CLRC

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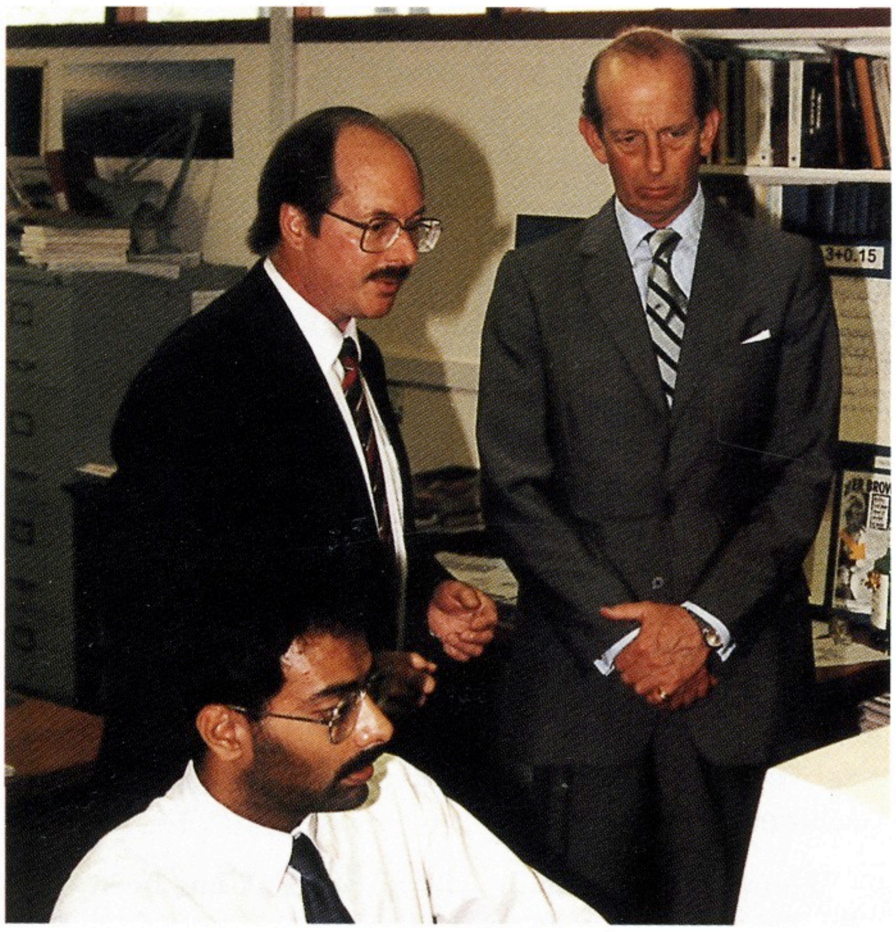

Duke of Kent visits Kent node

On 21st July 1995, the Duke of Kent visited the Starlink site at the University of Kent and met members of the Millimetre-wave Radio Astronomy Group in the Electronic Engineering Laboratory. He was given a demonstration of the use of Starlink in mapping molecular cloud structures in star forming regions and showed particular interest in the Group's recent discovery of copious quantities of ethyl alcohol in one such object!

The Duke was visiting the University to unveil a portrait of his mother, Princess Marina, who was the University's first Chancellor, but had expressed a keen interest to visit the Electronic Engineering Laboratory in his capacity as President of the Royal Academy of Engineering.

The photo shows the Duke of Kent (standing right), Dr Geoff Macdonald, Site Chairman at Kent (standing left), and Subhash Rehan, Starlink's Site Manager at Kent.

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Editorial

Starlink's software policy is to take full advantage of what is already available in other systems and to concentrate our development efforts on areas which are not already adequately covered. An example is our long-running collaboration with IRAF. Recent developments in this area are described in the following three articles. We are also discussing with NOAO how to incorporate IRAF applications into Starlink's benchmarking software so that future hardware choices can be matched to the needs of IRAF users.

In the last issue we described Starlink's plans to improve the friendliness and accessibility of Starlink software. Since then a lot of people have done a lot of hard work to implement these plans and many new products have appeared. Several of these are described in later articles, in particular the new catalogue software (page 11), a graphical interface for reducing CCD data (page 6), developments in echelle data reduction (page 20), and our exploration of visualisation software (page 8).

Perhaps the most revolutionary advance is in the area of documentation with the release of the HTX hypertext utilities. These can be used to establish hypertext links between Starlink documents and to help you find the information they contain. The goal is to transform Starlink's documents into an integrated hypertext web which can be browsed on the World Wide Web. This work is described on page 16.

The Starlink Project has been reviewed again. This one was called ROSO (Review of Starlink Operations) and was particularly concerned with the rôle of its administrative centre at RAL. Starlink is no stranger to reviews. The ADAM review reported earlier this year, the National Audit Office review reported in 1994, and the Willmore review reported in 1992. They are so common that we have set up a special link called *Starlink Reviews* on our central web page (`http://star-www.rl.ac.uk/`) to keep you informed of the latest developments.

Finally, I'm happy to announce the setting up of another Starlink node, this time at the University of Bristol. It came into official existence on 1st October 1995 and serves both Physics and Chemistry Departments. The Site Chairman is Professor Mark Birkinshaw and the Site Manager is Steff Watkins. The site was officially opened on 20th November, see page 14.

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SLALIB in IRAF

NOAO have recently been developing image registration tools for IRAF, based on the new FITS World Coordinate System conventions. In the course of this work, it became clear that a set of trustworthy and accurate celestial coordinate transformation routines were required, capable of supporting the equatorial (FK4, FK4-NO-E, FK5, and GAPPT), ecliptic, galactic, and supergalactic celestial coordinate systems. Although some of the required capabilities could already be found in existing IRAF applications, it was decided to use the more complete and consistent set offered by the Starlink SLALIB library, a version of which will be included in future IRAF distributions.

Beginning with IRAF V2.11, the SLALIB routines will be available in the IRAF core system math libraries, where they will be callable from SPP in all IRAF software and can also be used by freestanding Fortran applications (should the standard Starlink version be unavailable). IRAF SLALIB will be closely similar to, and will be kept up to date with, the Starlink Fortran implementation, as documented in SUN/67.

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IRAF archive mirrored by Starlink

Anyone who uses the IRAF ftp server or looks at the IRAF web pages will have noticed that the Internet connection between Tucson and the UK has been very poor in the last few months (see the article by Ian Smith on page 21 for some background on the reasons for this); so poor, in fact, that copying files has become almost impossible during the day, and although the connection improves during the night and at weekends, copying large files is still a frustrating and time consuming business.

To overcome these problems, Starlink has been collaborating with the IRAF team at NOAO to "mirror" a copy of the IRAF ftp archive on the Starlink anonymous ftp server and a copy of the IRAF World Wide Web pages on the Starlink web server. Both copies will be updated once a night to keep in step with the files in Tucson (although it may take more than one attempt to bring the Starlink copy up-to-date if the network is particularly bad).

When the mirror is in operation (which it should be by the time you read this) a copy of the directory tree `/iraf` of `ftp.noao.edu` can be found in `/pub/mirrors/iraf` on `starlink-ftp.rl.ac.uk`. The URL of the copy of the World Wide Web pages is `http://star-www.rl.ac.uk/iraf`; alternatively, simply follow the links on the Starlink or IRAF home pages.

If this service proves to be successful, NOAO will be looking for sites in other parts of the world (*e.g.* Australia and Japan) to host similar mirrors. The Starlink mirror site may also be expanded to mirror other astronomical software, such as PGPLOT and AIPS.

