



- Title: Identifying and characterizing cluster members.
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- Last update: 2019 Nov 1<sup>st</sup>.
- VO-Tools: Clusterix, TOPCAT, VOSA
- **Scientific background:** Open clusters (OCs) are coeval groups of stars formed from the same molecular cloud and, thus, having the same age and initial chemical composition. This makes them ideal targets to study the formation and evolution of stellar objects.

The determination of the mean properties of open clusters requires prior knowledge of their members to optimise the costly process of obtaining and reducing high resolution spectroscopic data on a large scale. Hence, a precise identification of the stars that compose a cluster is critical to accurately determine the kinematic and fundamental parameters of the clusters (age, total mass, etc.), which are essential for studies of Galactic dynamics.

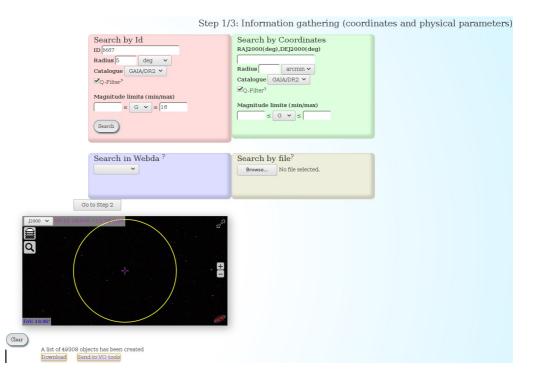
In this tutorial we will work with M67, an old cluster (~3.6 Gyr) at about 900 pc with a near solar metallicity and low reddening. M67 is one of the best studied open clusters, considered a cornerstone of stellar astrophysics and used as a calibrator in many surveys. However there is no study covering a large area in spite of some studies on its corona showing that it is an extended cluster. Gaia Collaboration et al. (2018b) studied an area of 1 deg with G <20 and found 1520 members.

Detailed information on Clusterix is given in Balaguer-Núñez et al. (https://arxiv.org/abs/1910.07356)

- Using Clusterix to estimate cluster membership probabilities.
  - $\circ \quad \text{Go to Clusterix web server} \rightarrow \underline{\text{http://clusterix.cab.inta-csic.es/clusterix/}}$
  - Fill in the fields as shown in Figure 1. Click "Search"

	● Clusterix 2.0 ●
This is a beta ve	rsion. Clusterix is still in development which means you can encounter some bugs or experience some changes as we are constantly adjusting and improving the application. × If you want to know more about the project, submit feedback or report a bug, please <b>contact us</b>
	teractive web-based application to calculate the grouping probability of a list of objects using proper motions and the non parametric method proposed by Cabrera-Caño& Alfaro in Galadi-Enriquez et al. 1998. It also allows the possibility of gathering physical parameters (parallaxes, radial velocities, proper motions,) from Vizier and estimating effective temperatures, surface gravities and metallicities using VOSA. For more information visit the following link Step 1/3: Information gathering (coordinates and physical parameters)
Search by Id ID [M67 Radius 5 deg Catalogue GAIA/DR2	Search by Coordinates RAJ2000(deg), DEJ2000(deg) Radius arcmin v Catalogue GALA/DR2 v Q-Filter Magnitude limits (min/max) S C v S
Search in Webda ?	Search by file? Browse No file selected.

 The result of the query is visualized using Aladin, where the objects obtained from the query are plotted as red diamonds. The individual representation of objects is limited to 40 000. If the result of a query exceeds this amount, then just a yellow circle enclosing the search region is drawn. (Figure 2)



## Figure 2

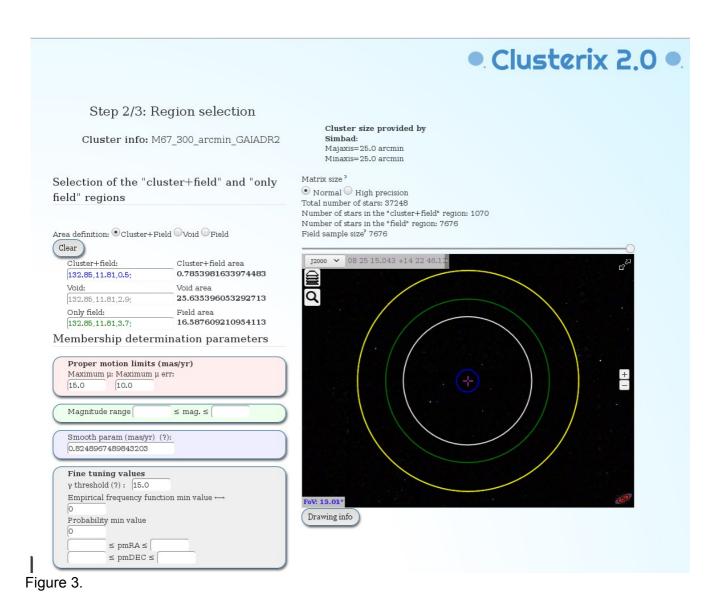
- Click on "Go to Step 2" to proceed to **Step2**.
  - The second step is to select the *cluster+field* (c+f) and *only field* (f) regions. The definition of these areas is one of the most critical decisions to take by the user, and Clusterix offers several ways to interactively shape and reshape these areas. The simplest option relies on mouse clicks to draw circles that define the *c+f* and *f* regions. The system also includes an easy way to set up a "clean" area around the c+f region to avoid a region that could still have a significant number of cluster members.

Alternatively, the user can specify the circular areas directly writing their parameters (in decimal degrees) in the corresponding boxes (format: "ra,dec,radius;"). For this tutorial, fill in the fields with the values given in Figure 3.

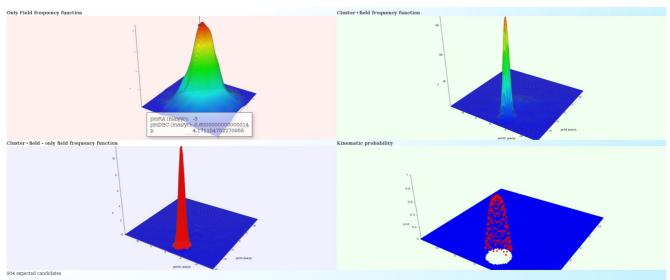
Also, in this second step, the user can customize the following parameters:

- Proper motion limits. Maximum value of the total proper motion (to discard objects that clearly cannot belong to the expected cluster population), and maximum value of the total proper motion error (to remove data of dubious quality).
- Magnitude range to further limit the selection done in Step 1.
- Smoothing parameter. Clusterix 2.0 proposes a default value for the smoothing parameter *h*. It represents the radius of the kernel windows used to compute the frequency functions. A large value would blur out the details of the frequency functions, while a small value would yield noisy results.

 Fine tuning values. To avoid meaningless probability values, Clusterix 2.0 restricts the probability calculations to stars with densities γ times above the noise.



• The distribution functions computed using the parameters given in Figure 3 are shown in Figure 4.



 Once the distribution functions have been computed you can go to Step 3 by clicking "Go to Step 3". Here you can find a summary of the main parameters used in the query as well as the list of cluster members. Those with the highest probabilities are ranked first. (Figure 5).

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Figure 5.

At the top left of this page there is a button "Send to VO tools". Click here to send the table with the membership probabilities to TOPCAT (NOTE: TOPCAT must be open. SAMP broadcasting requires user authorization. A new window ("SAMP Hub Security") may pop up asking for authorization. If so, click "Yes".). After this, a new table with 49 304 rows will be created.

# • Using TOPCAT to visualize the results

- Once the table has been uploaded, we can visualize the results in TOPCAT by doing this:
  - In the TOPCAT main window → Graphics / Plane Plot. A new window "Plane Plot" will pop up.
  - Select the columns to be plotted (X: RA\_PM; Y: DEC\_PM). Use the mouse to center / zoom in / zoom out the graphic. You will clearly see the M67 overdensity in the proper motion parameter space (Figure 6).

