Starlink 2012—The Kapuahi Release

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What is Starlink?

- Starlink is an open-source project hosted on github that provides a wide range of astronomical applications and associated infrastructure libraries.

- From an initial start in 1980, the software has been in continuous development and use ever since, and is now supported primarily by the Joint Astronomy Centre, Hawaii.

- Applications include:
  - GAIA: An interactive display and analysis tool for use with images and cubes.
  - SPLAT: An interactive spectral display and analysis tool.
  - ORAC-DR: An automated data processing pipe-line system.
  - KAPPA: Nearly 200 general purpose commands for the display and manipulation of *N*-dimensional arrays.
  - CCDPACK: Commands for the reduction of CCD data.
  - POLPACK: Commands for the creation and display of polarisation vectors from arrays of analysed intensity.
  - SMURF: Commands for the reduction of sub-mm data from the James Clerk Maxwell Telescope.
  - CUPID: Provides implementations of various clump-finding algorithms such as ClumpFind, GaussClumps, and others, together with other supporting commands.
  - ATOOLS: A command-line interface to the WCS management functions provided by the AST library.
  - CONVERT: Commands for converting to and from the Starlink NDF data format. Several foreign data formats are supporting, including FITS.

- Infra-structure libraries include:
  - AST: Provides a high-level object-oriented approach to handling spatial, spectral and temporal WCS meta-data, with facilities for handling STC-S format and a wide range of FITS formats.
  - NDF: The main data access library for Starlink—implements an extensible, hierarchical astronomical data model. *Native* NDF files use the HDS format, but the other formats such as FITS can also be read.
  - PAL: Provides low-level functions for manipulating celestial coordinate systems—a re-write in C of the earlier Fortran SLALIB library, using the SOFA library.
  - PCS: A collection of libraries that provide the integrated messaging and parameter system upon which the Starlink environment is built.
  - HDS: A low-level hierarchical data format.
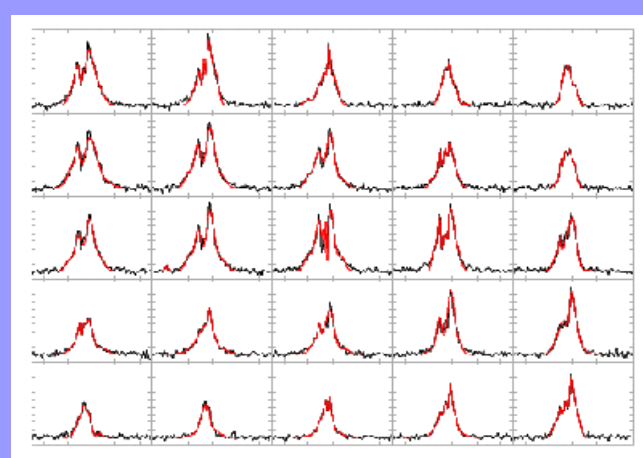
**FIT1D - Black: original profiles;
Red: results of a
3-component Gauss-Hermite2 fit
(fitting both h3 and h4)**

The *Kapuahi* Release - What's new?

- Released in September 2012, the current release of the Starlink Software Collection has code name "Kapuahi" - the Hawaiian name for Aldebaran. This section lists a few of the more important changes since the previous release ("Namaka"). The development version adds support for data values stored as 64-bit integers.