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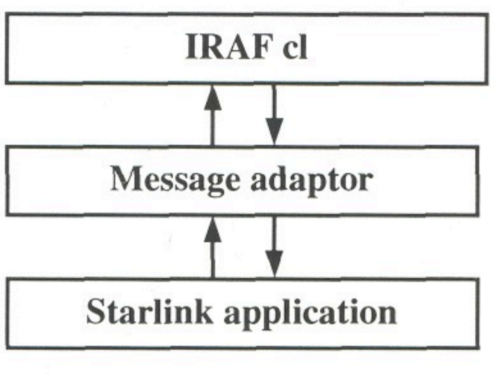
Starlink applications as IRAF packages

Starlink has long recognised that no one data-reduction environment can satisfy the needs of all users, even within one wavelength regime, and that the choice of which one to use is determined more by what you are familiar with and what your colleagues use than upon an exhaustive evaluation of the technical merits of the individual systems. At one time, using several packages in order to reduce and analyse a piece of data was the norm, but as the packages have become more comprehensive and more complicated it has become both less necessary and more difficult to do this. Unfortunately, this means that the users of any particular package have become isolated from the facilities in other packages which may do some jobs better or more efficiently than the package they are currently using. This "software xenophobia" also leads to demands that each package should have a comprehensive set of applications and an ever-increasing overlap between packages.

One way to break down these barriers between packages would be to make it possible to run the applications written for one system from the command language of another so that "foreign" applications can be run without having to grapple with the idiosyncracies of another "look and feel." The more similar the two systems are, the easier this is likely to be. As the architectures of IRAF and the Starlink environment are similar (having been developed at much the same time), we chose Starlink applications and the IRAF command language (cl) to pioneer this approach to inter-operability between data reduction systems. In addition, many Starlink applications can now read and write IRAF image files, so that the manual conversion of data files is not required.

IRAF and the Starlink environment may have similar architectures but the implementations are completely different! In particular, the inter-process messaging system used by the command language to control the applications tasks (and by the tasks to communicate with the user) are different – although the meanings of the various messages are broadly similar. After discussions with the IRAF developers at NOAO we decided to build a *message system adaptor* – a process that intercepts the messages sent between the cl and the task and converts the messages from the IRAF `clio` protocol to the Starlink message system and *vice-versa*.



To the IRAF cl, the adaptor behaves like a normal IRAF task; it responds to commands, requests parameter values and so on just like a "real" IRAF task. To the Starlink application, the adaptor looks like a command language; it sends commands to be executed, replies to requests for parameter values, accepts messages to be displayed to the user *etc*. To the user, the Starlink application is just another IRAF package; it implements a number of commands, each of which has parameters that can be listed with `lparam`, edited with `eparam`, and manipulated with the usual cl commands, and it accepts parameter values on the command line and prompts for missing values in the usual way. Since Starlink applications can read and write IRAF images transparently, the new commands can be freely mixed with other IRAF commands just like any other IRAF package.

There are things that give away the fact that a Starlink application is not just another IRAF package; the general style of the application tends to be a little different from the typical IRAF package – if you compare an IRAF application with a Starlink application that does essentially the same job, the Starlink application often has more options and more detailed messages. For example, the IRAF `imstatistics` command produces output that looks like:

```
#    IMAGE   NPIX   MEAN STDDEV     MIN     MAX
   comwest  65536  170.8  63.47   3.891   245.9
```

while the equivalent KAPPA command, `stats`, produces:

```
   Pixel statistics for the image structure
/home/user1/dec/dlt/tk4/iraf/comwest.imh

  Title                        : KAPPA - Sqorst
  image array analysed         : DATA

     Pixel sum                 : 11196413
     Pixel mean                : 170.8437
     Standard deviation        : 63.47324
     Minimum pixel value       : 3.890625
        At pixel               : (59, 83)
        Co-ordinate            : (58.5, 82.5)
     Maximum pixel value       : 245.9375
        At pixel               : (248, 45)
        Co-ordinate            : (247.5, 44.5)
     Total number of pixels    : 65536
     Number of pixels used     : 65536 (100.0%)
```

Of course, if all the Starlink applications had to offer the IRAF user was a slightly different way of doing the same thing, then there would be little point in all this. However, there are many examples of really significant differences, even where there is an apparent overlap in functionality. To give one example, FIGARO applications can handle spectra with uneven width bins as produced by some infra-red instruments and an error variance array is maintained throughout the data reduction process.

This work has reached the point where most of the applications in KAPPA have been demonstrated running under the IRAF cl, but work still remains to be done in the way of testing, organising the package structure, preparing "help" pages *etc*. Starlink's software development plans for 1996 include releasing FIGARO as an IRAF package.

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USSC release information

Starlink has implemented a new format for providing information about software releases which we hope will be more useful for both users and site managers.

Summary information about each release can be found in Starlink `news` and on the Starlink central web page in the link *News postings*. It is identified by the title "USSC: USSC*nnn* release summary" where *nnn* is the release number. It includes a summary of the released software, documents, and information files, together with where to find further information.

This same information appears as a preamble to the Release Note which is e-mailed to the Site Managers and which also appears in the Newsgroup `uk.org.starlink.announce`.

We hope that by providing information in this format users will be better informed and that site managers will find that the Release Note is more streamlined.

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New products

The products (software and documentation) released as part of the Starlink Software Collection (SSC) during the period 1st May to 15th December 1995 inclusive (releases 113 to 143) are summarised in the Table shown opposite. The left and centre panels show names and descriptions of software items that have been released, together with a code indicating the newly released documents (if any) associated with that item. In the right panel, an alphabetical list of the released items is shown under the heading "Items Released," followed by a classification code.

Some of the newly released documents are not associated with any of the listed software items. These are shown separately under the heading "Other Documents."

In the Table, the names of software items and documents which are completely new (rather than just updates of previous versions) are shown in bold type.

You can keep in touch with the latest Starlink software and document releases by following the link *Software and Document releases* in the Starlink Project's web page (`http://star-www.rl.ac.uk/`).

New software

In this section we give short descriptions of the 11 software items which are completely new. Some of them are described in more detail in separate articles in this Bulletin (along with others which are expected to be available by the time you read this article).

Applications and Utilities (9):

cursa: A package for handling astronomical catalogues and tables in FITS tables format. An important new facility is its graphical catalogue browser – see page 11. *(SUN/190)*

forum: Computer conferencing software – see page 22. *(SUN/205)*

ghostscript: This well-known interpreter and previewer for PostScript files is now available through Starlink. *(SUN/197)*

htx: A set of utilities to support the new hypertext documentation facilities – see page 16. *(SUN/188)*

latex2html: A tool for converting LaTeX files into hypertext (HTML) form. *(SUN/201, MUD/152)*

star2html: A utility that invokes **latex2html** (above) to convert Starlink documents into hypertext (HTML) form – see page 16. *(SUN/199)*

staradmin: A utility to help Site Managers maintain username lists *etc*. *(SSN/27)*

starman: A stellar photometry package. *(SUN/141)*

wfcpack: A package to analyse ROSAT wide-field camera data. Used to be called WFCSORT *(SUN/62)*

Subroutine libraries (1):

pda: This new "Public Domain Algorithms library" is a collection of numerical routines. It is intended to replace the NAG library in those items of Starlink software that need to be freely distributable. *(SUN/194)*

Infrastructure (1):

startcl: Contains extensions to the **tcl/tk** scripting language, including a widget to display Starlink graphics and interfaces for controlling tasks (such as existing applications). Together, these provide an important new facility for developing graphical user interfaces (see the article on CCDPACK on page 6 for example). *(SUN/186)*

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Applications

A1: Spectroscopy

Name	Description	Documents
FIGARO	General data reduction	SUN/86

A2: Image Processing & Photometry

Name	Description	Documents
KAPPA	Kernel applications	
PISA	Position, intensity & shape	SUN/109
SAOIMAGE	Image display	SUN/166
STARMAN	**Stellar photometry**	**SUN/141**

A4: Time Series & Polarimetry

Name	Description	Documents
TSP	Time series & polarimetry	SUN/66

A5: Database Management

Name	Description	Documents
CATAPP	Sample use of CAT routines	**SUN/181**
CURSA	**Catalogues and tables**	**SUN/190**