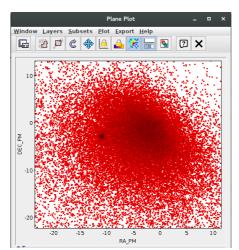
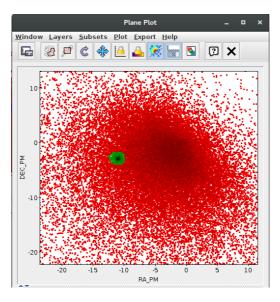


Figure 6.

- Let's now select the M67 members according the probabilities calculated by Clusterix.
  - In the TOPCAT main window → *View / Row Subsets*. A new window *"Row Subsets"* appears.
  - In the Row Subsets window → *Subsets / New subset*. A new window *"Define Row Subset"* pops up.
  - In the Define Row Subset window → *Subset name: filt; Expression:prob>0.8.* Click "OK". (Figure 7)





Alternatively, you can build an histogram with the probability values (TOPCAT main window → *Graphics / Histogram Plot*. A new window *"Histogram Plot*" appears → Select the column to be plotted (X: Prob)) and use it to define your probability cut (Figure 8).

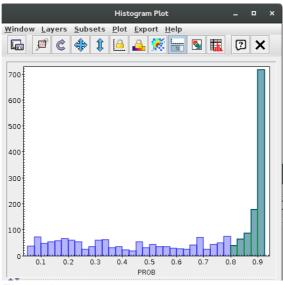


Figure 8

- Let's build now a colour-magnitude diagram with all the sources in the selected field.
  - In the TOPCAT main window → Graphics / Plane Plot. A new window "Plane Plot" will pop up.
  - Select the columns to be plotted (X: BP-RP; Y: Gmag).
  - $\circ$  Click Axes  $\rightarrow$  Tick "Y Flip". (Figure 9)

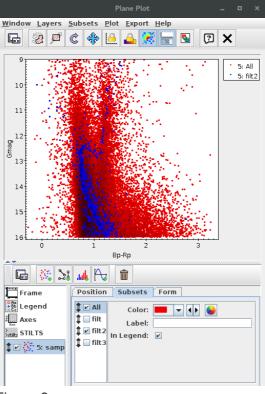


Figure 9.

- The membership selection made by Clusterix is based on proper motions only. Additionally, you can use the information on parallaxes to refine the selection.
  - Graphics / Histogram Plot (X: PLL). In the "Histogram Plot" window, tag "Subset", deselect "All" and tick "filt" (Figure 10).

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Figure 10

- In the TOPCAT main window → View / Row Subsets. A new window "Row Subsets" appears.
- In the Row Subsets window → Subsets / New subset. A new window "Define Row Subset" pops up.
- In the Define Row Subset window → Subset name: filt2; Expression:filt&&pll>0.8&&pll<1.4. Click "OK". The cluster sequence is now clearly seen in the colour-magnitude diagram (Figure 11).

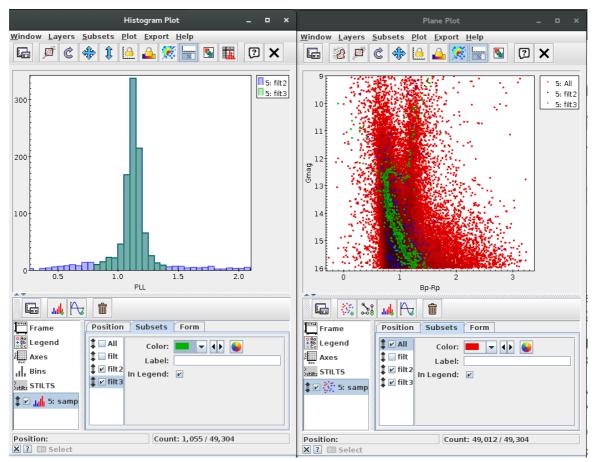


Figure 11

- The next step is to send the selected list of objects to VOSA to estimate their effective temperatures, luminosities and radii. →
  - In the TOPCAT main window → Row Subset: filt2 (to keep the filtered sources only).
  - In the TOPCAT main window → Views / Column info. A new window "Table Columns" appears.
  - In the Table Columns window → Colums / Hide all columns. Then, in the "Visible" column, tick STAR\_NO, RA, DEC
  - In the TOPCAT main window File / Save Table(s) or Session / Filestore Browser → File Name: clusterix4vosa.txt. Output format: ascii → Click "OK". The file will contain 939 rows.

## • Using VOSA to estimate physical parameters

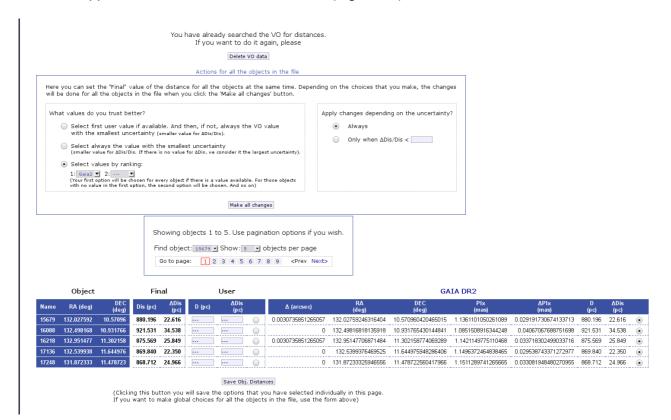
- Step 1.- Go to <u>http://svo2.cab.inta-csic.es/theory/vosa/</u>
- Step 2.- To use VOSA you need to be registered. Click on "Register" and fill in the fields (email, name and passwd).

#### • Tag "Files"

• Step 3.- Upload the vosa\_nice.txt file in VOSA ("File to upload"). It contains a subset (45 objects) of the orginal *clusterix4vosa.txt* file. We work with this subset in order to speed up the workflow. The file vosa\_nice.txt is available from the web page of the school.

Give a description (free text). And then, click "Upload" (do not bother about the File type). The message "*your- file-name has been succesfully uploaded!*" will appear. Click "Continue". If the message does not appear, go to "your files" section and click "Select".

- Tag "Objects"
  - Step 4.- Place the cursor on the "Objects" tag and then click "Distances". Click "Search for Obj. Distances". To make the Gaia DR2 distances the "final" distances, do the following: Go to the "Actions for all the objects in the file" panel, tick "Select values by ranking" and choose Gaia2 in the first place. Click "Make all changes". The Gaia DR2 coordinates will appear in bold in the "Final" column. (Figure 12)





- Tag "Build SEDs"
  - Step 5.- Place the cursor on the "Build SEDs" tag and then click "VO photometry". Here we
    will be able to look for phometric information of our objects in different VO catalogues. In
    order not to slow down too much the tutorial, click "unmark All" and select only 2MASS,

WISE and APASS9. Then, click "*Query selected services*" at the bottom of the page. Once this is done, a summary table with the VO photometry (in flux units) will appear (Figure 13).

