Interoperability Worksheet

In this worksheet, you will build a dataset from multiple sources, and send data back and forth between Iris and other applications via SAMP (Simple Application Messaging Protocol).

SAMP is a protocol which can be used to communicate with numerous tools, such as TOPCAT, DS9, and Aladin.

You will need TOPCAT to complete this worksheet, though you do not need it for everything on the worksheet. The lite version is sufficient for this worksheet; `topcat-lite.jar`is on the thumbdrive in `iris/ots/topcat-lite.jar` TOPCAT is a useful table manipulation and visualization tool, with hooks to many data archives, easy data editing, and interactive visualization tools.

Note: the `<path-to-iris>` refers to the full path to the directory in which the Iris demo material was downloaded. If you used Github to download the sources, `<path-to-iris>`will be `<path-to>/aas229iris` If you downloaded the data from the thumb drive, it'll be `<path-to>/iris.`

Building a dataset from multiple sources

Launch Iris if it is not already open.

```
$ source activate iris-workshop
(iris-workshop) $ iris
```

Import data from TOPCAT

1. Open TOPCAT. Double-click on the jar executable, or type

   ```
   java -jar <path-to-iris>/ots/topcat-lite.jar
   ```

2. In TOPCAT, do a cone search through the 2MASS Point Source Catalog for **PKS 1127-14**.

   a. Click on the Folder icon  in the top-left corner of the toolbar, then click on the Cone search icon  in the new frame.

   b. Under "**Available Cone Services**", type "`2mass irsa pcs`" into the "**Keywords**" field, and click "**Find Services**" to search.

   c. When the search is finished, select the row "2MASS All-Sky Point Source Catalog"

   d. Under "**Cone Parameters**," type in "**pks1127-145**" and click "**Resolve**" to retrieve the RA and Dec of the source.

   e. Use a search radius of 5 arc seconds.

   f. Click "**OK**" to retrieve the data from the 2MASS Point Source Catalog. You should have a new table in TOPCAT with the name *pks 1127-145-2MASS-PSC-5s*.

3. The photometric data provided from this dataset is in apparent magnitudes. Before importing the data into Iris, you can use TOPCAT to convert the photometric data from magnitudes to Janskys.

    a. Click on the column metadata icon  . This shows all the columns included in the table. The relevant columns are j_m, h_m, k_m, j_msigcom, h_msigcom, and k_msigcom, which show the J, H, and Ks band magnitudes and their uncertainties, respectively. From here, you can show/hide table columns.

    Hide all the table columns with  .

    Convert the J, H, and K magnitudes into Janskys in TOPCAT. The following conversion steps are taken from the 2MASS Point Source Catalog FAQs.

    b. Create three new columns, j_jy, h_jy, and k_jy one by one using the "**Add Column**" button  . These will contain the fluxes in Janskys.

    c. Use the respective expression for each flux column.

```
j_jy =  1594 * pow(10,-0.4*j_m)
h_jy =  1024 * pow(10,-0.4*h_m)
k_jy = 666.7 * pow(10,-0.4*k_m)
```

    d. Set the **Unit** to "**Jy**".

    You can leave the UCD and description blank if you wish.

    e. Create three new columns for the J, H, and Ks band flux uncertainties. Use the following expressions for the respective flux uncertainty columns.

```
j_jy_err =  sqrt(pow(j_jy*(-.4*j_m),2) * pow(j_msigcom,2) +
pow(pow(10,-.4*j_m),2) * pow(27.8,2))
h_jy_err =  sqrt(pow(h_jy*(-.4*h_m),2) * pow(h_msigcom,2) +
pow(pow(10,-.4*h_m),2) * pow(20.0,2))
k_jy_err = sqrt(pow(k_jy*(-.4*k_m),2) * pow(k_msigcom,2) +
pow(pow(10,-.4*k_m),2) * pow(12.6,2))
```

    f. Check the newly created columns, along with the ra and dec columns so that they will be shown in the table.

    The table now contains the PKS 1127-145 photometric data in Janskys.

4. Back in the main TOPCAT window, with the same 2MASS table highlighted, click the "**Broadcast**" button  to send the data over to Iris.

