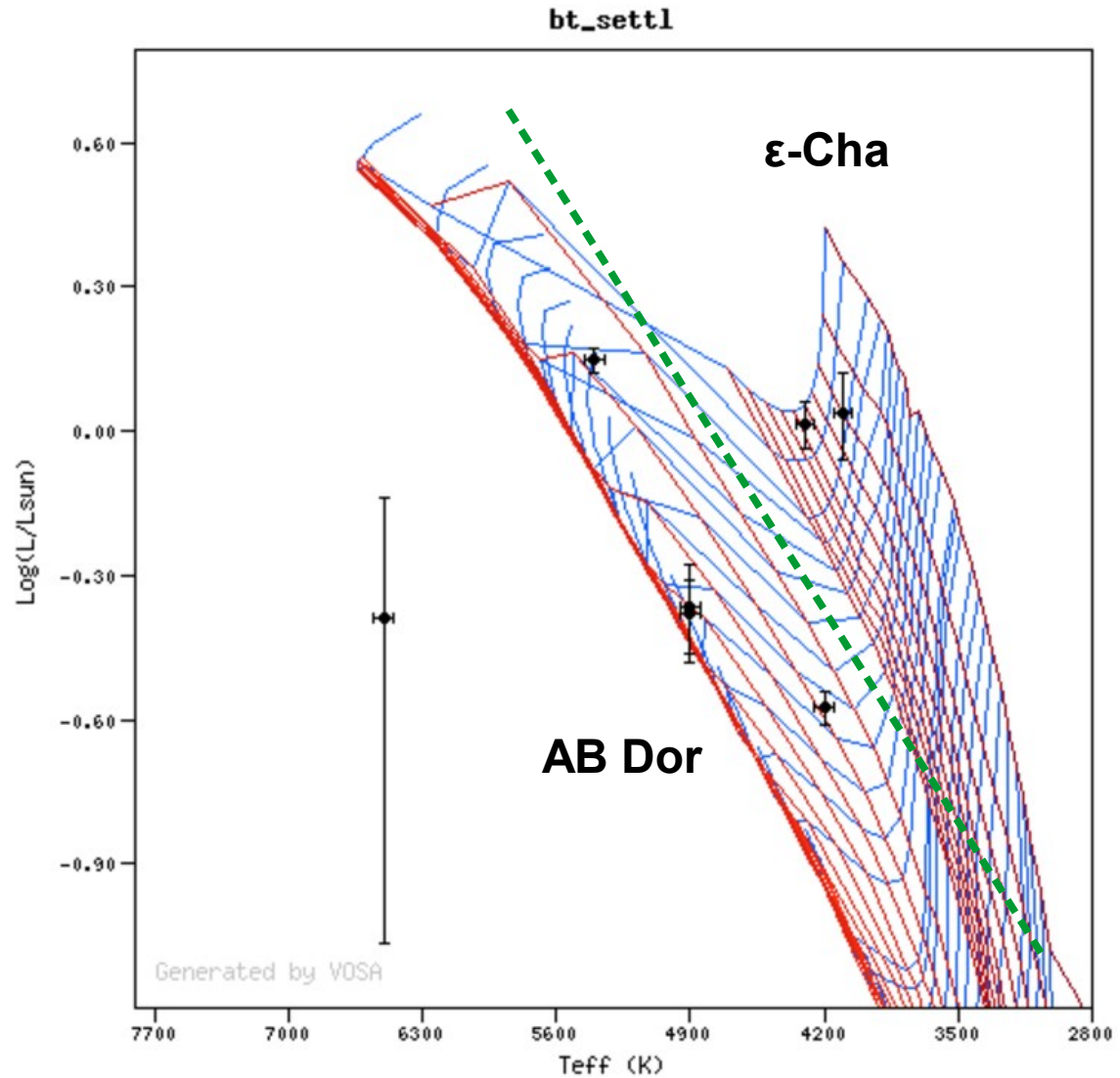
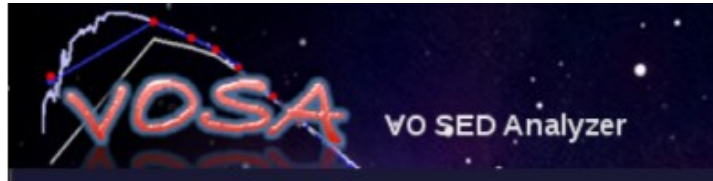
Science case #2: Identification of disks

CP-681894

BT-Settl, Teff:4300, logg:4, Meta.: -1.5



Science case#2: Age estimation



Science case #3

arXiv.org > astro-ph > arXiv:1609.04389

Search or

Astrophysics > Earth and Planetary Astrophysics

Accurate, Empirical Radii and Masses of Planets with Gaia Parallaxes

Keivan G. Stassun (1,2), Karen A. Collins (1), B. Scott Gaudi (3) ((1) Vanderbilt University, (2) Fisk University, (3) Ohio State University)

(Submitted on 14 Sep 2016 (v1), last revised 15 Sep 2016 (this version, v2))