A6: Specific Wavelengths

Name	Description	Documents
ASTERIX	X-ray data processing	SUN/98

A7: Specific Instruments

Name	Description	Documents
CCDPACK	CCD	SUN/139
CGS4DR	UKIRT (CGS4)	SUN/27
IRCAMPACK	UKIRT	
WFCPACK	**ROSAT (wide-field camera)**	**SUN/62**

A8: Data Handling & Format Conversion

Name	Description	Documents
HDSTRACE	HDS object listing	

A9: Observation Preparation etc

Name	Description	Documents
COCO	Coordinate conversion	SUN/56
FORMLOAD	Electronic form filler	SUN/22

A12: Document Preparation

Name	Description	Documents
GHOSTSCRIPT	**PostScript interpreter**	**SUN/197**
HTX	**Hypertext utilities**	**SUN/188**
ISPELL	Spelling checker	SUN/189
LATEX2HTML	**LaTeX to HTML converter**	**SUN/201** MUD/152
STAR2HTML	**Starlink to HTML converter**	**SUN/199**
TEX	Document typesetting	

A14: General Utilities

Name	Description	Documents
DOCFIND	Starlink document search	SUN/38
EMAIL	E-mail help	SUN/182
FORUM	**Computer conferencing**	**SUN/205 SSN/33**
NEWS	Starlink news & job adverts	**SUN/195**
PERL	Extraction & report language	SUN/193
STARADMIN	**User database maintainer**	**SSN/27**

Subroutine Libraries

S1: Astronomical & Mathematical

Name	Description	Documents
PDA	**Public domain algorithms**	**SUN/194**
SLALIB	Positional astronomy	SUN/67

S2: Data Access & Management

Name	Description	Documents
CAT	Catalogue manipulation	**SUN/181**
FIO	Fortran I/O	SUN/143
FITSIO	FITS I/O on disk	SUN/136 MUD/16,**162**
HDS	Hierarchical data system	SUN/92
NBS	Adam noticeboard system	SUN/77
NDF	Access NDF objects	SUN/33 **SSN/20**
REF	Reference HDS objects	
TRANSFORM	Coordinate transformation	

S3: Graphics

Name	Description	Documents
AGI	Graphics database	SUN/48
GKS	Low-level	
GNS	Workstation name service	SUN/57
GRAPHPAR	Adam graphics	
GWM	X window manager	SUN/130
IDI	Image display interface	SUN/65
PGPLOT	High-level	SUN/15
SGS	Simple interface to GKS	SUN/85

S4: Other

Name	Description	Documents
CHR	Character handling	SUN/40
CNF	C/Fortran programming	
EMS	Error message service	SSN/4
HLP	Interactive help system	SUN/124
MERS	Message & error reporting	SUN/104
PCS	Parameter/communications	SSN/29
PSX	Posix interface	

Infrastructure (I)

Name	Description	Documents
ADAM	Software environment	SUN/113,144
ICL	ADAM command language	,
SAE	Environment base files	**SUN/191**
STARTCL	**Starlink additions to TCL**	**SUN/186**
TCL	Embedded command language	**SUN/200**
TK	X-window toolkit for TCL	**SUN/200**

Items Released

Name	Description	Name	Description
ADAM	I	IRCAMPACK	A7
AGI	S3	ISPELL	A12
ASTERIX	A6	KAPPA	A2
CAT	S2	**LATEX2HTML**	**A12**
CATAPP	A5	MERS	S4
CCDPACK	A7	NBS	S2
CGS4DR	A7	NDF	S2
CHR	S4	NEWS	A14
CNF	S4	PCS	S4
COCO	A9	**PDA**	**S1**
CURSA	**A5**	PERL	A14
DOCFIND	A14	PGPLOT	S3
EMAIL	A14	PISA	A2
EMS	S4	PSX	S4
FIGARO	A1	REF	S2
FIO	S2	SAE	I
FITSIO	S2	SAOIMAGE	A2
FORMLOAD	A9	SGS	S3
FORUM	**A14**	SLALIB	S1
GHOSTSCRIPT	**A12**	**STAR2HTML**	**A12**
GKS	S3	**STARADMIN**	**A14**
GNS	S3	**STARMAN**	**A2**
GRAPHPAR	S3	**STARTCL**	**I**
GWM	S3	TCL	I
HDS	S2	TEX	A12
HDSTRACE	A8	TK	I
HLP	S4	TRANSFORM	S2
HTX	**A12**	TSP	A4
ICL	I	**WFCPACK**	**A7**
IDI	S3		

Other Documents

1. Associated with software items:

JCMTDR - Cookbook	**SC/1**
PHOTOM - Aperture photometry routine	SUN/45
IRAF - Image reduction analysis facility	SUN/179
NUTPU - A DEC TPU compatible editor for Unix	**SUN/192**

2. General:

HTML - Quick reference guide	**MUD/163**
Starlink site managers guide	SGP/25
How to write good documents for Starlink	SGP/28
Starlink	SGP/31
Starlink software strategy	**SGP/42**
Guidelines for Starlink Software Strategy Groups	**SGP/44**
ADAM review panel report	**SGP/45**
Installing the Unix Starlink software	SSN/9
Configuring SPARC/Solaris systems	**SSN/26**
SYSTUNE - Monitoring & tuning SPARC/Solaris	**SSN/30**
A Starlink guide to cartridge tape subsystems	**SSN/31**
Custom jumpstart tutorial	**SSN/32**
Starlink User's Guide	SUG
The Starlink software collection	SUN/1
tcsh - C shell with enhancements	**SUN/196**
Starlink subroutine libraries: linking guide	**SUN/202**

A new window on CCD data reduction

Users of the new version of CCDPACK (V2.0) might be forgiven for suffering a little culture shock, for this release not only introduces a new graphical user interface (GUI) but also breaks the mould of running a series of programs to reduce your CCD data.

Rather than presenting you with a button to "flat-field" your CCD frames, for example, the new interface concentrates on organising and categorising your data. Once this is done, the necessary processing steps are deduced and executed automatically. The approach bears more resemblance to the software you might run on your PC than to traditional astronomical data reduction software.

The decision to do things this way was determined in large part by the response to the last Starlink Software Survey, which showed a need for both software and documentation to be more approachable, tutorial and intuitive. In the new CCDPACK, software and documentation have therefore been closely integrated – into a form of "interactive cookbook" that guides you through each decision, presenting and describing the options available at each stage.

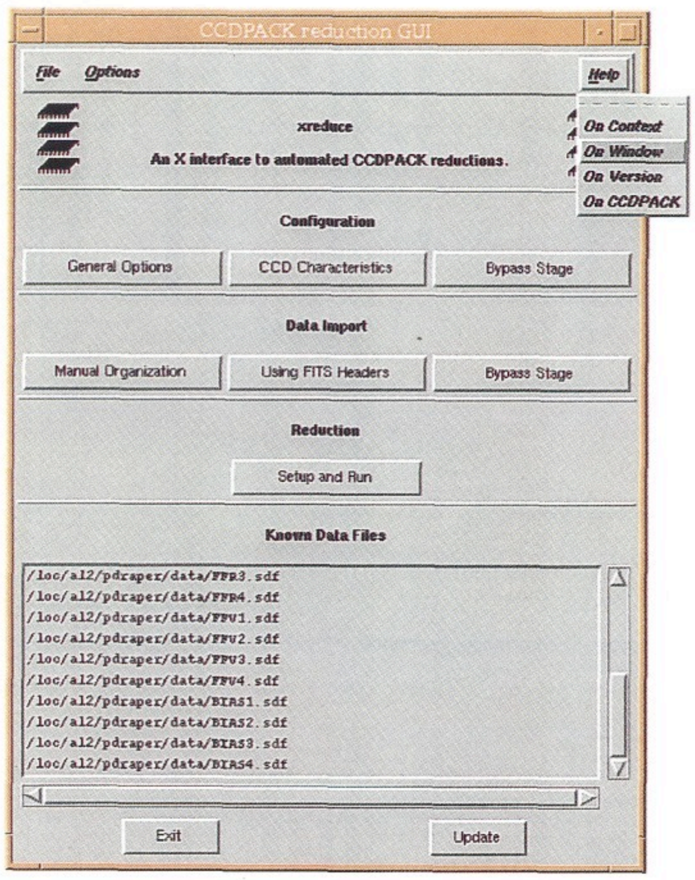

Figure 1. *The main window of the CCDPACK GUI (**xreduce**).*

Using this, you should be able to achieve high-quality results quickly and easily, even if initially you know little about CCD systems. Along the way, you will be introduced to each of the important factors that influence CCD data reduction, so that you quickly learn how to make the crucial decisions that affect your data. Even for more experienced users, the new interface presents a convenient and time-saving alternative to running the underlying CCDPACK programs directly.