5. A message window should pop up in Iris, asking you how to proceed with the incoming SAMP message. As the table in TOPCAT is formatted like a photometry catalog -- where each row is a different source, and columns represent the flux at a given wavelength -- select "**Photometry**

Catalog” in the bottom-left corner.

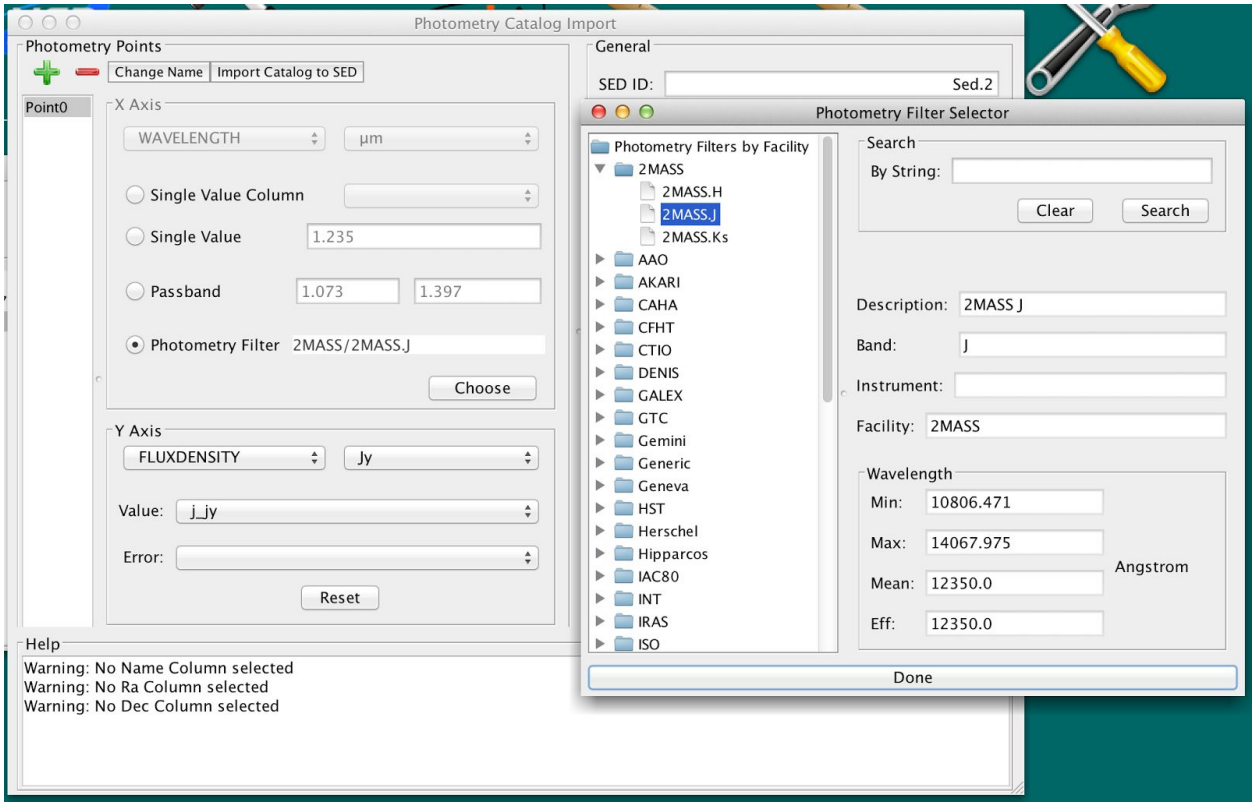
This opens the **Photometry Catalog Importer**, in which you map the columns in the incoming photometry catalog table to the spectral and flux values.

6. Points are added by clicking the “**New**” button in the top-left  . Click the “New” button once. Add the J band photometry first.

7. Specify the spectral values for the J band. You can either type the spectral value by hand in the “**Single Value**” or “**Pass band**” fields, or you can use the **Photometry Filter** service and select “**2MASS → 2MASS.J**”.

   Spectral information for 2MASS bands:

Band	Center (μm)	Bandwidth (μm)
J	1.235	0.162
H	1.662	0.251
Ks	2.159	0.262



8. Supply the **Y-Axis** information. Choose **FLUXDENSITY** for the quantity and **Jy** for the flux unit.

   Select column name **j_jy** for the **Value**, and **j_jy_err** for the **Error**.