We present new, empirical measurements of the radii of 132 stars that host transiting planets. These stellar radii are determined using only direct observables---the bolometric flux at Earth, the stellar effective temperature, and the parallax newly provided by the Gaia first data release---and thus are virtually model independent, extinction being the only free parameter. We also determine each star's mass using our newly determined radius and the stellar density, itself a virtually model independent quantity from the previously published transit analysis. The newly determined stellar radii and masses are in turn used to re-determine the transiting planet radii and masses, once again using only direct observables. The uncertainties on the stellar radii and masses are typically 8% and 30%, respectively, and the resulting uncertainties on the planet radii and masses are 9% and 22%, respectively. These accuracies are generally larger than the previously published model-dependent precisions of 5% and 6% on the planet radii and masses, respectively, but the newly determined values are purely empirical. We additionally report stellar radii for 366 stars that host radial-velocity (non-transiting) planets, with a typical achieved accuracy in the radii of 2%. Most importantly, the stellar bolometric fluxes and angular radii reported here---with typical accuracies of 1.7% and 1.8%, respectively---will serve as a fundamental data set to permit the re-determination of the planet radii and masses with the (1st Gaia) second data release to 3% and 5% accuracy, comparable to or better than currently published precisions, but in an entirely empirical fashion.

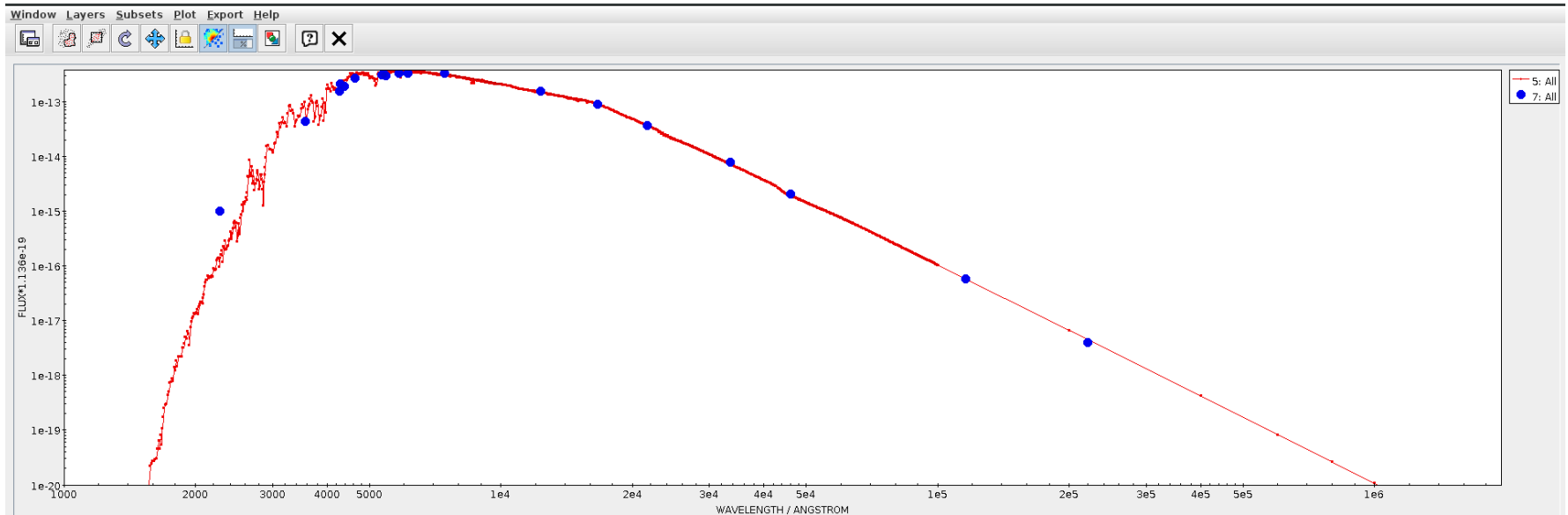
$$\Delta F = \left(\frac{R_{planet}}{R_{star}} \right)^2$$

$$M_p = \frac{K_{RV} \sqrt{1 - e^2}}{\sin i} \left(\frac{P}{2\pi G} \right)^{1/3} M_\star^{2/3}$$

Science case #3

- Masses and radii of planets are necessary to:
 - Shed light on inflated hot-Jupiters.
 - 0.2-2.1MJup. Radii larger than predicted by models.
 - Heat from the star and internal heating.
 - Planet radius as a function of irradiation, age, magnetic fields, winds,...
 - Infer the presence of rocky cores in hot-Jupiters.
 - Impact on formation theories (core accretion vs gravitational instability).

Science case #3



- Empirical determination (model independent) of the radii and masses of stars hosting planets.
- $F_{bol} \rightarrow$ empirical
- $L_{bol} = 4\pi D^2 F_{bol}$ (D from TGAS parallaxes)
- $R = \sqrt{L_{bol} / (4\pi\sigma T_{eff}^4)}$
- $g = G M / R^2$

Do you want to know more?

- vosa-support@cab.inta-csic.es

- VOSA:

 - <http://svo2.cab.inta-csic.es/theory/vosa/>

- VOSA workflow:

 - https://www.astron.nl/asterics/doku.php?id=open:wp4:view_vosa_tutorial