Confirmation of a Supernova candidate

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Uses Aladin, TOPCAT and SPLAT-VO or VOSpec.

Supernovae, rare stellar explosions, are extremely energetic events that can briefly outshine their host galaxy until they eventually fade out in timescales of weeks or months. The physical processes driving these explosions are very important for the understanding of stellar evolution. The tutorial describes how a supernova candidate appearing on an image of the galaxy NGC 6946, taken by the Col Druscie Remote Observatory Supernovae Search (CROSS) programme; is confirmed by comparison of the image against archival image data retrieved through VO interfaces. It is completed by looking for available spectra of other Supernovae and objects in the field.

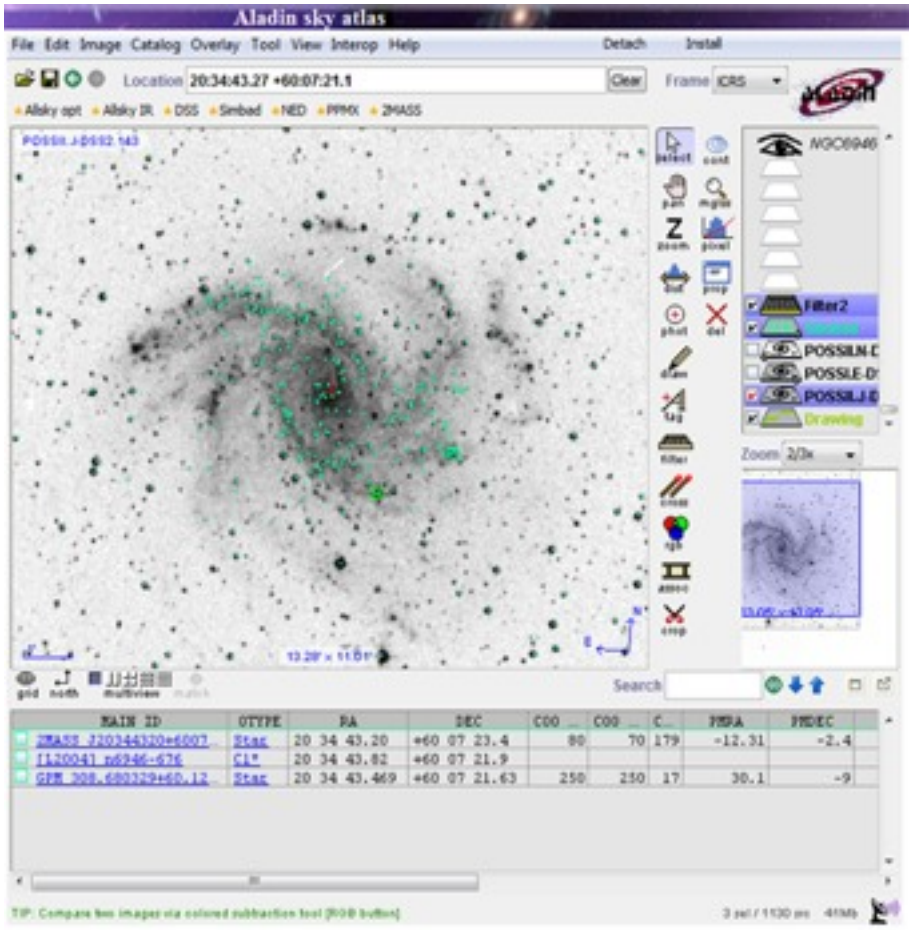
- launch **Aladin**, **TOPCAT** and **SPLAT-VO**
- load the local image of NGC6946 (ngc6946.fit) taken by the Col Druscie Remote Observatory Supernovae Search (CROSS) programme in **Aladin**,
- to make the image clearer, modify the pixel distribution (*"pixel"* button, 3rd from the bottom in the vertical tool bar, right next to the image window -> *Contrast->Log*) you can change the colour map by again selecting *"pixel"* and then *Color map* play with contrast and colour map

The image has no **astrometric calibration**; the calibration can be done from within **Aladin**:

- open the *Server Selector* by clicking on the **Load** button
- select *allVO*; explore *allVO* for NGC6946
  - tick off *Catalogues* and *Spectra* and open the *Server list* (click on **"Detailed list ..."**)
  - the button marked "?" on the right side next to each ***Registry*** will give information about the Registry (browse to learn about them)
  - you can **Filter** the resources
- select a few resources (e.g. Aladin image server) and fire the query (**"SUBMIT"**)
- the response will appear in the form of a tree in the Server selector window
- pick two images of your choice (**tip:** do not select large images!)
- **select a reference catalogue** from the Catalogue Servers list on the right (e.g. 2MASS, USNO) and **Load** it
- if you move the cursor over the calibrated image you see the coordinates at the top of the Aladin image window
- place both images (calibrated and non-calibrated) side by side by splitting the display window in two panels (click on the corresponding option at the bottom left of the display window - **multiview**)

- highlight the non-calibrated image plane and select the properties button *"prop",* 2nd from the bottom (or right-click on the image plane and select **"Properties ..."**)
- in the **Astrometric Reduction** section select **New** and select **by matching stars**
- activate the cells under **"x y" position** (by clicking on them) and click on a star in the uncalibrated image; then the cells under **hh mm ss +dd mm ss** are activated, click on the corresponding star in the calibrated image,
  repeat this for a few (3-4) stars; then click **Create**