- Global changes:
  - Mutexes are used to serialise access to Fortran subroutines from within C code, making it safe to call them within a thread.
  - All use of the SLALIB library within C code has been replaced the new PAL library (Fortran still uses SLALIB).
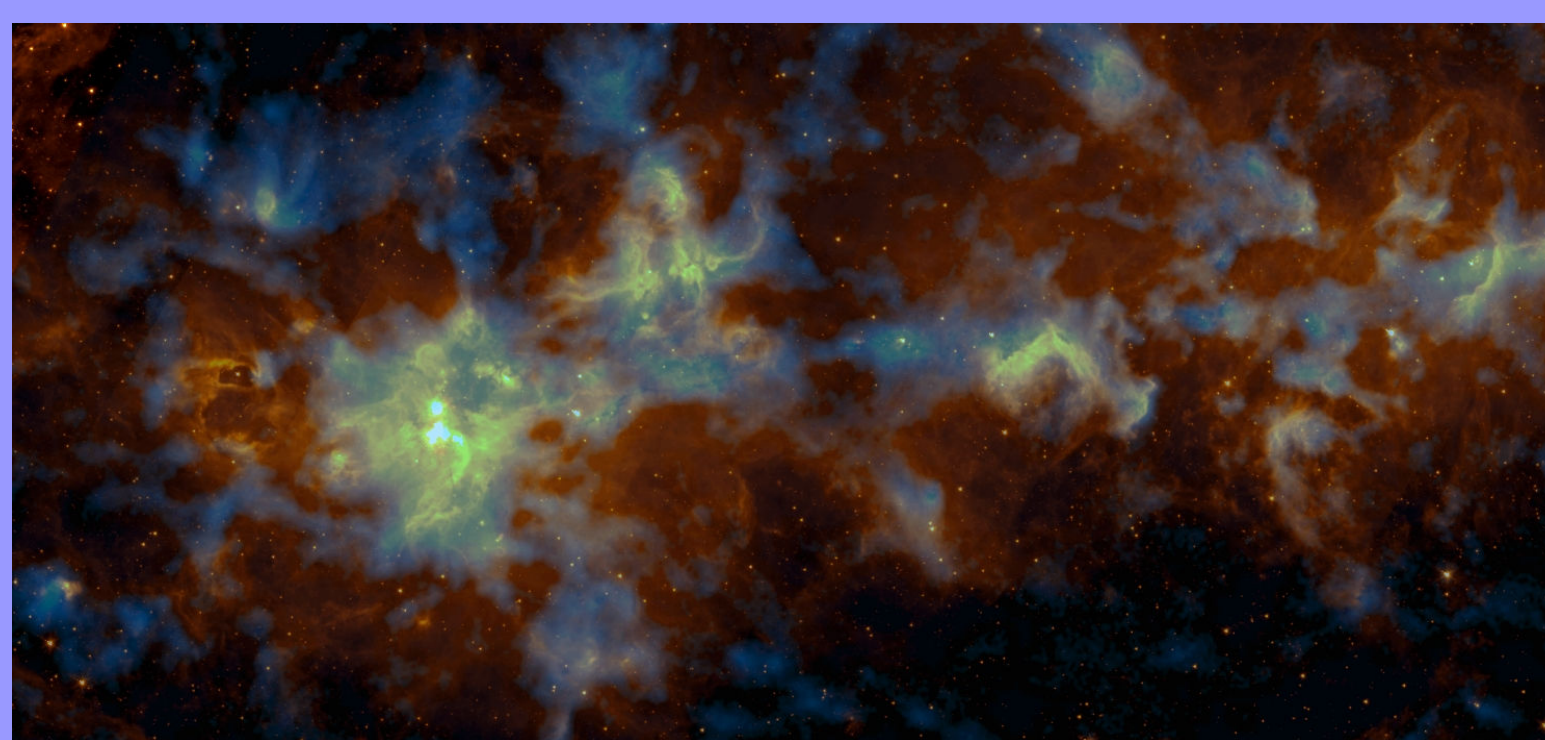
W51—The background is a mid-infrared Spitzer image while the blue overlay is an 850µm SCUBA-2 created by the Starlink SMURF package.

- ATOOLS: All commands now allow the output WCS information to be created in various textual formats, including AST, XML, STC-S, or a variety of common FITS header formats.

- CUPID:
  - GaussClumps now excludes peaks below the specified threshold from the output catalogue and NDF.
  - GaussClumps has improved its ability to decompose merged clumps.
  - FINDBACK now uses multiple processors or cores (if available) to speed up the the procesing of independent slices.
  - FINDBACK can now find and use an independent default noise value for each slice of supplied NDF.