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15679 16088 16218	5.88e-15 ± 4.87e-16 5.16e-15 ± 4.61e-16 4.97e-15 ± 2.57e-16 5.61e-15 ± 3.20e-16 4.45e-15 ± 1.56e-16	SLOAN/SDSS.g 6.70e-15 ± 3.33e-16 5.10e-15 ± 1.50e-15 5.17e-15 ± 1.09e-15 5.23e-15 ± 2.09e-15 4.95e-15 ± 5.25e-16	(Flux densities a Go to page: Misc/APASS.V 6.64e-15 ± 5 20e-16 5.43e-15 ± 1 72e-16 5.43e-15 ± 1 55e-16 5.95e-15 ± 1 59e-16 4.89e-15 ± 2 75e-16	are given in erg/cm 1 2 3 <prev h<br="">SLOAN/SDSS.r 6.71e-15 ± 2.54e-16 5.33e-15 ± 5.02e-16 5.36e-15 ± 1.04e-16 4.42e-15 ± 2.68e-16</prev>	12/s/A) lext> SLOAN/SDSS.i 6.84e-15 ± 1.07e-16 3.94e-15 ± 1.03e-16 3.85e-15 ± 1.04e-15 3.51e-15 ± 1.04e-15 3.51e-15 ± 1.04e-16	1.40e-15 ± 3.36e-17 1.52e-15 ± 2.94e-17 1.42e-15 ± 3.13e-17 1.47e-15 ± 3.26e-17 1.36e-15 ± 3.27e-17	6.93e-16 ± 1.98e-17 7.55e-16 ± 1.81e-17 6.90e-16 ± 1.52e-17 7.11e-16 ± 1.70e-17	2.78e-16 ± 8.97e-18 2.91e-16 ± 6.71e-18 2.69e-16 ± 5.70e-18 2.74e-16 ± 7.07e-18	5.60e-17 ± 1.91e-18 5.72e-17 ± 1.32e-18 5.38e-17 ± 1.19e-18 5.66e-17 ± 1.30e-18 5.28e-17 ± 1.17e-18	1.55e-17 ± 5.71e-19 1.60e-17 ± 4.13e-19 1.53e-17 ± 4.21e-19 1.64e-17 ± 4.22e-19	< 7.35e-19 7.80e-19 ± 2.93e-19 < 1.04e-18 6.63e-19 ± 3.11e-19	< 1.74e-18 < 1.31e-18 < 2.02e-18
15679 16088 16218 17136 17248 30955	$\begin{array}{c} 5.88e\cdot15\pm4.87e\cdot16\\ 5.16e\cdot15\pm4.61e\cdot16\\ 4.97e\cdot15\pm2.57e\cdot16\\ 5.61e\cdot15\pm3.20e\cdot16\\ 4.45e\cdot15\pm1.56e\cdot16\\ 4.83e\cdot15\pm3.07e\cdot16\end{array}$	SLOAN/SDSS.g 6 70e-15 ± 3 33e-16 5 10e-15 ± 1 50e-15 5 17e-15 ± 1 03e-15 5 23e-15 ± 2 08e-15 4 95e-15 ± 5 25e-16 5 15e-15 ± 9 63e-16	(Flux densities a Go to page: Misc/APASS.V 664e-15 ± 5 20e-16 5.82e-15 ± 1.72e-16 5.33e-15 ± 1.55e-16 5.35e-15 ± 1.55e-16 5.35e-15 ± 2.75e-16 5.38e-15 ± 2.75e-16	1         2         3 <prev< td="">         N           SLOAN/SDSS,         6         718-15 ± 2548-16         5.138-15 ± 5.628-16         4         5.138-15 ± 5.628-16         4.368-15 ± 2.088-16         5.366-15 ± 1.048-15 ± 2.088-16         4.428-15 ± 2.088-</prev<>	12/s/A) lext> SLOAN/SDSS.i 6.84e-15 ± 1.07e-16 3.94e-15 ± 1.03e-16 3.85e-15 ± 1.04e-15 3.51e-15 ± 1.04e-15 3.51e-15 ± 1.04e-16	1.40e-15 ± 3.36e-17 1.52e-15 ± 2.94e-17 1.42e-15 ± 3.13e-17 1.47e-15 ± 3.26e-17 1.36e-15 ± 3.27e-17 1.42e-15 ± 3.41e-17	6.93e-16 ± 1.98e-17 7.55e-16 ± 1.81e-17 6.90e-16 ± 1.52e-17 7.11e-16 ± 1.70e-17 6.50e-16 ± 1.86e-17	2.78e-16 ± 8.97e-18 2.91e-16 ± 6.71e-18 2.69e-16 ± 5.70e-18 2.74e-16 ± 7.07e-18 2.71e-16 ± 8.00e-18	5.60e-17 ± 1.91e-18 5.72e-17 ± 1.32e-18 5.38e-17 ± 1.19e-18 5.66e-17 ± 1.30e-18 5.28e-17 ± 1.17e-18	1.55e-17 ± 5.71e-19 1.60e-17 ± 4.13e-19 1.53e-17 ± 4.21e-19 1.64e-17 ± 4.22e-19 1.49e-17 ± 3.83e-19	< 7.35e-19 7.80e-19 ± 2.93e-19 < 1.04e-18 6.63e-19 ± 3.11e-19 < 1.23e-18 6.42e-19 ± 3.16e-19	<1.74e-18 <1.31e-18 <2.02e-18 <1.77e-18 <1.88e-18 <1.40e-18
15679 16088 16218 17136 17248 30955 30978	$\begin{array}{c} 5.88e\cdot15\pm4.87e\cdot16\\ 5.16e\cdot15\pm4.61e\cdot16\\ 4.97e\cdot15\pm2.57e\cdot16\\ 5.61e\cdot15\pm3.20e\cdot16\\ 4.45e\cdot15\pm1.56e\cdot16\\ 4.83e\cdot15\pm3.07e\cdot16\\ 4.60e\cdot15\pm8.06e\cdot17\\ \end{array}$	SLOAN/SDSS-g 6.70e-15 ± 3.39e-16 5.10e-15 ± 1.50e-15 5.17e-15 ± 1.09e-15 5.23e-15 ± 2.08e-15 4.95e-15 ± 2.5e-16 5.15e-15 ± 9.63e-16 	(Flux densities a Go to page: Misc/APASS.V 6.64+15±5.20+16 5.622+15±172=16 5.432+15±172=16 5.935+15±159=16 4.893+15±275+16 5.386+15±2736+16 5.818+15	are given in erg/cm           1         2         3 <prev< td="">         N           SLOAN/SDSS.r         6.71e-15 ± 2.54e-16         5.13e-15 ± 5.62e-16         4.55e-15 ± 2.10e-16         5.36e-15 ± 2.10e-16         5.36e-15 ± 2.10e-16         5.36e-15 ± 2.10e-16         5.36e-15 ± 2.10e-16         4.42e-15 ± 2.68e-16         4.81e-15 ± 2.21e-16         5.03e-15         5.03</prev<>	I2/s/A) I2/s/A) 5.84+15 ± 1.07+16 3.84+15 ± 1.07+16 3.84+15 ± 1.08+16 3.51+15 ± 1.08+15 3.59+15 ± 1.36+16 3.76+15 ± 1.66+16 	1.40e-15 ± 3.36e-17 1.52e-15 ± 2.94e-17 1.42e-15 ± 3.13e-17 1.47e-15 ± 3.26e-17 1.36e-15 ± 3.27e-17 1.42e-15 ± 3.41e-17 1.49e-15 ± 3.29e-17	6.93e-16 ± 1.98e-17 7.55e-16 ± 1.81e-17 6.90e-16 ± 1.52e-17 7.11e-16 ± 1.70e-17 6.50e-16 ± 1.86e-17 7.16e-16 ± 2.18e-17	2.78e-16 ± 8.97e-18 2.91e-16 ± 6.71e-18 2.69e-16 ± 5.70e-18 2.74e-16 ± 7.07e-18 2.71e-16 ± 8.00e-18 2.90e-16 ± 4.80e-18 3.00e-16 ± 8.29e-18	5.60e-17 ± 1.91e-18 5.72e-17 ± 1.32e-18 5.38e-17 ± 1.19e-18 5.66e-17 ± 1.30e-18 5.28e-17 ± 1.17e-18 5.59e-17 ± 1.29e-18 5.90e-17 ± 1.30e-18	1.55e-17 ± 5.71e-19 1.60e-17 ± 4.13e-19 1.53e-17 ± 4.21e-19 1.64e-17 ± 4.22e-19 1.49e-17 ± 3.83e-19 1.63e-17 ± 4.21e-19 1.72e-17 ± 4.27e-19	< 7.35e-19 7.80e-19 ± 2.93e-19 < 1.04e-18 6.63e-19 ± 3.11e-19 < 1.23e-18 6.42e-19 ± 3.16e-19 8.49e-19 ± 3.16e-19	<pre>&lt; 1.74e-18 &lt; 1.31e-18 &lt; 2.02e-18 &lt; 1.77e-18 &lt; 1.88e-18 &lt; 1.40e-18 &lt; 2.15e-18</pre>
