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GAIA 3D: Visualising Data Cubes

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Abstract. The GAIA[1] application has been a popular choice for examining and analysing astronomical images for several years. As data volumes have increased and spectral and time data cubes have become more prevalent there has been a strong demand for cube visualization. This paper will briefly describe the major enhancements that have been made to GAIA to support data cubes including real-time spectral extraction (single spectrum or area), calculation of moments, creation of channel maps and movie displays. It will also say how the PLASTIC protocol has been used to inter-operate with VO-enabled applications.

1. Introduction

The JAC, has started producing data cubes using the HARP focal plane array receiver and its digital autocorrelation spectrometer ACSIS. These instruments will be used by astronomers of various levels of experience, so require a straightforward data visualisation system, but which is also astronomically focused, that is has full support for celestial and spectral coordinates, and can read astronomy

[1] `http://www.starlink.ac.uk/gaia`

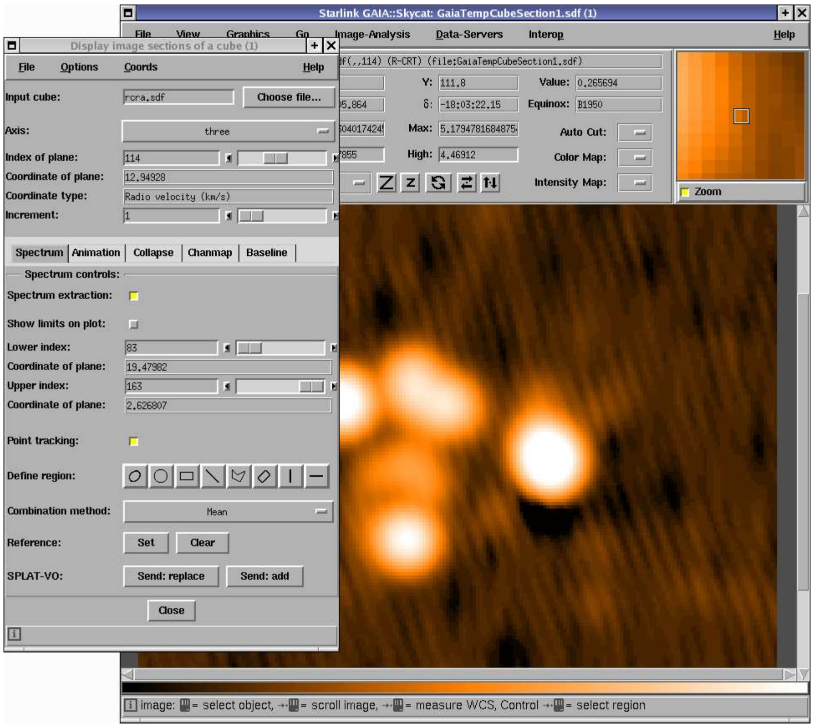

Figure 1. GAIA toolbox displaying a cube. Note the image slice is no. 114 along the 3rd axis, which has a velocity of 12.94929 km/s.

data formats (FITS and NDF). A review of what software is currently available was undertaken by Leech and Jenness (2004), and with those conclusions in mind work has been undertaken to enhance the GAIA image display tool to work with data cubes from many different sources and extreme sizes (4Gb+).

Inter-operating with other environments, like the VO, and co-operating with specialised tools is clearly desirable, so we have extended GAIA to broadcast spectra, images and tables and accept images and tables using the PLASTIC protocol (Taylor et al. 2006). This allows the sophisticated selections of a tool like TOPCAT (Taylor, 2005) to be used, without the need to extend GAIA's table handling.

2. Displaying Image Slices from Cubes

The most basic operation when handling cubes is displaying image slices. This shown in Figure 1. Care has been taken to make sure moving between slices is a very fast operation.

3. Spectral Extraction

Extracting and displaying a spectrum from a cube is very simple, just click on an image position and drag around. The spectrum will be interactively updated.