- GAIA:
  - A snapshot can now be taken of the whole image, including the off-screen parts, so it is now possible to capture a graphic of the whole image at full or higher resolution when it is larger than the main window.
  - The "Intensity Map:" selector in the main panel has been replaced by a "Color Scale:" selector, which gives more careful transformation of intensity into log-like space, reducing the false contouring seen in low intensities.
  - The Coords menus in the cube and spectral display now also offers a selection of standards of rest.
  - Several issues with the axes plotting in the three-dimensional visualisation toolboxes have been fixed. There is a new free-form entry area for AST attributes so that the axes can be configured.

- KAPPA:
  - HISTOGRAM now allows different weights to be associated with each input pixel value.
  - MFITTREND now permits processing of very large datasets by dividing into manageable sections.
  - PASTE now allows a constant shifts of origin between successive pasted data. For instance, this can be used to paste a set of 2D images into a 3D cube.
  - SCATTER now displays the Pearson coefficient of the data in the scatter plot, and writes it to a parameter.
  - SETAXIS can now create axes describing a linear approximation to the WCS in the supplied NDF.
  - SQORST now has an option to conserve flux.
  - The REGRID, WCSALIGN and WCSMOSAIC commands now have more control over the details of how (as well as if) flux is conserved.

- SMURF:
  - Many improvements have been made that allow better maps to be created from SCUBA-2 data.
  - FIT1D is a new command that fits profiles to spectral lines. It can fit complex spectra with multiple components and non-Gaussian shapes.

- AST library:
  - Now has a python interface—PyAST (see "Links").
  - Now included in Fedora and Debian repositories.
  - Now based on the SOFA and PAL libraries rather than SLALIB.
  - Extended support for a variety of distorted FITS projections including SIP, TPV, TNX, ZPX, SAO, and SCAMP.
 - Boundaries of complex Regions are now plotted much faster.

- NDF library:
  - Now has a python interface—PyNDF (see "Links").
  - Problems with the interpretation of NDF sections specified in WCS coordinates have been fixed.
  - Foreign format NDFs may now have dots in the file base-name.

- PAL library: A new C library that provides the functionality of the older Fortran SLALIB library through use of equivalent SOFA routines where available, or by a re-writing of the SLALIB Fortran code otherwise. See poster P56.

- THR: A new library that provides facilities to manage pools of persistent threads, allowing jobs to be run in parallel from within C applications.

The Starlink Github Repository

- The Starlink git repositories have been moved from the Joint Astronomy Centre, Hawaii, and are now hosted on github (see "Links"). It is expected that this will ease collaboration, give greater visibility and some degree of future-proofing for the Starlink Software Collection.