15679 16088 16218 17136 17248 30955 30978 31107	$\begin{array}{c} 5.88e\cdot15\pm4.87e\cdot16\\ 5.16e\cdot15\pm4.61e\cdot16\\ 4.97e\cdot15\pm2.57e\cdot16\\ 5.61e\cdot15\pm3.20e\cdot16\\ 4.45e\cdot15\pm1.56e\cdot16\\ 4.83e\cdot15\pm3.07e\cdot16\\ 4.83e\cdot15\pm3.07e\cdot16\\ 4.80e\cdot15\pm8.06e\cdot17\\ 4.30e\cdot15\pm4.52e\cdot16\end{array}$	SLOAN/SDSS.g 6 70e-15 ± 3 33e-16 5 10e-15 ± 1 50e-15 5 17e-15 ± 1 03e-15 5 23e-15 ± 2 08e-15 4 95e-15 ± 5 25e-16 5 15e-15 ± 9 63e-16	(Flux densities a Go to page: Misc/APASS.V 6.64+15±5.20+16 5.622+15±172=16 5.432+15±172=16 5.935+15±159=16 4.893+15±275+16 5.386+15±2736+16 5.818+15	are given in erg/cm 1 2 3 <prev n<br="">SLOAN/SDS5.r 6.71a+15 ± 254a+16 5.13a+15 ± 5.62a+16 4.456+15 ± 2.10a+16 4.42a+15 ± 2.68a+16 4.42a+15 ± 2.68a+16 4.61a+15 ± 2.12a+16 5.03a+15 4.44a+15 ± 4.29a+16</prev>	IZ/s/A) Iext> SLOAN/SDSS.i 6.84e-15 ± 107e-16 3.94e-15 ± 107e-16 3.95e-15 ± 108e-15 3.59e-15 ± 1.36e-16 3.76e-15 ± 1.66e-16  3.67e-15 ± 1.42e-16	$\begin{array}{c} 1,40e\cdot15\pm3,36e\cdot17\\ 1,52e\cdot15\pm2,94e\cdot17\\ 1,42e\cdot15\pm3,13e\cdot17\\ 1,47e\cdot15\pm3,26e\cdot17\\ 1,36e\cdot15\pm3,27e\cdot17\\ 1,42e\cdot15\pm3,27e\cdot17\\ 1,42e\cdot15\pm3,41e\cdot17\\ 1,49e\cdot15\pm3,29e\cdot17\\ 1,31e\cdot15\pm3,03e\cdot17\\ \end{array}$	6.93e-16 ± 1.98e-17 7.55e-16 ± 1.81e-17 6.90e-16 ± 1.52e-17 7.11e-16 ± 1.70e-17 6.50e-16 ± 1.86e-17 7.16e-16 ± 2.18e-17	2.78e-16 ± 8.97e-18 2.91e-16 ± 6.71e-18 2.69e-16 ± 5.70e-18 2.74e-16 ± 7.07e-18 2.71e-16 ± 8.00e-18 2.90e-16 ± 4.80e-18	5.60e-17 ± 1.91e-18 5.72e-17 ± 1.32e-18 5.38e-17 ± 1.19e-18 5.66e-17 ± 1.30e-18 5.28e-17 ± 1.17e-18 5.59e-17 ± 1.29e-18	1.55e-17 ± 5.71e-19 1.60e-17 ± 4.13e-19 1.53e-17 ± 4.21e-19 1.64e-17 ± 4.22e-19 1.49e-17 ± 3.83e-19 1.63e-17 ± 4.21e-19	< 7.35e-19 7.80e-19 ± 2.93e-19 < 1.04e-18 6.63e-19 ± 3.11e-19 < 1.23e-18 6.42e-19 ± 3.16e-19 8.49e-19 ± 3.16e-19 < 1.05e-18	< 1.74e-18 < 1.31e-18 < 2.02e-18 < 1.77e-18 < 1.88e-18 < 1.40e-18 < 2.15e-18 < 1.83e-18
15679 16088 16218 17136 17248 30955 30978 31107 31455	$\begin{array}{c} 5.88e \cdot 15 \pm 4.87e \cdot 16 \\ 5.16e \cdot 15 \pm 4.61e \cdot 16 \\ 4.97e \cdot 15 \pm 2.57e \cdot 16 \\ 5.61e \cdot 15 \pm 3.20e \cdot 16 \\ 4.45e \cdot 15 \pm 1.56e \cdot 16 \\ 4.83e \cdot 15 \pm 3.07e \cdot 16 \\ 4.83e \cdot 15 \pm 3.07e \cdot 16 \\ 4.60e \cdot 15 \pm 8.06e \cdot 17 \\ 4.30e \cdot 15 \pm 4.52e \cdot 16 \\ 4.34e \cdot 15 \pm 1.24e \cdot 15 \end{array}$	SLOAN/SDSS.g 6.70e-15 ± 3.39e-16 5.10e-15 ± 1.50e-15 5.77e-15 ± 1.09e-15 5.23e-15 ± 2.08e-15 5.15e-15 ± 2.63e-16 5.15e-15 ± 9.63e-16 6.62e-15 ± 3.26e-16 6.62e-15 ± 3.26e-16	(Flux densities a Go to page: Misc/APASS.V 6.649-15 ± 5 20e-16 6.529-15 ± 172e-16 6.539-15 ± 1.559-16 4.839-15 ± 2 739-16 6.581-15 ± 2 739-16 6.519-15 ± 3 739-16 5.199-15 ± 5 31e-16	are given in erg/cm           1         2         3 <prev h<="" td="">           5:LOAN/SDS.st.           6:71e-15 ± 2.54e-16         5:3e-15 ± 5.2e-16           5:38e-15 ± 1.04e-16         5:3e-15 ± 1.04e-16           5:38e-15 ± 1.04e-16         5:38e-15 ± 1.2e-16           5:33e-15 ± 2.12e-16         5:33e-15 ± 2.12e-16           4:31e-15 ± 2.23e-16         4:38e-15 ± 1.23e-16           4:44e+15 ± 2.32e-16         4:44e+15 ± 4.23e-16</prev>	22/s/A) Hert> SLOAN/SDSS.i 6.849-15 ± 1.079-16 3.949-15 ± 1.053-16 3.859-15 ± 1.09-16 3.619-15 ± 1.089-15 3.679-15 ± 1.089-15 3.779-15 ± 1.089-15 3.779-15 ± 1.089-15 3.779-15 ± 1.299-16 4.119-15 ± 1.259-16	$\begin{array}{c} 1.40e{-}15\pm 3.36e{-}17\\ 1.52e{-}15\pm 2.94e{-}17\\ 1.42e{-}15\pm 3.13e{-}17\\ 1.47e{-}15\pm 3.26e{-}17\\ 1.36e{-}15\pm 3.27e{-}17\\ 1.42e{-}15\pm 3.41e{-}17\\ 1.42e{-}15\pm 3.32e{-}17\\ 1.31e{-}15\pm 3.33e{-}17\\ 1.46e{-}15\pm 3.36e{-}17\\ \end{array}$	6.93e-16 ± 1.98e-17 7.55e-16 ± 1.81e-17 6.90e-16 ± 1.52e-17 7.11e-16 ± 1.70e-17 6.50e-16 ± 1.86e-17 7.16e-16 ± 2.18e-17	2.78e-16 ± 8.97e-18 2.91e-16 ± 6.71e-18 2.69e-16 ± 5.70e-18 2.74e-16 ± 7.07e-18 2.71e-16 ± 8.00e-18 2.90e-16 ± 4.80e-18 3.00e-16 ± 8.29e-18	5.60e-17 ± 1.91e-18 5.72e-17 ± 1.32e-18 5.38e-17 ± 1.19e-18 5.66e-17 ± 1.30e-18 5.28e-17 ± 1.17e-18 5.59e-17 ± 1.29e-18 5.90e-17 ± 1.30e-18	$\begin{array}{c} 1.55e\cdot 17\pm 5.71e\cdot 19\\ 1.60e\cdot 17\pm 4.13e\cdot 19\\ 1.53e\cdot 17\pm 4.21e\cdot 19\\ 1.63e\cdot 17\pm 4.22e\cdot 19\\ 1.49e\cdot 17\pm 3.83e\cdot 19\\ 1.63e\cdot 17\pm 4.21e\cdot 19\\ 1.63e\cdot 17\pm 4.21e\cdot 19\\ 1.72e\cdot 17\pm 4.27e\cdot 19\\ 1.48e\cdot 17\pm 3.82e\cdot 19\\ \end{array}$	< 7.35e-19 7.80e-19 ± 2.93e-19 < 1.04e-18 6.63e-19 ± 3.11e-19 < 1.23e-18 6.42e-19 ± 3.16e-19 8.49e-19 ± 3.16e-19	< 1.74e-18 < 1.31e-18 < 2.02e-18 < 1.77e-18 < 1.88e-18 < 1.40e-18 < 2.15e-18 < 1.83e-18 < 1.83e-18 < 1.77e-18