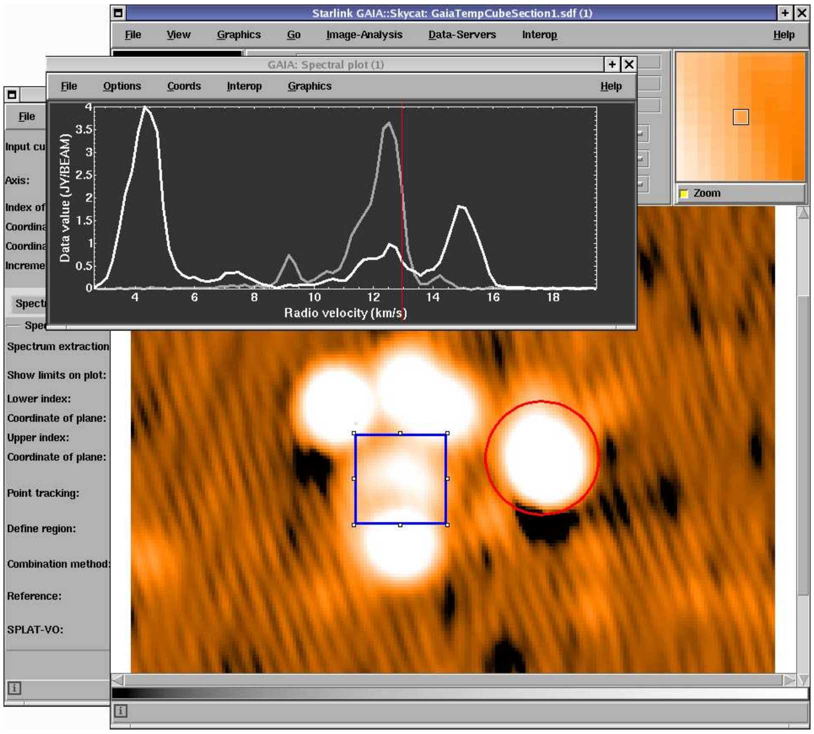

Figure 2. GAIA extracting region spectra. The two regions shown have been averaged and extracted from the cube.

In addition to single point extraction you can also extract spectra which are averaged over regions – circles, rectangles, ellipses, polygons and lines of various kinds. You can also mark an extracted spectrum as the reference spectrum for simple point-to-point and region-to-region comparisons. The results of doing these operations are shown in Figure 2.

4. Coordinate Systems

GAIA allows you to switch between a preset list of common coordinate systems. So you can see spectra in wavelength, frequency and, if a rest-frequency is defined, velocity. Most of the spectral systems defined in FITS paper III are supported (using the AST library).

5. Other Operations

Other operations that are supported on cubes are animating through a range, collapsing to various integrated measurements, creating channel map images (where each sub-panel is itself a collapsed range), and interactive baseline subtraction. Each extracted image can also be operated on by the image analysis tools of GAIA, so you can get region statistics, aperture photometry, object detection, contouring, grid overlays etc.

6. Spectral analysis

GAIA does not offer any spectral analysis features, concentrating mainly on visualisation, so you can 'send' the extracted spectrum to the SPLAT-VO[2] tool, or any other PLASTIC enabled spectral tool, as they become available. You can also save spectra to several formats (FITS, NDF & text) for more traditional processing.

7. Future Developments

The most obvious missing feature, to support data cube visualisation, is some kind of 3D rendering. Clearly there are many sophisticated packages already available in this field, but they tend to have a steep learning curve and to not support astronomy concepts very well. With that in mind we expect to produce a simple interface, that renders iso-surfaces and volumes (using an existing library) and that deals with coordinates and astronomy data formats.

Support for visualisation of CUPID results (HARP and SCUBA-2 data products, Berry 2006) are also a priority.

7.1. Obtaining the software

GAIA is available under the GPL and is part of the 'Keoe' JAC binary releases described at (this release does not include PLASTIC spectrum support):

`http://www.jach.hawaii.edu/software/starlink/`

Currently they are 32/64 bit Linux & Mac OS X 10.4 builds. The GAIA source code can be obtained from (with latest developments):

`http://cvsweb.starlink.ac.uk`
`http://dev.starlink.ac.uk`

This known to build under Solaris, Tru64 UNIX and Cygwin, as well.

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References

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[2] `http://www.starlink.ac.uk/splat`