The programs **makecal**, **calcor**, **makeflat** *etc* remain at the core of the new system, but have been augmented by a new **schedule** command that decides how to reduce your data from the information you supply (using your preferences if several approaches are possible). Reductions can even be stopped mid-way and continued later from where you left off. This scheme was inspired by the **ccdproc** approach in IRAF/CCDRED and broadly corresponds to it, but it also performs complete reductions in one pass (as it can combine calibration data automatically) and features specialized facilities for handling Infra-Red array data. It is **schedule** that lies beneath the GUI and allows it to talk about instruments, filters and data frames, rather than the low-level details of how to process the data.

CCDPACK also has facilities for registering, aligning and normalizing frames so that large mosaic images can be produced. It is fully described in SUN/139, which can be viewed on-line from the **xreduce** GUI or by using the **ccdwww** command.

Figure 1 shows the main window of the CCDPACK GUI (**xreduce**). Probably the first thing you will want to do here is pull down the Help menu and select "On Window." This starts a browser that lets you read about the window and CCD data reduction in general. Selecting "On Context" tells you how to get help on a particular part of the window – just place the pointer over the part and press the F1, F2 or Help key.

Figure 2 shows a window which allows you to select the characteristics of a known CCD camera. This also allows **xreduce** to understand your data better. For example, if you have WHT data from around 1994-ish onwards, then its header information contains enough detail to allow it to be reduced automatically. All you need to do is identify your data files (in a separate window) and tell **xreduce** to reduce them.

Figure 3 shows a window which allows you to supply details of a CCD camera which is unknown to the program. The most important parameters are the extents of the light-sensitive area and the bias strips. If you don't happen to know these, then help is at hand – in this window you can pan and zoom the image and select the regions you want by dragging the mouse.

Figure 4 shows a window which enables you to identify frames. When you've finished, this information is recorded inside the frames themselves – so you won't need to do it again.

Figure 5 shows the last window in **xreduce**. Note the *save disk space* option which deletes frames after processing. Selecting "lots" will reduce your disk space requirement to just a few frames more than the raw data, although your original data will be lost (you should keep a tape copy). Selecting "some" saves less space but retains the original data.

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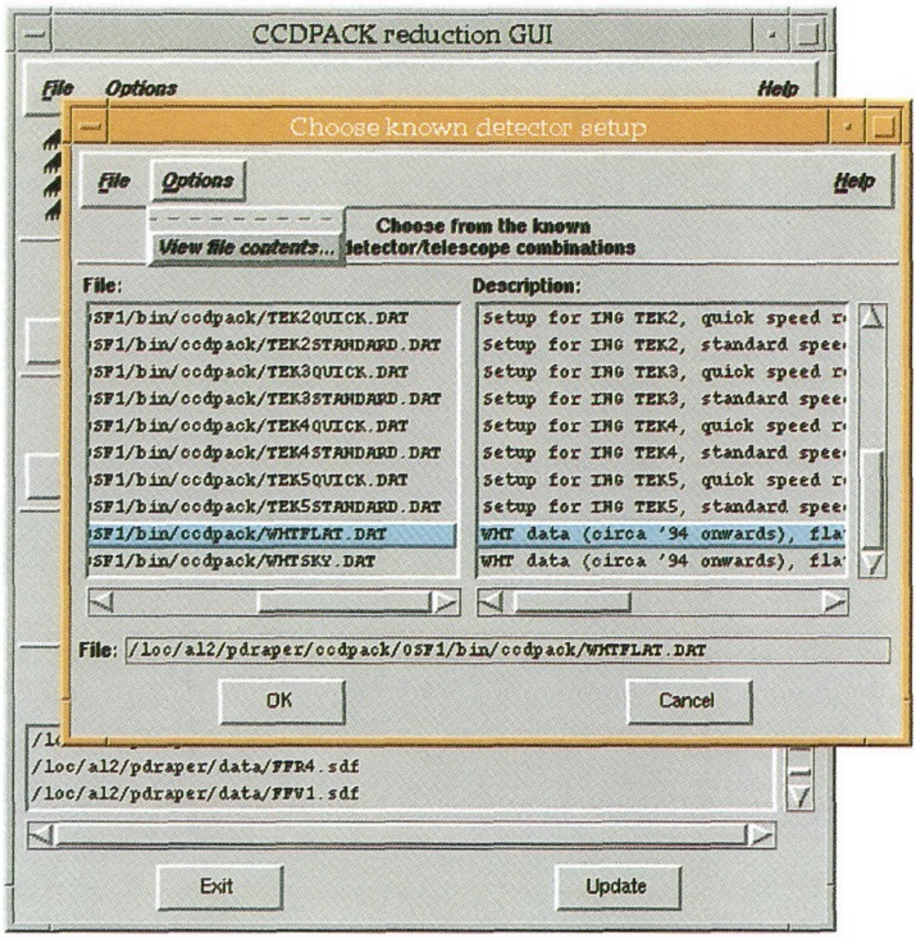

Figure 2. *CCDPACK already knows about the characteristics of many CCD cameras and this window allows you to select one of these standard configurations (or you can define your own).*