15679 16088 16218 17136 17248 30955 30978 31107 31455 31581	$\begin{array}{c} 5.88e\cdot15\pm4.87e\cdot16\\ 5.16e\cdot15\pm4.61e\cdot16\\ 4.97e\cdot15\pm2.57e\cdot16\\ 5.61e\cdot15\pm3.20e\cdot16\\ 4.45e\cdot15\pm1.56e\cdot16\\ 4.83e\cdot15\pm3.07e\cdot16\\ 4.83e\cdot15\pm3.07e\cdot16\\ 4.80e\cdot15\pm8.06e\cdot17\\ 4.30e\cdot15\pm4.52e\cdot16\end{array}$	SLOAN/SDSS.g 6.70e+15 ± 3.39e-16 5.10e+15 ± 1.50e-15 5.77e+15 ± 1.09e-15 5.23e+15 ± 2.08e-15 4.35e+15 ± 2.08e-15 5.15e+15 ± 9.63e-16 	(Flux densities a Go to page: Misc/APASS.V 6:64-15 ± 5:20-16 5:82-15 ± 1:72-16 5:83-15 ± 1:52-16 4:83-15 ± 1:52-16 4:83-15 ± 2:75-16 5:38-15 ± 2:13-16 5:81-15 4:37-15 ± 1:79-16	are given in erg/cm 1 2 3 <prev n<br="">SLOAN/SDS5.r 6.71a+15 ± 254a+16 5.13a+15 ± 5.62a+16 4.456+15 ± 2.10a+16 4.42a+15 ± 2.68a+16 4.42a+15 ± 2.68a+16 4.61a+15 ± 2.12a+16 5.03a+15 4.44a+15 ± 4.29a+16</prev>	IZ/s/A) Iext> SLOAN/SDSS.i 6.84e-15 ± 107e-16 3.94e-15 ± 107e-16 3.95e-15 ± 108e-15 3.59e-15 ± 1.36e-16 3.76e-15 ± 1.66e-16  3.67e-15 ± 1.42e-16	$\begin{array}{c} 1.40 {\scriptstyle \pm 0.5} \pm 3.36 {\scriptstyle \pm 17} \\ 1.52 {\scriptstyle \pm 15} \pm 2.94 {\scriptstyle \pm 17} \\ 1.42 {\scriptstyle \pm 15} \pm 3.13 {\scriptstyle \pm 17} \\ 1.47 {\scriptstyle \pm 15} \pm 3.26 {\scriptstyle \pm 17} \\ 1.36 {\scriptstyle \pm 15} \pm 3.27 {\scriptstyle \pm 17} \\ 1.42 {\scriptstyle \pm 15} \pm 3.27 {\scriptstyle \pm 17} \\ 1.49 {\scriptstyle \pm 15} \pm 3.23 {\scriptstyle \pm 17} \\ 1.31 {\scriptstyle \pm 15} \pm 3.33 {\scriptstyle \pm 17} \\ 1.31 {\scriptstyle \pm 15} \pm 3.33 {\scriptstyle \pm 17} \\ 1.36 {\scriptstyle \pm 15} \pm 3.35 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.35 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.35 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.35 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.35 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.35 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.35 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.35 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.35 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.35 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.35 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.35 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.35 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.35 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.38 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.38 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.38 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.38 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.38 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.38 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.38 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.38 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.38 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.38 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.38 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.38 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.38 {\scriptstyle \pm 17} \\ 1.38 {\scriptstyle \pm 15} \pm 3.38 {$	$\begin{array}{c} 6.93e\cdot16\pm1.98e\cdot17\\ 7.55e\cdot16\pm1.81e\cdot17\\ 6.90e\cdot16\pm1.52e\cdot17\\ 7.11e\cdot16\pm1.70e\cdot17\\ 7.16e\cdot16\pm2.18e\cdot17\\ 7.16e\cdot16\pm2.18e\cdot17\\ 7.36e\cdot16\pm2.10e\cdot17\\ 6.44e\cdot16\pm2.31e\cdot17\\ 6.89e\cdot16\pm2.11e\cdot17\\ 6.89e\cdot16\pm1.71e\cdot17\\ 6.89e\cdot16\pm1.70e\cdot17\\ \end{array}$	$\begin{array}{c} 2.78{16}\pm8.97{18}\\ 2.91{16}\pm6.71{18}\\ 2.93{16}\pm5.70{18}\\ 2.74{16}\pm7.70{18}\\ 2.74{16}\pm8.00{18}\\ 3.90{16}\pm8.00{18}\\ 3.90{16}\pm8.29{18}\\ 2.61{16}\pm7.70{18}\\ 2.61{16}\pm7.70{18}\\ 2.83{16}\pm5.27{18}\\ 2.83{16}\pm5.27{18}\\ 2.83{16}\pm5.27{18}\\ 