- the local **image is now calibrated** (check) **and can be superposed** on the POSSII (or other) image, the catalogue plane is loaded
- click the **match** bottom (below the images, next to **multiview**) and zoom all diplayed images simultaneously
- in order to **identify the Supernova**: go back to single view mode (showing one single image in the main `Aladin` window) and change the transparency of the POSSII image by sliding the bar appearing on the bottom of the image logo to the right **OR** associate the two images (this can be done by clicking on the *"assoc"* icon, 7th from the bottom)
- *"tag"* the supernova (7th button from the top)



- further steps:
  - **measure the distance** from the centre of the galaxy, by clicking on the *"dist"* icon, 4th from the top of the vertical tool bar: then click on the centre of the galaxy and without releasing the mouse button, drag the pointer all the way to the supernova; the distance is displayed on the main window

  - **check for more SNe and other interesting objects** in the same galaxy: load Simbad from the Server Selector, apply **no filter**

  - clicking on either of the object, the available information will appear in tabular form at the bottom of the **Aladin** window, linking directly to the Simbad query results on your browser if you click on **MAIN_ID** - try it
    - to see immediately the SNe, select the image area with the Simbad plane highlighted and click on the column named OTYPE
    - the corresponding histogram (objects grouped per type) will appear in the little graphic window below the stacks; move the mouse over each bar to see the corresponding objects highlighted in the main Aladin window, click on the entries in the OTYPE column to get an description of them in your browser

  - send the Simbad plane to **TOPCAT** by clicking the little antenna on the lower right corner and choosing "broadcast selected planes"
  - view the column metadata selecting **View -> Column Info**
  - view the Simbad table selecting **View -> Table Data**
  - place the cursor on any Simbad identification on the main Aladin window and see how the relevant column is highlighted in the **TOPCAT** **Table Data**

  - **create the SN sub-sample** as follows:
    - click on **Views -> Row Subsets** -> **add a new subset using an algebraic expression** as *equals(OTYPE,"SN")*
    - **OR** (if you don't know the syntax for the algebraic expression) display the **column metadata**; highlight the OTYPE column; rank the table based on the selected column by clicking on one of the yellow arrows at the top of the column metadata window; display the table; select the rows with OTYPE=SN; define a new sub-set including the selected rows only by clicking on the upper left button of the display table window
    - **OR** you can click on *"filter"* within Aladin (make sure the Simbad plane is highlighted), **Advanced mode** and define:
      $[src.class]="SN" {draw red square} (the SNe will appear in red);
      Apply and/or **Export**; a new plane with the filtered source is now created
      [**OR** search for SNe in VizieR (and other, using the *allVO* button) catalogues]

Bonus exercises:

- select other images taken in other wavebands and different epochs
    - look for e.g. X-ray (or other wavelengths) counterparts: in **TOPCAT**:
      Load -> **DataSources** -> **Cone Search**
    - in the "Keywords" field type your constraints (e.g. x-rays, radio, gamma, supernovae) and select the resources to be queried
    - put the objects name (NGC6946) in the "Object Name" field and query
    - **cross-correlate the resulting catalogues** with the one(s) already loaded in **TOPCAT**, send them to Aladin, check them against the images, improvise!

- other things to try with Aladin:
    - **draw contours** (*"cont"*) on any of the image
    - activate the **Simbad automatic pointer** (from the *"Tools"* menu), place the pointer on any object of the image
    - try to **create an RGB image** (*"rgb"*) from three images of your choice

- **look for available spectra in the field**: one can look either for available spectra of particular sources or make a larger search around the centre of the galaxy, encompassing the entire field covered by our image
    - in **SPLAT**, **Search SSAP Servers** (3rd button from the left on the main SPLAT window)
    - (all following steps can be also done using VOSpec instead)
        - put the name of the Object (NGC6946) in the relevant field and "lookup"
        - once resolved, set the radius to half the size of your image (up to 10' should be enough)
        - "Go". This will return results from all the SSAP servers available in the VO and they will be listed, by service, at the bottom of the "Query VO for Spectra" window which you have already launched
        - select (highlight) spectra from any (more than one is possible) resource and click on "Display selected"; all selected spetra will be listed in the main **SPLAT** window and will be displayed in one single graphics window
        - select one from the list and visualise it; try zooming in and out; try fitting lines; familiarise yourself with the various functionalities
    - **OR:** "Load a new table" in **TOPCAT** and select an SSAP query (7th button from the left on the Load pop-up window)
      type e.g. HST in the *Keyword* field to find lists of resources potentially holding HST spectra around NGC6946
        - select one resource, type the object name in the relevant field as well as the diameter size (search radius) and press "OK"
        - if there are available spectra within the specified area, a table will appear in the main **TOPCAT** window; go to "Activation Action" and select "View URL as spectrum" putting the adequate column in "Spectrum Location column" and **SPLAT** as "Spectrum Viewer" press "OK"
        - open the table containing the spetral information and click on any of the rows; the spectrum will be sent to **SPLAT** and you can then visualise it
        - use the line fitting functionalities in **SPLAT**, explore the tools