Obtaining Starlink Software

- The Starlink Software Collection may be obtained in three ways:
  1. By downloading a pre-built Kapuahi release. These are available for both Linux and OS X (32 and 64 bit). See the Starlink home page for instructions.
  2. By copying the current cutting-edge build from the Joint Astronomy Centre, using rsync. Again, see the Starlink home page for instructions.
  3. By checking out the current source files from the github repository and building from source. See the README file in the root directory of the checkout for instructions.
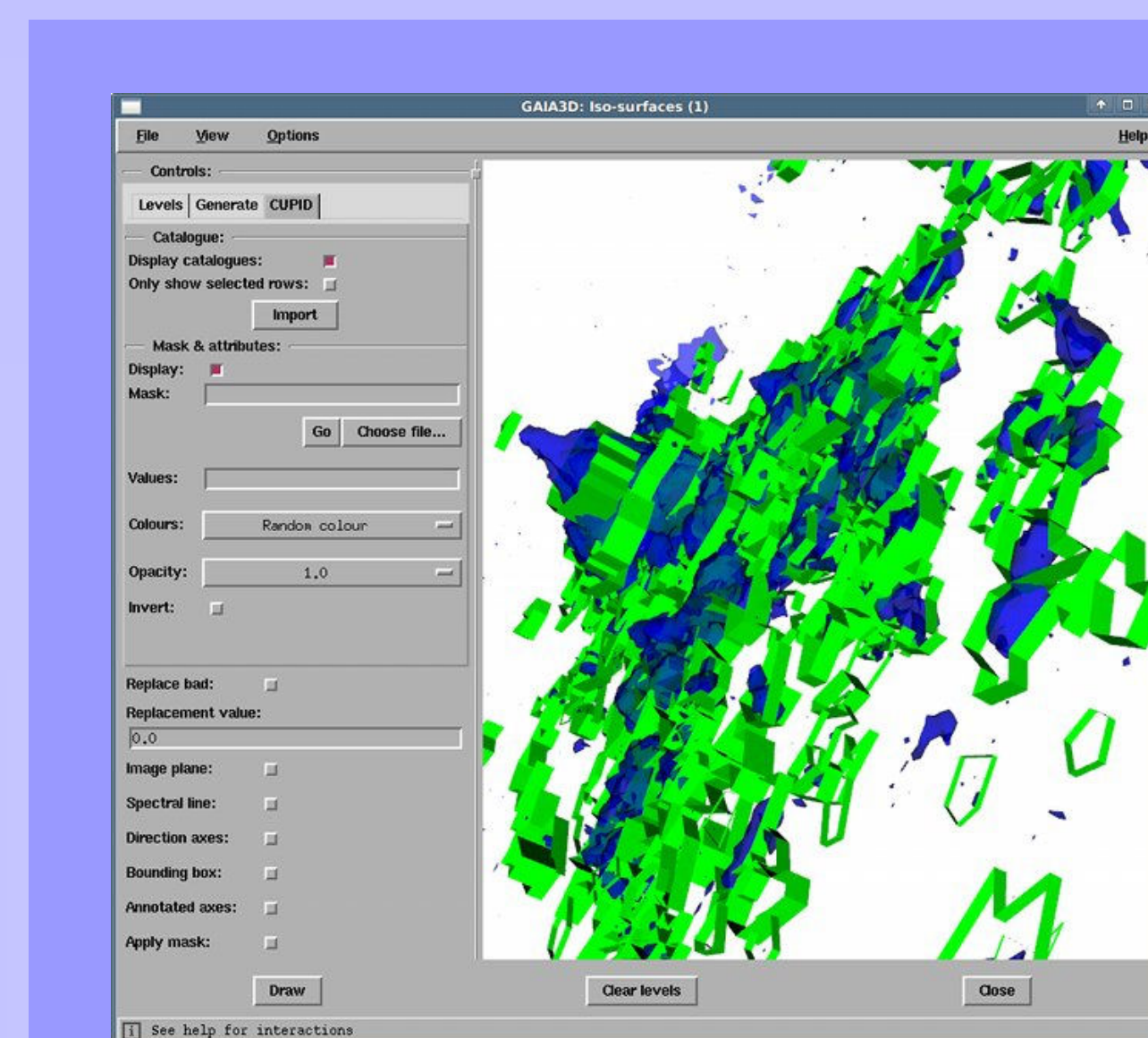
GAIA showing a 3D visualisation of clumps within a sub-millimetre spectral cube, found using CUPID.

Links:

Starlink home page: **www.starlink.ac.uk**

Starlink Github repository: **github.com/Starlink/starlink**

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

SCUBA-2: **scuba2.wordpress.com**

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

ORAC-DR: **www.oracdr.org**

GAIA: **star-www.dur.ac.uk/~pdraper/gaia/gaia.html**

SPLAT: **star-www.dur.ac.uk/~pdraper/splat/splat.html**

PyAST: **github.com/timj/starlink-pyast**

PyNDF: **github.com/timj/starlink-pyndf**