2.83{16}\pm5.27{18}\\ 2.83{16}\pm5.27{18}\\ 2.83{16}\pm5.27{18}\\ \end{array}$	$\begin{array}{c} 5.60e{-}17\pm1.91e{+}18\\ 6.72e{-}17\pm1.32e{-}18\\ 5.38e{-}17\pm1.19e{-}18\\ 5.66e{-}17\pm1.30e{-}18\\ 5.28e{-}17\pm1.30e{-}18\\ 5.28e{-}17\pm1.29e{-}18\\ 5.90e{-}17\pm1.29e{-}18\\ 5.90e{-}17\pm1.30e{-}18\\ 5.16e{-}17\pm1.19e{-}18\\ 5.53e{-}17\pm1.22e{-}18\\ 5.53e{-}17\pm1.2e{-}18\\ 5.53e{-}17\pm1.2e{-}18\\ \end{array}$	$\begin{array}{c} 1.55e\cdot17\pm5.71e\cdot19\\ 1.60e\cdot17\pm4.13e\cdot19\\ 1.53e\cdot17\pm4.21e\cdot19\\ 1.64e\cdot17\pm4.22e\cdot19\\ 1.48e\cdot17\pm3.83e\cdot19\\ 1.63e\cdot17\pm4.27e\cdot19\\ 1.72e\cdot17\pm4.27e\cdot19\\ 1.72e\cdot17\pm4.27e\cdot19\\ 1.57e\cdot17\pm4.05e\cdot19\\ 1.57e\cdot17\pm4.05e\cdot19\\ 1.57e\cdot17\pm4.05e\cdot19\\ 1.53e\cdot17\pm3.94e\cdot19\\ \end{array}$	< 7.35e-19 7.80e-19 ± 2.33e-19 < 1.04e-18 6.63e-19 ± 3.11e-19 < 1.23e-18 6.42e-19 ± 3.16e-19 8.43e-19 ± 3.16e-19 < 1.05e-18 9.13e-19 ± 3.45e-19 1.32e-19 ± 3.45e-19	<1.74e-18 <1.31e-18 <2.02e-18 <1.77e-18 <1.88e-18 <1.40e-18 <2.15e-18 <1.83e-18 <1.83e-18 <1.77e-18 <1.50e-18
15679 16088 16218 17136 17248 30955 30978 31107 31455 31581 31634	$\begin{array}{c} 5.88e \cdot 15 \pm 4.87e \cdot 16 \\ 5.16e \cdot 15 \pm 2.57e \cdot 16 \\ 5.61e \cdot 15 \pm 2.57e \cdot 16 \\ 5.61e \cdot 15 \pm 2.27e \cdot 16 \\ 5.61e \cdot 15 \pm 2.20e \cdot 16 \\ 4.45e \cdot 15 \pm 1.55e \cdot 16 \\ 4.83e \cdot 15 \pm 3.07e \cdot 16 \\ 4.83e \cdot 15 \pm 3.07e \cdot 16 \\ 4.30e \cdot 15 \pm 4.52e \cdot 16 \\ 4.34e \cdot 15 \pm 4.52e \cdot 16 \\ 4.34e \cdot 15 \pm 1.24e \cdot 15 \\ 4.88e \cdot 15 \pm 3.38e \cdot 16 \\\end{array}$	SLOAN/SDS5.g 6 70-15 ± 3 30-16 5 10-15 ± 3 30-16 6 10-15 ± 3 30-16 5 17-15 ± 100-15 5 12-16 ± 100-15 5 12-16 ± 2 00-15 5 15-15 ± 2 00-15 5 15-15 ± 2 00-15 5 15-15 ± 0 50-16 5 52-15 ± 0 50-16 5 52-15 ± 3 20-16 	(Flux densities a Go to page: Misc/APASS.V 6 64-15 4 5 20-16 5 82+16 4 5 20-16 5 98+15 4 152+16 5 98+15 4 158+16 5 38+15 4 158+16 5 38+15 4 2 37+16 5 38+15 4 157+16	are given in erg/cm <b>1</b> 2 3 	12/s/A) 14x5 1510AWSDS51 510AWSDS51 510AWSDS51 510AWSDS51 510AF52 1074-16 3364-152 1074-16 3364-152 108-16 3364-152 108-16 3364-152 108-16 3574-152 108-16 3574-16 3574-16 3574-16	$\begin{array}{c} 1.40e+15\pm3.36e+17\\ 1.52e+15\pm2.94e+17\\ 1.42e+15\pm3.13e+17\\ 1.47e+15\pm3.26e+17\\ 1.47e+15\pm3.27e+17\\ 1.42e+15\pm3.27e+17\\ 1.42e+15\pm3.29e+17\\ 1.31e+15\pm3.03e+17\\ 1.36e+15\pm3.36e+17\\ 1.38e+15\pm2.91e+17\\ 1.38e+15\pm2.78e+17\\ \end{array}$	$\begin{array}{c} 6.93e\cdot 16\pm 1.98e\cdot 17\\ 7.55e\cdot 16\pm 1.81e\cdot 17\\ 6.90e\cdot 16\pm 1.52e\cdot 17\\ 7.11e\cdot 16\pm 1.70e\cdot 17\\ 7.16e\cdot 16\pm 1.70e\cdot 17\\ 7.16e\cdot 16\pm 2.18e\cdot 17\\ 7.36e\cdot 16\pm 2.10e\cdot 17\\ 7.36e\cdot 16\pm 2.10e\cdot 17\\ 6.44e\cdot 16\pm 2.31e\cdot 17\\ 6.49e\cdot 16\pm 2.31e\cdot 17\\ 6.99e\cdot 16\pm 1.70e\cdot 17\\ 6.99e\cdot 16\pm 1.70e\cdot 17\\ \end{array}$	$\begin{array}{c} 2.78 { + 16 \pm 8} \ .77 { + 16 } \\ 2.91 { + 16 \pm 5} \ .77 { + 16 } \\ 2.63 { + 16 \pm 5} \ .77 { + 16 } \\ 2.63 { + 16 \pm 5} \ .77 { + 16 } \\ 2.74 { + 16 \pm 8} \ .77 { + 16 } \\ 2.90 { + 16 \pm 8} \ .29 { + 16 } \\ 3.00 { + 16 \pm 8} \ .29 { + 18 } \\ 3.00 { + 16 \pm 8} \ .29 { + 18 } \\ 2.61 { + 16 \pm 7} \ .70 { + 18 } \\ 2.83 { + 16 \pm 5} \ .77 { + 18 } \\ 2.86 { + 16 \pm 7} \ .79 { + 18 } \\ 2.85 { + 16 \pm 6} \ .37 { + 18 } \\ 2.85 { + 16 \pm 6} \ .37 { + 18 } \\ \end{array}$	$\begin{array}{c} 5\ 60e^{-17}\pm 1\ 91e^{-18}\\ 6\ 72e^{-17}\pm 1\ 32e^{-18}\\ 5\ 38e^{-17}\pm 1\ 39e^{-18}\\ 5\ 65e^{-17}\pm 1\ 30e^{-18}\\ 5\ 28e^{-17}\pm 1\ 32e^{-18}\\ 5\ 59e^{-17}\pm 1\ 32e^{-18}\\ 5\ 90e^{-17}\pm 1\ 30e^{-18}\\ 5\ 90e^{-17}\pm 1\ 30e^{-18}\\ 5\ 6e^{-17}\pm 1\ 39e^{-18}\\ 5\ 53e^{-17}\pm 1\ 39e^{-18}\\ 5\ 53e^{-17}\pm 1\ 39e^{-18}\\ 5\ 35e^{-17}\pm 1\ 38e^{-18}\\ 5\ 35e^{-17}\pm 1\ 38e^{-18}\\ 5\ 57e^{-17}\pm 1\ 38e^{-18}\\ \end{array}$	$\begin{array}{c} 1.55{\pm}17\pm5.71{\pm}9\\ 1.60{\pm}17\pm4.13{\pm}19\\ 1.53{\pm}17\pm4.21{\pm}9\\ 1.54{\pm}17\pm4.22{\pm}19\\ 1.64{\pm}17\pm4.22{\pm}19\\ 1.63{\pm}17\pm3.83{\pm}19\\ 1.63{\pm}17\pm4.21{\pm}19\\ 1.72{\pm}17\pm4.27{\pm}19\\ 1.48{\pm}17\pm3.82{\pm}19\\ 1.57{\pm}17\pm4.05{\pm}19\\ 1.57{\pm}17\pm4.05{\pm}19\\ 1.57{\pm}17\pm4.05{\pm}19\\ 1.53{\pm}17\pm3.94{\pm}19\\ 1.53{\pm}17\pm4.05{\pm}19\\ \end{array}$	< 7.35e-19 7.80e-19 ± 2.93e-19 < 1.04e-18 6.63e-19 ± 3.11e-19 < 1.23e-18 6.42e-19 ± 3.16e-19 8.49e-19 ± 3.16e-19 < 1.05e-18 9.13e-19 ± 3.45e-19 9.13e-19 ± 3.45e-19 8.52e-19 ± 3.40e-19	<1.74e-18 <1.31e-18 <2.02e-18 <1.77e-18 <1.88e-18 <1.40e-18 <1.40e-18 <1.50e-18 <1.50e-18 <1.50e-18 <1.40e-18
