Using the AST library to create and use STC-S region descriptions

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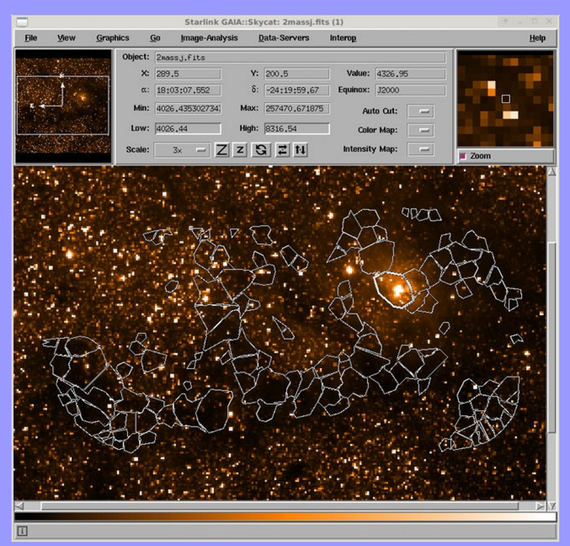
New to AST? Start here…

- AST is a library of functions that implement an object oriented model for describing physical coordinate systems, and the transformations that exist between them.
- It provides a comprehensive range of facilities for attaching world coordinate systems (WCS) to astronomical data, for retrieving and manipulating that information and for generating graphical output such as coordinate grids based upon it.
- It can read and write WCS information in several different forms, including FITS-WCS headers.
- It is written in pure ANSI C but also has interfaces for FORTRAN, Perl and Java (via JNI).
- It has built-in intelligence for identifying flavours of celestial, spectral, time and other coordinate systems (including compound systems that combine axes of different types) and determining how to transform between them. This allows general purpose code to be written that makes no assumptions about the nature of the coordinate systems.
- It includes a flexible and versatile "tool-kit" for creating and modifying collections of coordinate frames interconnected by arbitrarily complex transformations.
- It includes easy-to-use graphical facilities that allow the production of annotated 2D or 3D grids. Graphics are draw via a simple "driver" module which AST calls to draw lines, strings, markers, etc. AST includes drivers for PGPLOT; drivers for other graphics systems (e.g. Tcl/Tk, Java/Swing, etc.) can easily be (and have been) written.
- It is actively supported and developed by the Joint Astronomy Centre, Hawaii.
- It forms the basis of the coordinate handling facilities in the Starlink software collection, including GAIA, SPLAT, KAPPA, *etc*. It is also used in other non-Starlink software such as DS9 and XIMAGE.



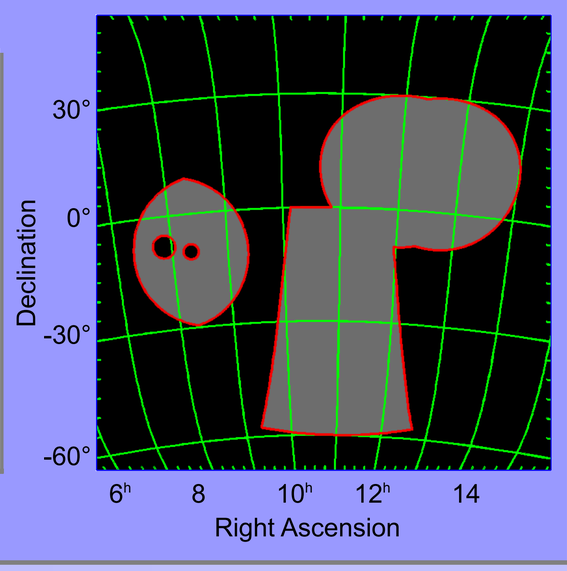
GAIA displaying polygons segmenting a SCUBA image into clumps over a 2MASS J-band image.

The STC-S language:

- STC is a data model, developed by Arnold Rots and the IVOA, for describing regions with a space, time and spectral coverage.
- STC-S is a linear textual representation of the STC data model geared towards human readers.