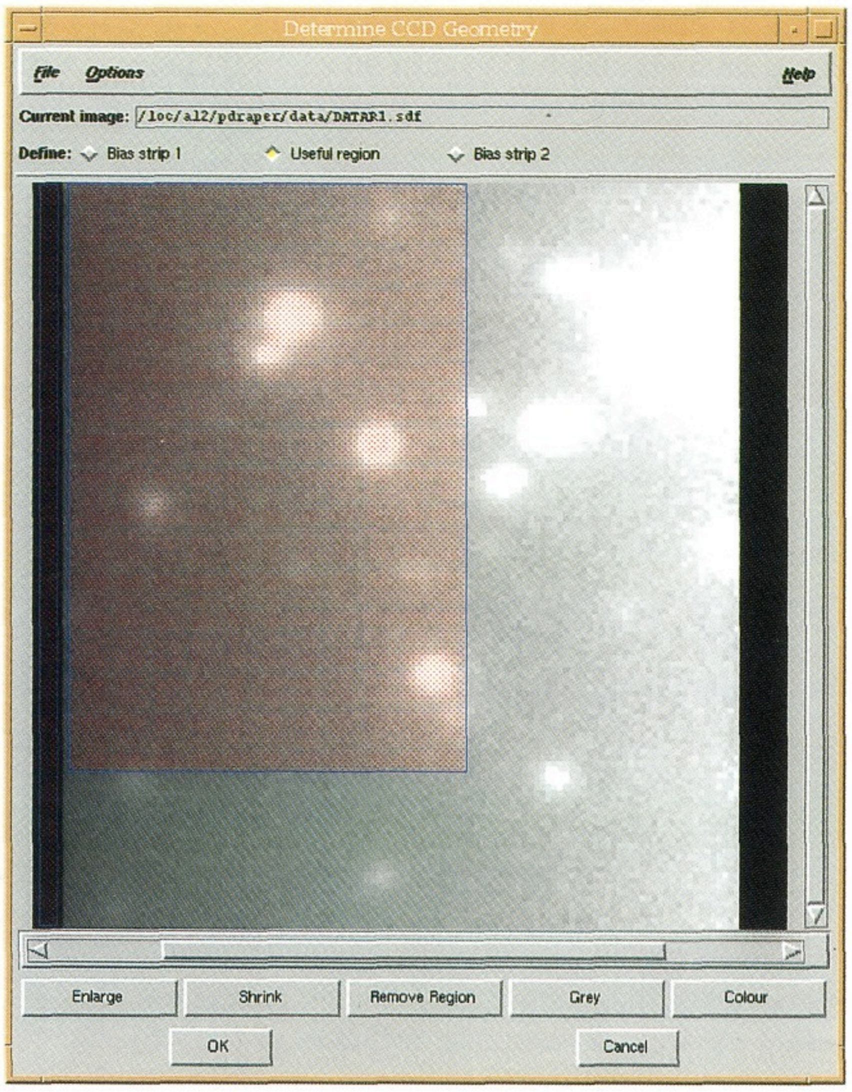

Figure 3. *If your CCD camera isn't already known to CCDPACK, then you will need to supply some information about it. This window lets you do this.*

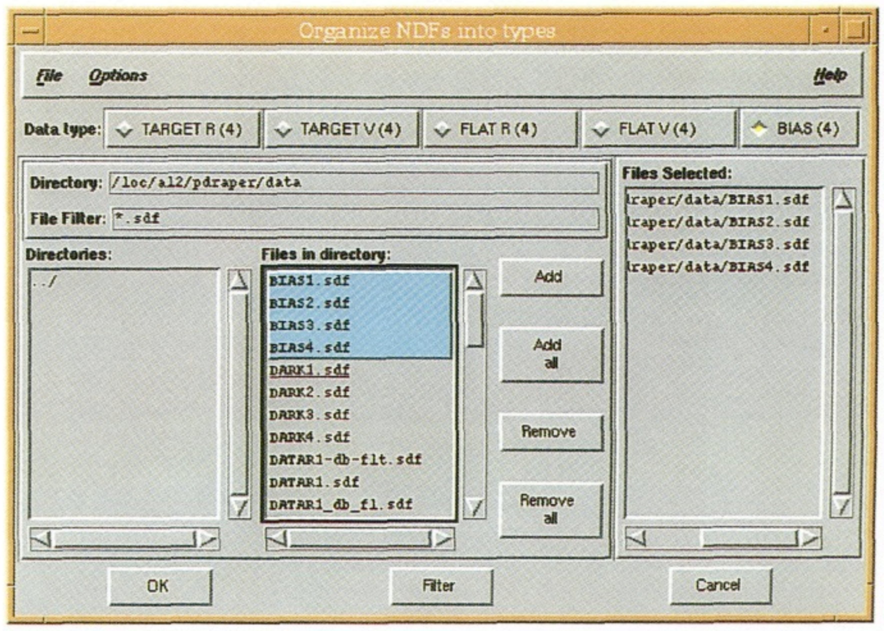

Figure 4. *Unless your frames already contain this information, you may have to identify which ones are "targets" (i.e. astronomical objects), "flats", "bias" frames etc. This is done in this window. You can also categorise frames by filter colour.*

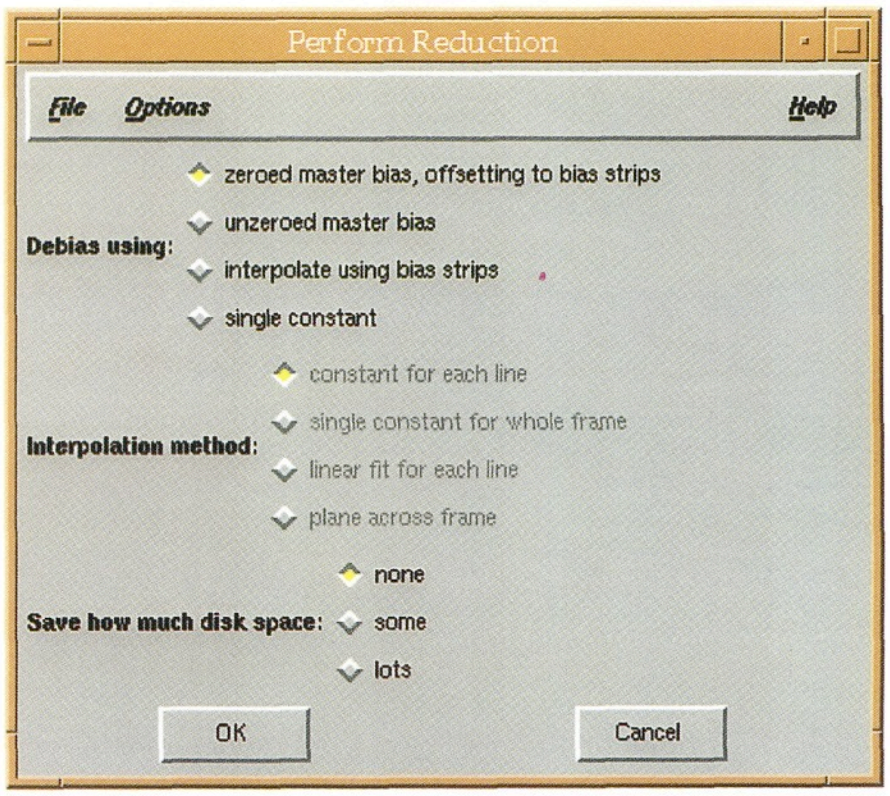

Figure 5. *The last window in* **xreduce** *where you choose final options before a reduction is scheduled and executed.*

Visualisation of 3-dimensional data

Over the past year Starlink has been looking into the problems of displaying data sets defined in 3 dimensions. The primary motivation behind this was a request by the Theory and Statistical Analysis Software Strategy Group to provide software to display the results of theoretical modelling of astrophysical systems. Similar problems are, however, also faced by people attempting to visualise 3-dimensional stacks of observational data.

These sorts of data can be characterised by:

- A set of 3-D positions. These may form a regular grid which divide the data volume up into a set of notional cells, or they may be completely irregular scattered points.
- A set of one or more data values associated with each position or cell, each of which may be scalar or vector.

Displaying data of this type is commonly called "data visualisation" and this has been the subject of much study over the past few years. Various standard techniques have been developed, but nearly all of them are extremely greedy in their use of computing resources. Until recently, the typical computer hardware in use at Starlink sites has not really been sufficiently powerful to allow these techniques to be used effectively. However, this is changing. Commercial visualisation packages can now be run on the typical DEC Alpha and Sun workstations available to most Starlink users, provided they are willing to put up with a somewhat slower response time than is typical when displaying 2-D data.