15679 16088 16218 17136 17248 30955 30978 31107 31455 31581 31634 31637	$\begin{array}{c} 5.88e \cdot 15 \pm 4.87e \cdot 16 \\ 5.16e \cdot 15 \pm 4.61e \cdot 16 \\ 4.97e \cdot 15 \pm 2.57e \cdot 16 \\ 5.61e \cdot 15 \pm 3.20e \cdot 16 \\ 4.45e \cdot 15 \pm 1.56e \cdot 16 \\ 4.83e \cdot 15 \pm 3.07e \cdot 16 \\ 4.83e \cdot 15 \pm 3.07e \cdot 16 \\ 4.60e \cdot 15 \pm 8.06e \cdot 17 \\ 4.30e \cdot 15 \pm 4.52e \cdot 16 \\ 4.34e \cdot 15 \pm 1.24e \cdot 15 \end{array}$	SLOAN/SDS5.g 6.70e-15.g.3.39e-16 5.10e-15.g.15.9e-16 5.12e-15.g.15.9e-16 5.23e-15.g.20e-15 5.23e-15.g.20e-15 5.34e-15.g.20e-15 5.15e-15.g.20e-16 5.15e-15.g.20e-16 5.15e-15.g.20e-16 5.02e-15.g.20e-16 4.30e-15.g.20e-16 4.30e-15.g.20e-16 4.30e-15.g.127e-15 	(Flux densities a             Go to page:	are given in erg/cm           1         2         3 <prev h<="" td="">           5:LOAN/SDS.st.           6:71e-15 ± 2.54e-16         5:3e-15 ± 5.2e-16           5:38e-15 ± 1.04e-16         5:3e-15 ± 1.04e-16         5:3e-15 ± 1.04e-16           4:38e-15 ± 1.04e-16         5:30e-16 ± 1.2e-16         5:30e-16 ± 1.2e-16           4:38e-15 ± 2.12e-16         5:30e-16 ± 1.29e-16         4:4e+15 ± 1.2e-16           4:44e+15 ± 1.29e-16         4:44e+15 ± 1.2e-16         4:44e+15 ± 1.2e-16</prev>	22/s/A) <b>SLOANVSDS.I</b> 6.84+15.2 + 107+16 3.94+15.2 + 107+16 3.94+15.2 + 107+16 3.95+15.2 + 108+15 3.75+15.2 + 108+15 3.	$\begin{array}{c} 1.40 \pm 15 \pm 3.36 \pm 17 \\ 1.52 \pm 15 \pm 2.94 \pm 17 \\ 1.42 \pm 15 \pm 3.13 \pm 17 \\ 1.47 \pm 15 \pm 3.13 \pm 17 \\ 1.36 \pm 15 \pm 3.26 \pm 17 \\ 1.36 \pm 15 \pm 3.27 \pm 17 \\ 1.49 \pm 15 \pm 3.29 \pm 77 \\ 1.31 \pm 15 \pm 3.33 \pm 17 \\ 1.31 \pm 15 \pm 3.33 \pm 17 \\ 1.34 \pm 15 \pm 3.36 \pm 17 \\ 1.34 \pm 15 \pm 3.36 \pm 17 \\ 1.34 \pm 15 \pm 2.31 \pm 17 \\ 1.34 \pm 15 \pm 2.31 \pm 17 \\ 1.34 \pm 15 \pm 2.78 \pm 17 \\ 1.32 \pm 15 \pm 2.79 \pm 17 \\ 1.32 \pm 1.5 \pm 1.52 \\ 1.32 \pm 1.$	$\begin{array}{c} 6.93e\cdot16\pm1.98e\cdot17\\ 7.55e\cdot16\pm1.81e\cdot17\\ 6.90e\cdot16\pm1.52e\cdot17\\ 7.11e\cdot16\pm1.70e\cdot17\\ 7.56e\cdot16\pm1.86e\cdot17\\ 7.36e\cdot16\pm2.18e\cdot17\\ 7.36e\cdot16\pm2.18e\cdot17\\ 7.36e\cdot16\pm2.19e\cdot17\\ 6.44e\cdot16\pm2.31e\cdot17\\ 6.89e\cdot16\pm1.71e\cdot17\\ 6.89e\cdot16\pm1.71e\cdot17\\ 6.89e\cdot16\pm1.71e\cdot17\\ 6.99e\cdot16\pm1.87e\cdot17\\ 6.99e\cdot16\pm1.87e\cdot17\\ 6.99e\cdot16\pm1.87e\cdot17\\ 6.99e\cdot16\pm1.87e\cdot17\\ \end{array}$	$\begin{array}{c} 2.78 {\small -16} \pm 8.97 {\scriptstyle e-18} \\ 2.91 {\scriptstyle e-16} \pm 5.71 {\scriptstyle e-18} \\ 2.63 {\scriptstyle e-16} \pm 5.70 {\scriptstyle e-18} \\ 2.74 {\scriptstyle e-16} \pm 7.70 {\scriptstyle e-18} \\ 2.74 {\scriptstyle e-16} \pm 7.70 {\scriptstyle e-18} \\ 3.00 {\scriptstyle e-16} \pm 4.80 {\scriptstyle e-18} \\ 3.00 {\scriptstyle e-16} \pm 4.80 {\scriptstyle e-18} \\ 3.00 {\scriptstyle e-16} \pm 4.80 {\scriptstyle e-18} \\ 2.51 {\scriptstyle e-16} \pm 7.70 {\scriptstyle e-18} \\ 2.83 {\scriptstyle e-16} \pm 5.27 {\scriptstyle e-18} \\ 2.83 {\scriptstyle e-16} \pm 5.27 {\scriptstyle e-18} \\ 2.85 {\scriptstyle e-16} \pm 5.30 {\scriptstyle e-18} \\ \end{array}$	$\begin{array}{c} 560e{-}17\pm191e{-}18\\ 672e{-}17\pm132e{-}18\\ 538e{-}17\pm119e{-}18\\ 558e{-}17\pm130e{-}18\\ 566e{-}17\pm130e{-}18\\ 559e{-}17\pm130e{-}18\\ 559e{-}17\pm129e{-}18\\ 650e{-}17\pm130e{-}18\\ 559e{-}17\pm130e{-}18\\ 556e{-}17\pm119e{-}18\\ 556e{-}17\pm119e{-}18\\ 556e{-}17\pm119e{-}18\\ 556e{-}17\pm119e{-}18\\ 557e{-}17\pm126e{-}18\\ 572e{-}17\pm126e{-}18\\ 517e{-}17\pm114e{-}18\\ \end{array}$	$\begin{array}{c} 1.55e\cdot17\pm5.71e\cdot19\\ 1.60e\cdot17\pm4.13e\cdot19\\ 1.53e\cdot17\pm4.21e\cdot19\\ 1.64e\cdot17\pm4.22e\cdot19\\ 1.48e\cdot17\pm3.83e\cdot19\\ 1.63e\cdot17\pm4.27e\cdot19\\ 1.72e\cdot17\pm4.27e\cdot19\\ 1.72e\cdot17\pm4.27e\cdot19\\ 1.57e\cdot17\pm4.05e\cdot19\\ 1.57e\cdot17\pm4.05e\cdot19\\ 1.57e\cdot17\pm4.05e\cdot19\\ 1.53e\cdot17\pm3.94e\cdot19\\ \end{array}$	<pre>&lt; 7.35e-19 </pre> 7.80e-19 ± 2.33e-19  < 1.04e-18  6.63e-19 ± 3.11e-19  < 1.23e-18  6.42e-19 ± 3.16e-19  < 4.05e-18  .1.3e-19 ± 3.45e-19  .1.3e-19 ± 3.45e-19  .1.3e-19 ± 3.45e-19  < 1.0e-18  .1.3e-18 ± 3.40e-19  < 1.06e-18	<1.74e-18 <1.31e-18 <2.02e-18 <1.77e-18 <1.88e-18 <1.40e-18 <2.15e-18 <1.83e-18 <1.83e-18 <1.77e-18 <1.50e-18