An example of a (rather complex!) compound spatial STC-S description and its rendering by AST

```
Union ICRS GEOCENTER (
  Circle 180 10 20
  Circle 190 10 20
  Intersection (
    Circle 120 -10 20
    Difference (
      Circle 130 -10 20
      Circle 125 -10 2
    )
    Not (Circle 118 -8 3)
  )
  Box 165 -30 30 60
)
```



The AST StcsChan class:

- AST version 5.2 includes a new class called StcsChan. This class provides methods for creating an AST Region from a textual STC-S description, and for creating an STC-S description from an AST Region. Once an AST Region has been created, all the facilities of AST can be used to manipulate and use the Region.
- The AST StcsChan and Region classes support the full range of STC-S axes (time, space, spectral and redshift).
- The StcsChan class supports most of STC-S version 1.33, including compound spatial regions. There are, however, a few exceptions and provisos, the main ones of which are
  - There is no support for multiple intervals specified within a TimeInterval, PositionInterval, SpectralInterval or RedshiftInterval.
  - The Convex identifier for the space sub-phrase is not supported.
  - There is no support for the following reference positions: LOCAL_GROUP_CENTER, EMBARYCENTER, MOON, MERCURY, VENUS, MARS, JUPITER, SATURN, URANUS, NEPTUNE, PLUTO.
  - Error values are supported but error ranges are not.
  - Resolution, PixSize and Size values are ignored.
  - Space velocity sub-phrases are ignored.

What can AST do with an STC-S description?

- Query and set values for individual STC-S properties.
- Test whether two STC-S regions overlap.
- Test whether points are within an STC-S region.
- Plot the boundary of the STC-S Region
- Convert STC-S Regions into other coordinate systems.
- Mask pixel arrays using an STC-S Region.
- Get the transformation between two STC-S coordinate systems.
- Extract specified axes from an STC-Region

STC-S and the Starlink Software Collection:

- CUPID is an application package within the Starlink Software collection that identifies and characterises clumps of emission within a 2D or 3D data array. The package has been modified to include an STC-S description of the spatial shape of each clump within the output clump catalogue.
- The GAIA image and cube visualisation tool has been modified to allow the 2D and 3D visualisation of the spatial STC-S descriptions created by CUPID.

Links:

AST: **www.starlink.ac.uk/ast**

Starlink Software Collection: **starlink.jach.hawaii.edu**

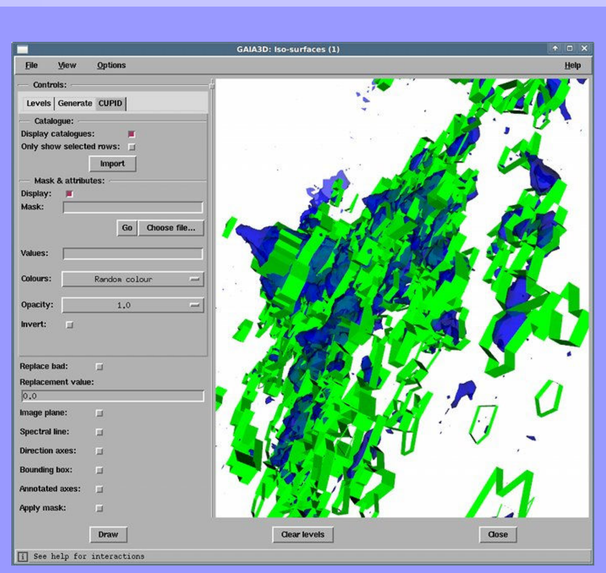
STC-S: **hea-www.harvard.edu/~arots/nvometa/v1.30/STC-S-20090724.pdf**

STC: **www.ivoa.net/Documents/latest/STC.html**

GAIA: **www.starlink.ac.uk/gaia**

CUPID: **www.starlink.ac.uk/cupid**

Joint Astronomy Centre, Hawaii: **www.jach.hawaii.edu**



GAIA displaying STC-S polygon regions extruded to define the extents of 3D clumps of emission in a submillimetre cube.