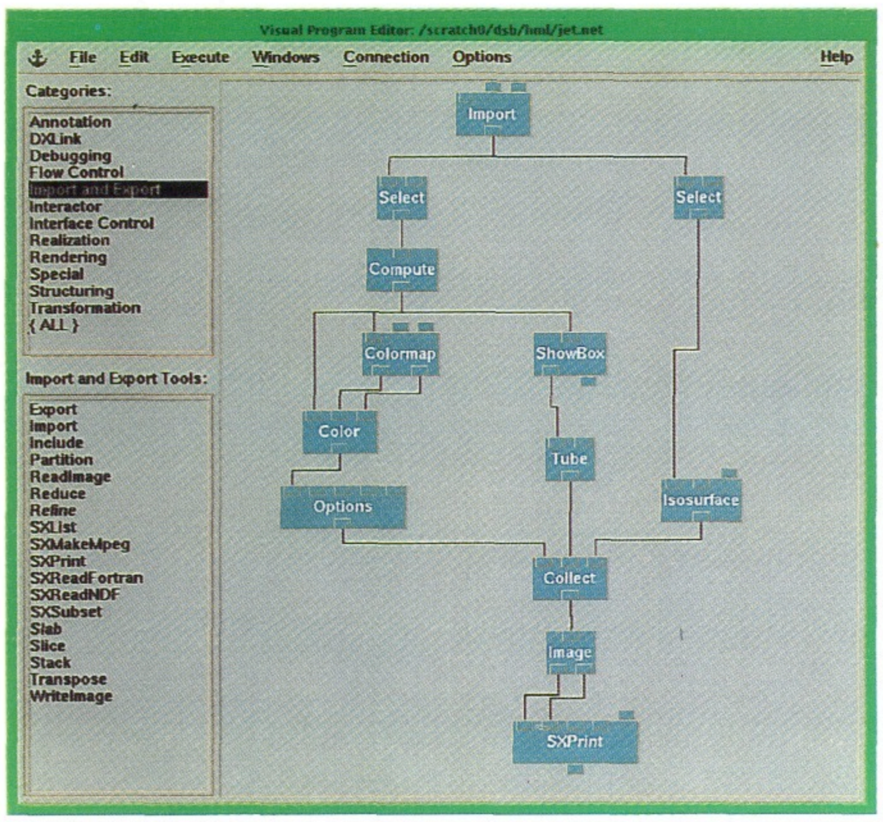

Figure 1. *The graphical user interface for the DX network editor. This network produced the image shown in Figure 2.*

There are several suitable commercial packages on the market, most of which provide very similar facilities, usually based on a graphical user interface which allows users to connect low-level modules together to form "networks" (see Figure 1 for an example).

Starlink currently recommends the *Data Explorer* package produced by IBM (commonly called "DX"), although it is not inconceivable that this recommendation may change in future years as other packages (particularly AVS) continue to be developed. This does not mean that DX will be made available at all sites, however. It is up to each site to decide for themselves if they want DX, and if so, how to get it (one possible way is to include it in your site's next bid for Starlink equipment).

To support the use of DX at Starlink sites, some extra modules and documents have been produced, together with some demonstration "networks" and an NDF to DX data file converter. Together, this package of Starlink extensions to DX goes by the name of "SX."

3-D hydrodynamic data

To illustrate the sort of displays that can be produced, we have used DX to look at the results of a 3-D hydrodynamic simulation (produced by Steve Higgins and Tim O'Brien at Liverpool JMU in collaboration with James Dunlop at the University of Edinburgh) of an extragalactic jet propagating through a medium containing an ensemble of cool, dense clouds. The data are defined on a regular 3-D grid of $90 \times 90 \times 90$ points, with values of the density, velocity and pressure defined at each grid point. The jet material is tracked separately from the pre-existing ambient gas.

These data have been visualised in several ways. Three of these are illustrated in Figures 2, 3 and 4.

Figure 2 shows the results of *volume rendering* the total density field. Using this technique, a scalar value defined over an entire volume can be rendered as a single image. Each position (or cell) is assumed to emit light with a colour and brightness determined by its associated data value. Each cell is also assumed to absorb a certain fraction of any light passing through it, with the opacity again being determined by the associated data values. The resulting image is said to resemble a "self-luminous gel."

This particular technique is very CPU-hungry (it took several minutes to produce the image displayed in Figure 2). The figure also contains an iso-surface taken from the jet density field (*i.e.* a surface of constant jet density). The resulting object can be viewed from any direction, so for instance, a movie could be created showing a complete rotation of the object.

The figure shows that the jet has been deflected at least twice, where it has encountered clouds, but clearly remains collimated and produces a bow-shock at its head.