Figure13

Step 6.- Place the cursor on the "Build SEDs" tag and then click "SED edit/visualize". This tag gives us the possibility of visualising/modifying the SED before the model fitting. VOSA gathers from VO services not only the photometric information but also different metadata of interest (Object name, observing date and information on quality). In particular, VOSA uses the information on quality to automatically identify bad photometric points and remove them from the fitting. Upper limits are treated in a similar way (see, for instance, WISE W3 and W4 for object "15679"). The user can manually override this selection of photometric points by ticking/unticking the appropriate boxes. (Figure 14)

For this use case, do not make any change in the SED edit/visualize section.

		Obs	erved	Deree	dened		Point Op	əts	1	Actions	8							Info				
Filter	λ <sub>med</sub>	Obs.Flux	∆0bs.Flux	Flux	ΔFlux	ln SED	NoFit Upl	lim Bae	d Igno	re De	lete	Source	RA (V0)		DEC (VO)	∆ (V0)		∆_2 (V0)	Nobjs	Obj.Name (VO)	Obs.Date (VO)	Obs.Qua (VC
lisc/APASS.B	4297.17	5.877e-15	4.871e-16	5.877e-15	4.871e-16	×				1		APASS	132.027194	)0 +	+10.57132000	1.91400958675	31 :	3.753524523726	2			
LOAN/SDSS.g	4640.42	6.701e-15	3.394e-16	6.701e-15	3.394e-16	×				) (		APASS	132.027194	)0 +	+10.57132000	1.91400958675	31 :	3.753524523726	2			
lisc/APASS.V	5394.29	6.640e-15	5.198e-16	6.640e-15	5.198e-16	<ul> <li>Image: A second s</li></ul>				1 (		APASS	132.027194	)0 +	10.57132000	1.91400958675	31 :	3.753524523726	2			
LOAN/SDSS.r	6122.33	6.714e-15	2.536e-16	6.714e-15	2.536e-16	<ul> <li>Image: A second s</li></ul>				1 (		APASS	132.027194	)0 +	10.57132000	1.91400958675	31 :	3.753524523726	2			
LOAN/SDSS.i	7439.49	6.845e-15	1.072e-16	6.845e-15	1.072e-16	1				1 (		APASS	132.027194	)0 +	+10.57132000	1.91400958675	31 3	3.753524523726	2			
MASS/2MASS.J	12350.00	1.402e-15	3.356e-17	1.402e-15	3.356e-17	×				) (		2MASS	132.027622	00 +	10.57095100	0.11103259799	)37	0	1	08480662+1034154	2000-02-11	[A]
MASS/2MASS.H	16620.00	6.928e-16	1.978e-17	6.928e-16	1.978e-17	<ul> <li>Image: A set of the set of the</li></ul>				1 (		2MASS	132.027622	)0 +	10.57095100	0.11103259799	)37	0	1	08480662+1034154	2000-02-11	[A]
MASS/2MASS.Ks	21590.00	2.783e-16	8.972e-18	2.783e-16	8.972e-18	1				1 (		2MASS	132.027622	)0 +	10.57095100	0.11103259799	37	0	1	08480662+1034154	2000-02-11	[A]
VISE/WISE.W1	33526.00	5.601e-17	1.909e-18	5.601e-17	1.909e-18	×				1 (		WISE	132.0276277	00 +	10.571031900	0.28801641112	594	0	1			
VISE/WISE.W2	46028.00	1.551e-17	5.713e-19	1.551e-17	5.713e-19	×				1 (		WISE	132.0276277	00 +	10.571031900	0.28801641112	594	0	1			
VISE/WISE.W3	115608.00	7.351e-19	0.000e+00	7.351e-19	0.000e+00	1		1		16		WISE	132.0276277	00 +	10.571031900	0.28801641112	594	0	1			
VISE/WISE.W4	220883.00	1.738e-18	0.000e+00	1.738e-18	0.000e+00	1		/		1 6	ā i	WISE	132.0276277	00 +	10.571031900	0.28801641112	594	0	1			
Apply infrarec Apply UV/blue Change excess				stroms.			<ul> <li>Every</li> <li>Every market</li> <li>If there the set</li> </ul>	/ point / point ed as 'l re exis ame filt	mark mark Nofit t two ter (n	ed as ed as and ti or mo ot ma	s 'Noi s 'Bao thus nore   arkeo	fit' will no d' or 'Upli not usec photome d as 'Igno		for the autom corre	e fit. natically esponding to calculate an							
			15679													15679						
1e-14	•••	•	_				11 1	Observ 3 sigma Final St Upper	a ED				-14	• •	•	<u> </u>				Observed 2MASS WISE APASS	8	

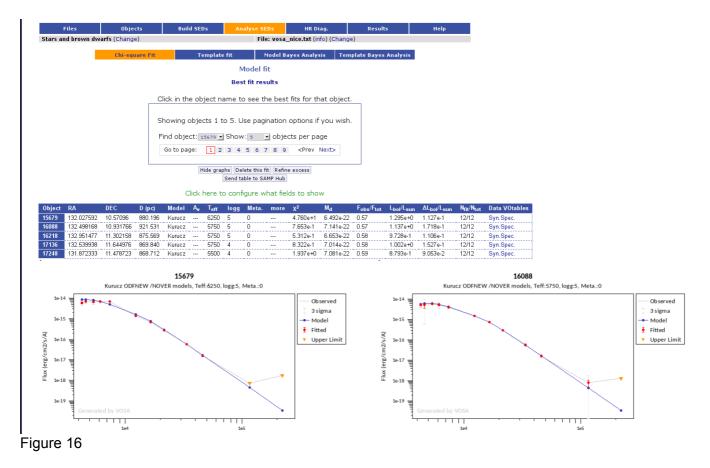
#### • Tag "Analyse SEDs"

 Step 7: Place the cursor on the "Analyse SEDs" tag and then click "Chi-square fit". Different grids of theoretical models covering different ranges of physical parameters are displayed. For this tutorial select only the "Kurucz ODFNEW /NOVER models". Click "Next: Select mode params". (Figure 15).

ios/	VO SED Analyz	ter	This is VO	SA 6.0	Union's Se (FP7-SPAC developm	eventh Fram CE-2013-1)	ved funding fro ework Program for research, te nonstration und 0	ime chnological	an
Files	Objects	Build SEDs	Analys	e SEDs	HR Diag.		Results		Help
tars and brown	dwarfs (Change)			File: vosa	nice.txt (info) (	Change)			
	Chi-square Fit	Templat	e fit	Model B	yes Analysis	Templat	e Bayes Anal	ysis	
			Mode	el fit					
each obje	n allows you to estimate ct comparing its SED with k to the corresponding He	those derived from	n theoretica	spectra o	otained from VC			d luminosity	) for
	Fir	st select the m		•	t to use for	the fit			
		[	Mark All UNext: Select n		]				
AMES-Dus	sty 2000			AM	S-Cond 2000	Ē			
The AMES dwarfs/extra including du	-Dusty Model grid of asolar planets atmosphere i ist opacity (fully efficient dus ted to air wavelengths.	models without irradi	iation but	The dwa no to a	AMES-Cond fs/extrasolar pla lust opacity (no r wavelengths. a info	Model gri anets atmo	sphere models	without irra	diation and
Kurucz OD	FNEW /NOVER models			🗌 Hu	feld et al mod	lels for no	on-LTE Heliu	m-rich sta	s
	ucz ODFNEW /NOVER mode. ties and better abundances i		DFs with		<i>feld et al models</i> e info	for non-LTE	E Helium-rich s	tars	
BT-Settl-0	CIFIST			BT	Settl				
valid across	tl Model grid of theoretical the entire parameter rang r abundances. Wavelength: s.	e and using the Caf	fau et al.	vali con	BT-Settl Model across the en erted to air wave info	ntire param			



- Step 8.- In this window, we can limit the range of physical parameters that will be used for the fit. To save time we will make the following assumptions:
  - Teff: 4000-8000K
  - logg: 4.0-5.0 dex.
  - [M/H]=0.0
    - Then, click "Make the fit"
- Step 9.- We will see now a summary table with the best fit results. Click on "Show graphs" to have a look at the graphics. The table can be sent to TOPCAT using the "Send Table to SAMP hub" button. (Figure 16).



To get information on the radii derived from VOSA, click *"Click here to configure what fields to show"* and tick R1 and R2. Click *"Save config."* Radii obtained using two different approaches will now appear in the summary table. More information on how VOSA calculates radii can be found at:

http://svo2.cab.inta-csic.es/theory/vosa/helpw4.phpotype=star&action=help&what=fit#fit:radius