9. Repeat steps 6-8 for the H and Ks bands.

10. You can supply the RA, Dec, ID and other publisher on the right side. The RA, Dec, and ID are expected to be columns in the photometric table.

11. When finished, import the photometric data by clicking 

at the top of the

frame.

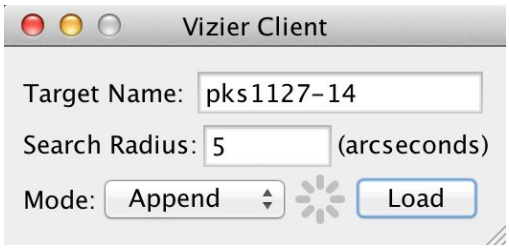
Load data from VizieR

There are a couple ways you can grab data from the VizieR catalogs. Here, we describe two of them: through the built-in Vizier SED Client, or directly from the Vizier.

Using the built-in client

1. Search for photometric points of source PKS 1127-14 using the VizieR catalog importer.

This will search through the VizieR catalogs for all photometric points within 5 arcseconds of sources identified with PKS 1127-14.



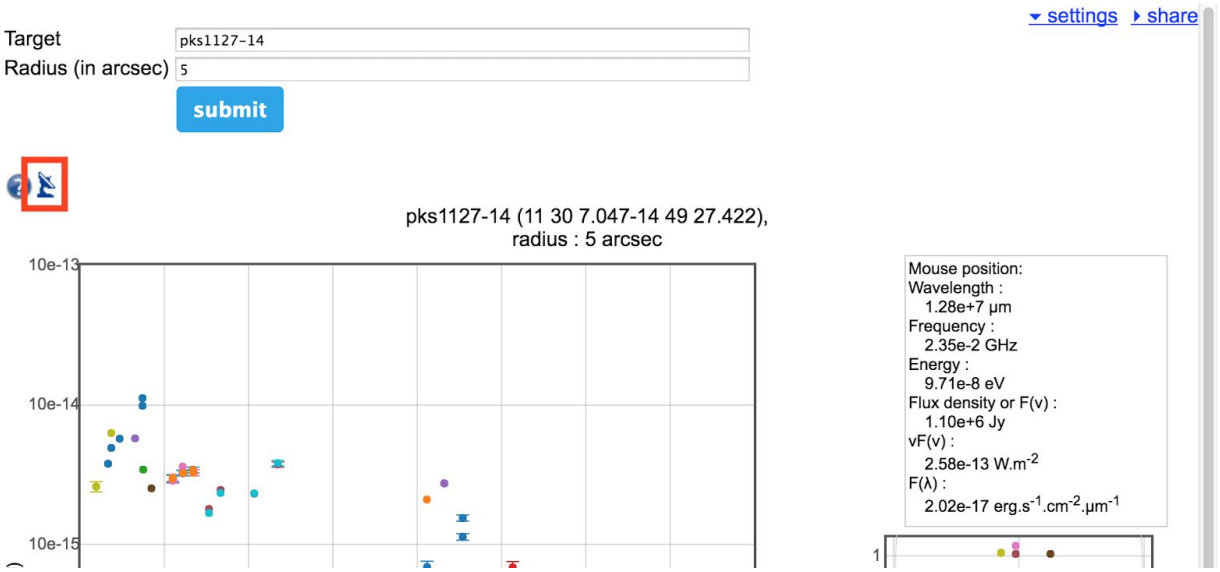
You can either "**Append**" the data onto the currently selected SED, or "**Create**" a new SED with the new data.

Using the CDS Photometry Viewer

You can also visit CDS's VizieR Photometry Viewer, search for data, then send it over to Iris via SAMP.

1. On the website, search for **Target = pks1127-14** and **Radius = 5**. A plot with the discovered points is shown, color-coded by the CDS table it came from.