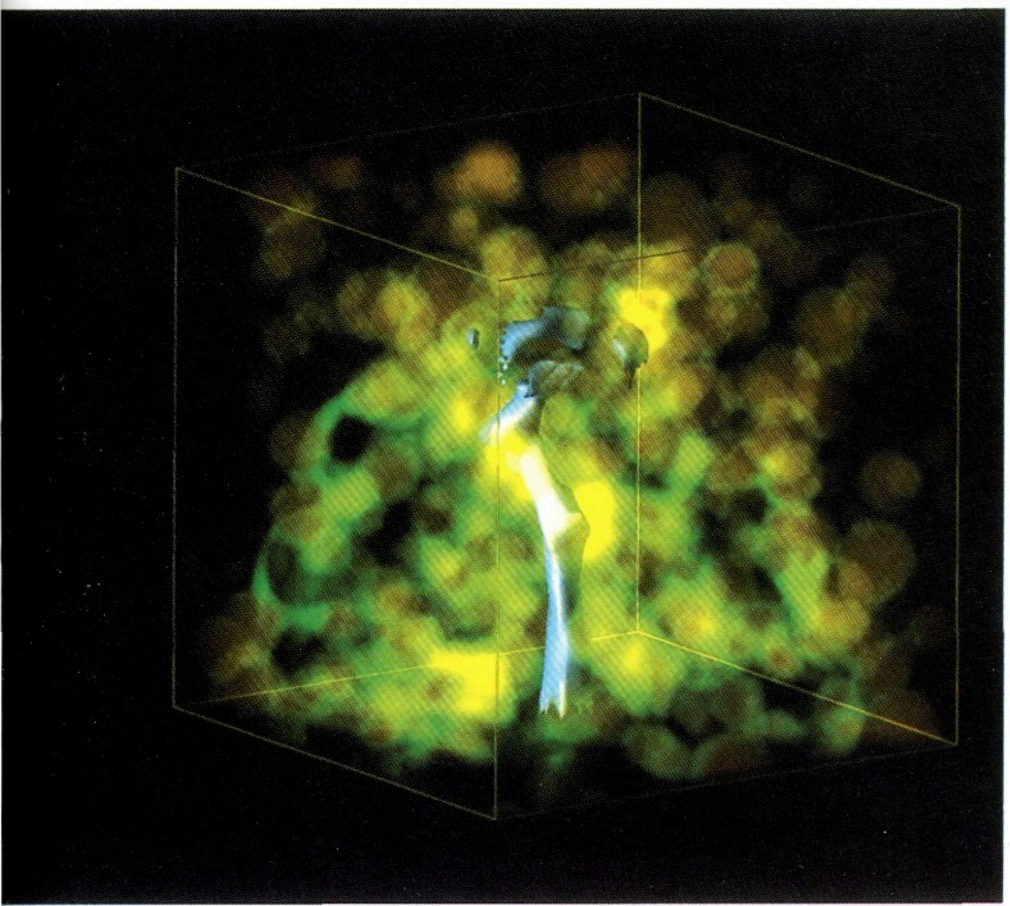

Figure 2. *The results of volume rendering the total density field.*

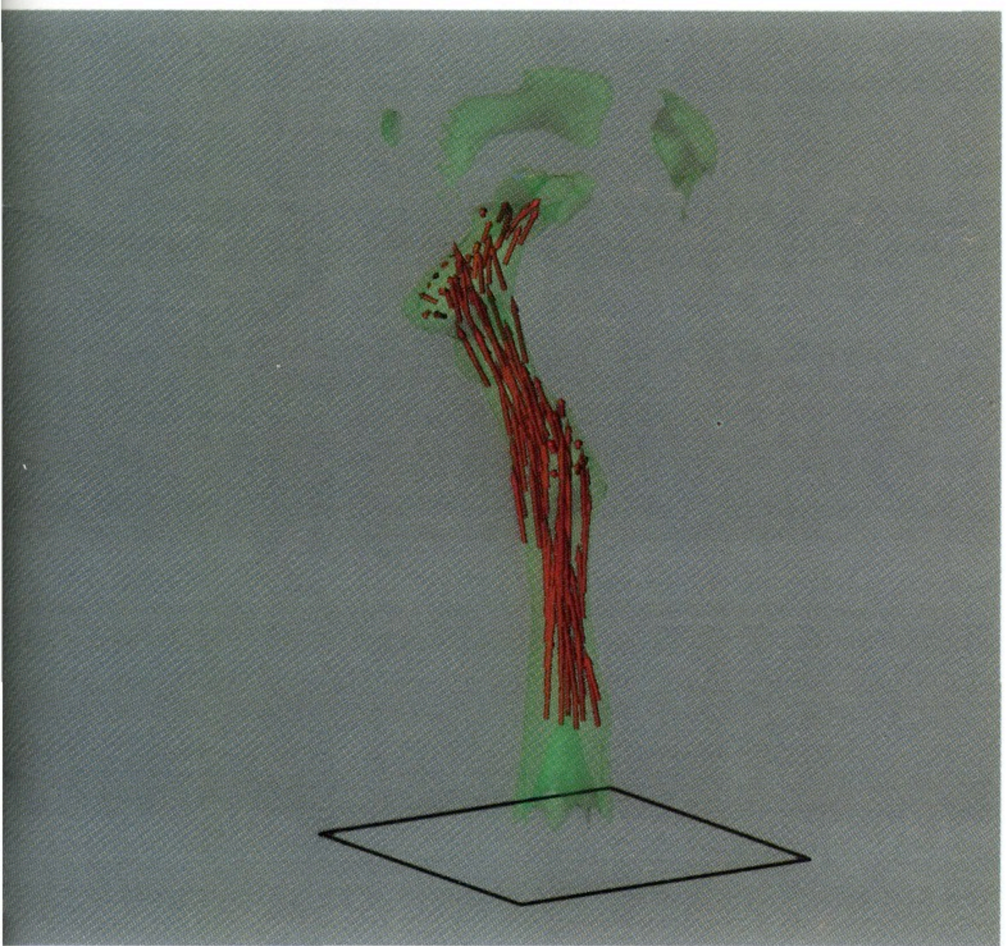

Figure 3. *The velocity field within the bounds of the iso-surface shown in Figure 2.*

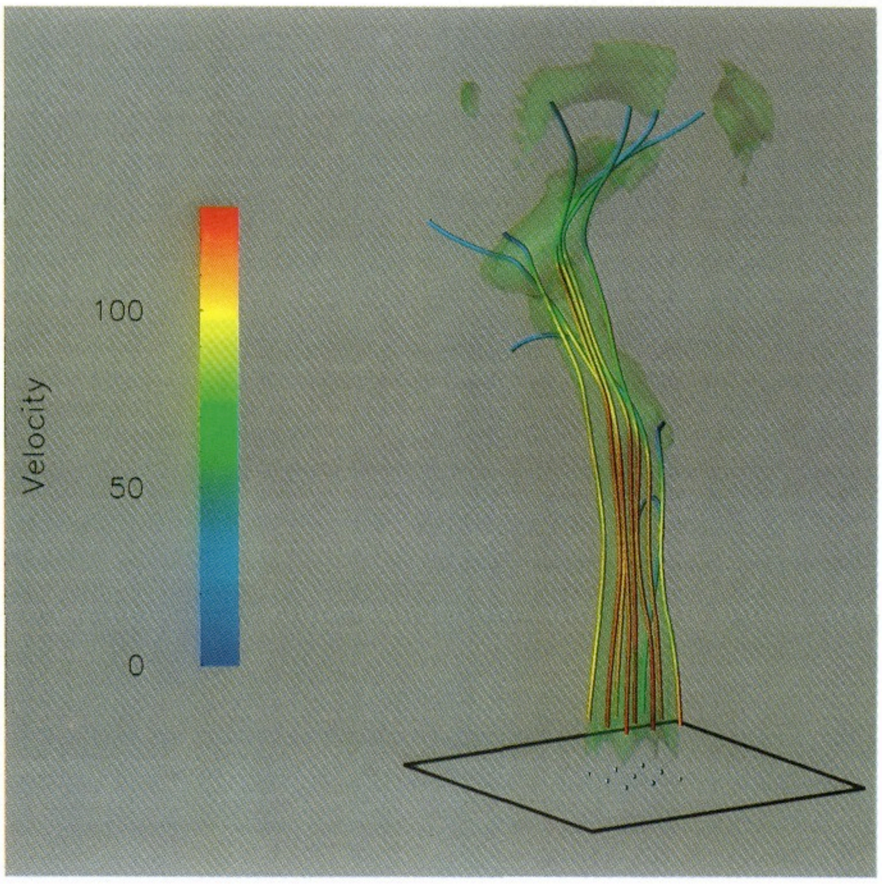

Figure 4. *An alternative way of representing vector fields using streamlines.*

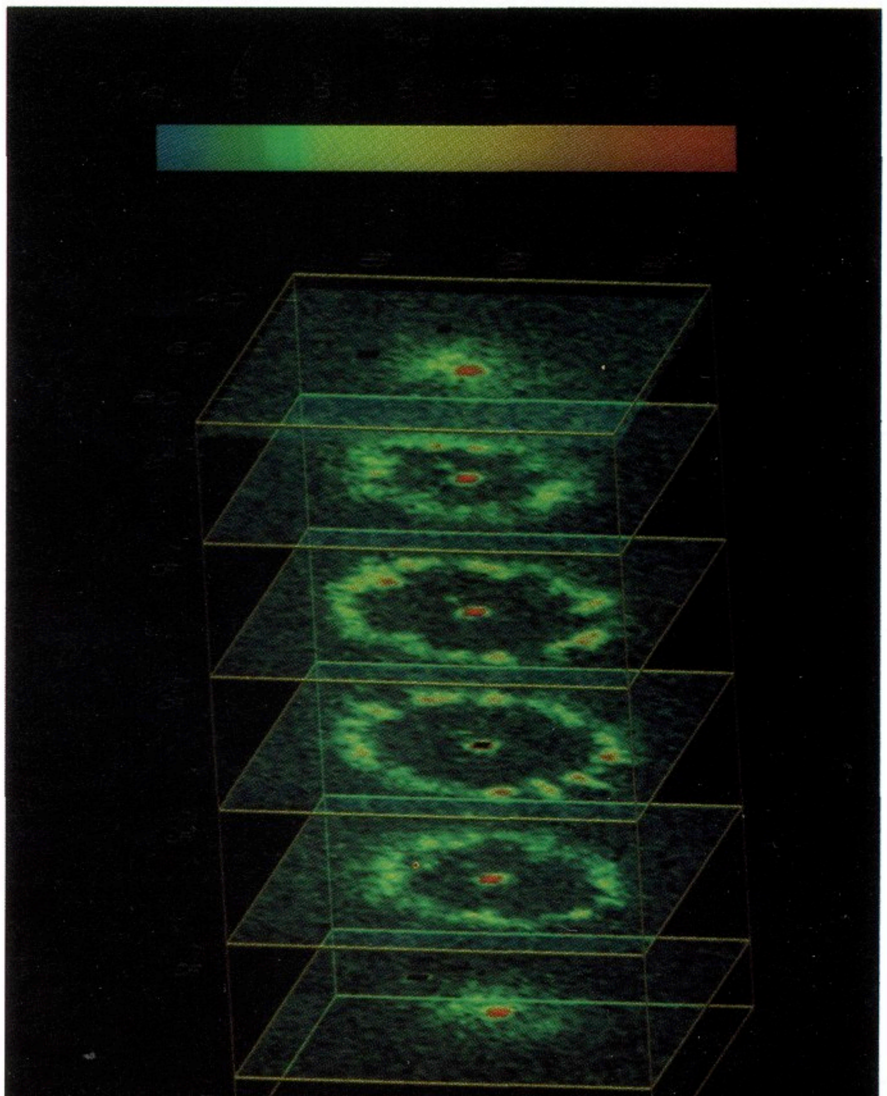

Figure 5. *A velocity cube displayed as a number of slices in the velocity direction.*

Figure 3 shows the velocity field within the bounds of the iso-surface shown in Figure 2. Each velocity value is shown as a 3-D "rocket" pointing in the direction of the velocity with length proportional to the magnitude of the velocity. The velocity field has been sampled onto a coarser grid to reduce the number of displayed vectors. The iso-surface shown in Figure 2 is included again, but this time it is partially transparent so that the vectors behind the surface can be seen.