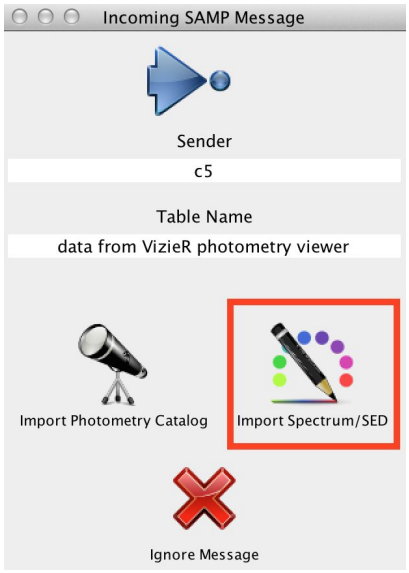
2. Click on the satellite icon at the top of the Photometry Viewer (highlighted in red below).



You may get a "**SAMP Hub Security**" pop-up, asking you if you allow the the photometry service to access following pop-up. This allows the CDS VizieR service to send data directly to your computer. Say "**Yes**" to authorize the connection.

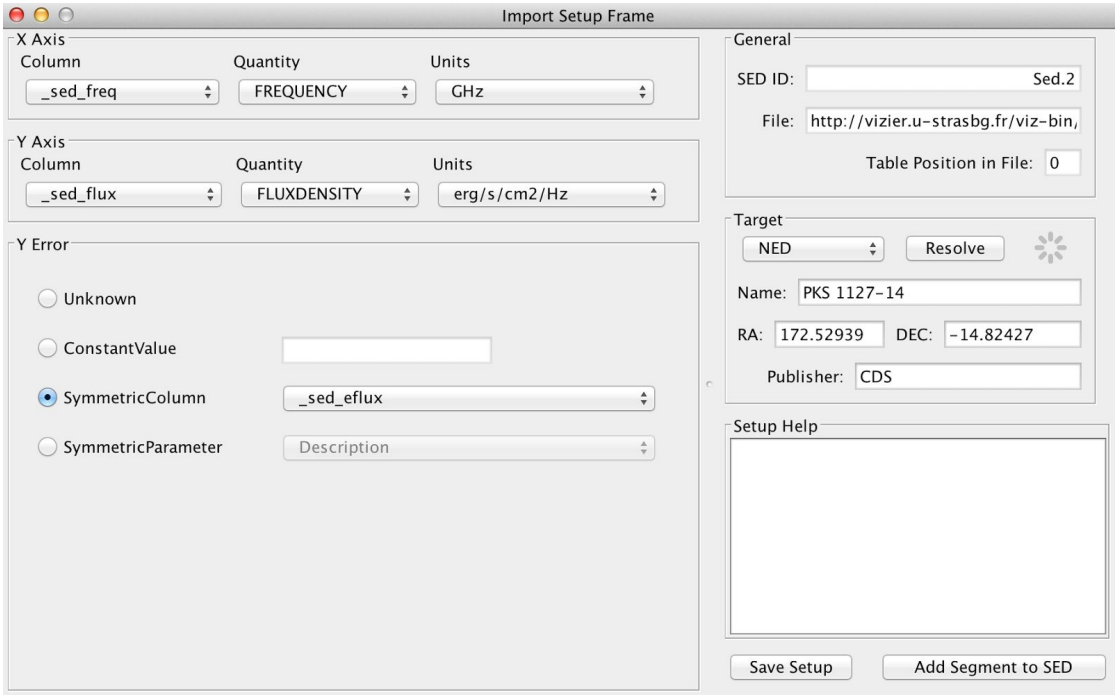
After confirming the SAMP connection, click the "**Broadcast**" button on the Photometry Viewer to send the data over into Iris.

The table broadcast from the Photometry Viewer is in a "spectrum" file format, meaning each row in the table represents one photometric point. Therefore, in Iris, select "**Import Spectrum/SED**" for the incoming SAMP message.



This brings up the **Import Setup** frame, in which you map each column in the CDS table to the spectral, flux, and uncertainties. The units of the data from the Photometry Viewer are returned in erg/s/cm/Hz vs Ghz, so select these units when importing the data into Iris.

The Import Setup frame should have the following configuration:



Note that a lot of tables in VizieR publish data from previous papers that are also in VizieR. Therefore, there are a number of duplicate points. You can use the **Metadata Browser** in Iris to remove these duplicate points.

Sending data from Iris to TOPCAT

You can send data from Iris into TOPCAT via SAMP as well. This section shows you where and how you can send data back and forth between two SAMP-enabled applications.

1. Create a new SED with the 

button in the **SED Builder** in Iris.

2. Click on the "**Load File**" button 

in the **Segments** panel. Check the "**Get a SED from the NED Service**" radio button, type in "**m87**" for Messier 87, and click "**Import NED SED**".

3. In the SED Builder, a broadcast icon  is on the top bar. This will send the SED data (spectral, flux, and uncertainties) to any listening application, in this case, TOPCAT. You can choose which units to send over the data in using the "**x unit:**" and "**y unit:**" drop-down menus next to the **broadcast** button.

   Choose the units **Hz** and **Jy-Hz**. Then, click the broadcast button to send the data to TOPCAT

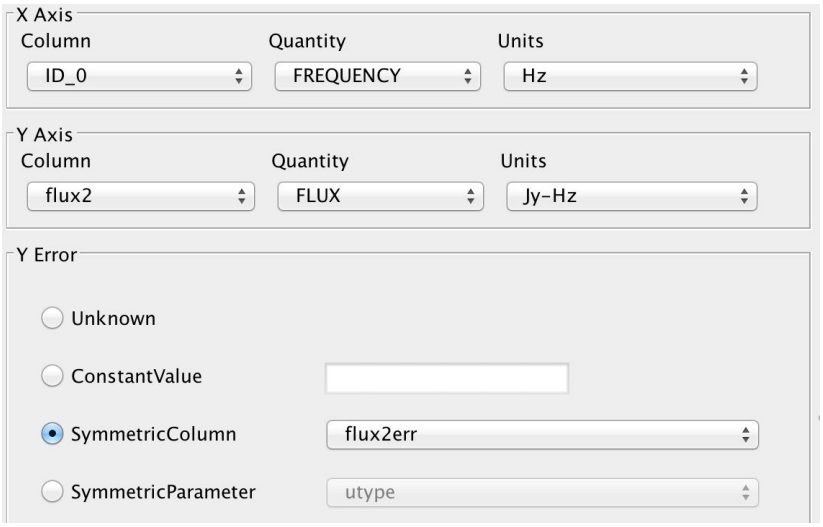
4. Over in TOPCAT, you'll see a new table named "ExportedSegment." View the SED data in a table with  . As done in the first section in TOPCAT, you can create new columns based off of the current columns in the Metadata view  .

5. Create two new columns in TOPCAT based off of the fluxes named "**flux2**" and "**flux2err**". As a simple example, just multiply the fluxes by the average values in the flux column, **ID_1**.

   ```
   Flux2 expression:     ID_1 * mean(array(ID_1))
   Flux2err exporession: ID_2 * mean(array(ID_1))
   ```

6. Uncheck columns **ID_1** and **ID_2** in the TOPCAT Metadata table.

7. Send the data back into Iris with TOPCAT's broadcast button; with the table "ExportedSegment" highlighted, click  , and load the table back into Iris with the **Import Setup** frame:



8. Back in Iris, you can broadcast specific datasets (called "segments" in Iris) instead of the full SED. In this case, the data displayed in the Metadata tab of the Metadata Browser will be sent over into TOPCAT. Note that the spectral, flux, and flux uncertainties are included in metadata, so you can still edit the SED points in TOPCAT via this method.

   You can select multiple SED segments and send them all to TOPCAT at once, too. It will send each dataset as a separate table.

   Load another dataset into the SED, e.g.,
   `<path-to-iris>/worksheets/data/pks1127-14_planck.vot`

   Highlight both datasets in the **Builder** (hold down Command and click each segment), then click the  in the Segments panel.

9. In TOPCAT, you should see two new tables appear: one named "<sedID>ExportedSegment", and the other "<sedID>ExportedSegment2", where <sedID> is the SED ID name in Iris.

Play around sending data back and forth. TOPCAT has many functions you can use to create new columns; take a look at all the available functions by clicking the  button in the main TOPCAT window. Note that for statistical functions (mean, median, std, etc.), you may need to wrap the table column in an array() function: e.g., `$1 / mean(array($1))`.