An alternative way of representing vector fields is to use "streamlines" which track the paths particles would follow if released into the vector field (assuming the vector field to be fixed in time). The current data are not ideally represented in this way because the vector field changes with time, but Figure 4 illustrates how the technique can be used to visualise a useful snapshot of the flow. We have chosen to make the colour of the streamlines indicative of the velocity magnitude (in arbitrary units).

Visualising observational data

Visualising 3-D observational data presents a few more problems than the results of theoretical models because of the presence of noise. For instance, taking an iso-surface of data with poor signal-to-noise ratio can consume huge amounts of memory and CPU time as the algorithm tries to follow every little noise spike in the data. A similar effect is seen when making a contour plot of 2-D data, where the plot can break up into lots of tiny circles.

Attempts to visualise observational data using a volume rendering technique produces a result which looks like a projection of the data cube onto the sky. If this is what you want then it could be useful, but it does not give much feel for the 3-D structure of the data.

A technique which *can* reveal the structure in the data is illustrated in Figure 5, which shows an Hα TAURUS-2 velocity cube of the nebular remnant of the old nova DQ Her, obtained by Andy Slavin and Tim O'Brien using the WHT. The plot shows a number of slices in the velocity direction, with the radial velocity towards the observer increasing with z – the image at $z = 25$ is at approximately the rest wavelength. The data show a wealth of structure and that the remnant, ejected during the nova outburst observed in 1934, clearly consists of an ellipsoidal, clumpy shell which is expanding into the interstellar medium.

Scattered Data

All the examples in this article use data on a regular grid. However, it is perfectly possible to use irregularly scattered data such as that produced by n-body codes.

Each particle may be represented by a simple point on the screen, or by a 3-D object (or "glyph") such as a sphere, rocket, or indeed any object the user can construct. The size, shape, colour and opacity of these glyphs can be determined by any of the data values associated with the position, or with any arbitrary algebraic combination of them. The positions are projected onto the screen either with a simple orthographic view, or with a perspective view in which objects get smaller as they recede from the view point. The position of the view point can be incorporated into the glyph colouring so that, for instance, particles which are further away get fainter.

Conclusion

The typical hardware available at Starlink sites is now sufficiently powerful to make the use of visualisation packages such as *Data Explorer* practical.

These packages are still evolving quite quickly and cannot be said to have reached full maturity yet. In particular, they are still rather complicated to use and require a significant investment of time and effort to learn how to make the most of them. Nonetheless, with some effort it is possible to use DX to produce images such as those shown in this article. With a little extra effort it is possible to make movies in which (for instance) objects can be rotated, iso-surfaces can be swept through the range of the data, journeys can be made through a collection of scattered particles *etc*.

For those who are interested in further reading, SG/8 gives an overview of several different visualisation packages and techniques, including some public domain software. It also gives pointers to other sources of information, including several for DX. SUN/203 gives more details about using DX at Starlink sites.

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Viewing the sky with a CAT's eye

CAT and CURSA are two new packages for manipulating astronomical catalogues and similar tabular datasets. CURSA is a set of ready-to-use applications and CAT is a subroutine library which you can use to write your own specialised programs. CURSA has facilities for examining, listing, sorting, pairing and selecting subsets from catalogues. Though CURSA and CAT are intended primarily for use with astronomical catalogues, they can be used equally well with other tabular data, such as a table of private astronomical results, or, indeed, data which are entirely non-astronomical, provided only that they are in an appropriate format.

Browsing the sky

The main component of CURSA is `xcatview`, a powerful and flexible catalogue browser for examining the contents of a catalogue. It contains facilities for listing columns and auxiliary information from a catalogue, selecting subsets according to some criteria (for example, all the objects in the catalogue brighter than some limiting magnitude), computing new columns from existing columns (for example, computing the V magnitude from a catalogue where only the B magnitude and B-V colour are tabulated), and saving subsets (including any new columns) as either text files suitable for printing or as new catalogues. `xcatview` has a mouse-driven 'point-and-click' graphical user interface (GUI), making it easy to learn and use. Alternatively, the catalogue browser can be driven from a simple script in order to facilitate 'batch'-type operations.

As an example, Figure 1 shows `xcatview` being used to display a subset of the Veron-Cetty and Veron *Catalogue of Quasars and Active Galactic Nuclei*[5]. This subset comprises all the quasars in the catalogue brighter than nineteenth magnitude and with a redshift greater than three; a total of some 74 objects out of a total of 4234 entries in the catalogue. Figure 1 shows the first screen-full of objects; buttons in the GUI allow any desired region of the subset to be displayed. In Figure 2, the same subset has been saved as a text file and then plotted as a Hammer-Aitoff all-sky projection using the PONGO[4] package. PONGO is not the only package which can be used for plotting; files created with `xcatview` can be plotted with most of the plotting packages available on Starlink systems.

As another example, you might use `xcatview` during the preparation of an observing programme. If you were planning to observe a certain type of object, such as planetary nebulæ, you could first obtain a suitable specialised catalogue and then use `xcatview` to find nebulæ which matched your constraints. These constraints might include the range of Right Ascension and Declination observable during your observing time, the limiting magnitude of the telescope you were going to observe with, and any specific criteria relevant to your investigation or the instrumentation you were planning to use. Thus, you would derive a list of potential candidates for your observing programme.

CURSA contains a number of other applications as well as the catalogue browser. `catsort` sorts a catalogue into ascending or descending order on a specified column. `catpair` pairs two catalogues, objects being considered to match if they have similar celestial coordinates. `catpair` has options to control the set of objects retained in the paired catalogue and the treatment of multiple matches.

Finding catalogues

Catalogues are ubiquitous in astronomy. They have been used since classical antiquity; the first star catalogue was a list of about a hundred stars produced by Timocharis and Aristyllus of Alexandria in the third century BC. Today many catalogues are available, often with hundreds of thousands or even millions of entries, providing a wealth of information on most branches of astronomy. Most modern catalogues are produced in a computer readable form. Many different formats (and, indeed, media) have been used to store catalogues. However, currently the standard FITS tables format is becoming increasingly common. CURSA reads catalogues in this format, thus immediately giving you convenient access to a large number of catalogues.

Several CD-ROMs have been distributed with catalogues in FITS tables format. Some of the more generally useful ones are:

- *Selected Astronomical Catalogs volume 1*, produced by the US Astronomical Data Center (ADC) at the NASA Goddard Space Flight Center. This CD-ROM is an extremely useful collection of widely used catalogues. The ADC will be publishing a second version shortly,
- *HST Guide Star Catalog* (GSC), produced by the NASA Space Telescope Science Institute. The CURSA application `catgscin` should be used to convert a GSC region to a slightly more convenient format for subsequent access with CURSA,
- several of the *Einstein Observatory* CD-ROMs.

Most Starlink sites will have at least some of these CD-ROMs. If your site does not have copies, then see SUN/162[1] which gives further details about them, including how to obtain copies.

Also, the US Astronomical Data Center and the Centre de Données astronomiques de Strasbourg (CDS) are increasingly making catalogues from their collections available as FITS tables. Both these institutions are accessible via the World Wide Web. Their URLs are:

ADC: `http://adc.gsfc.nasa.gov/`
CDS: `http://cdsweb.u-strasbg.fr/CDS.html`

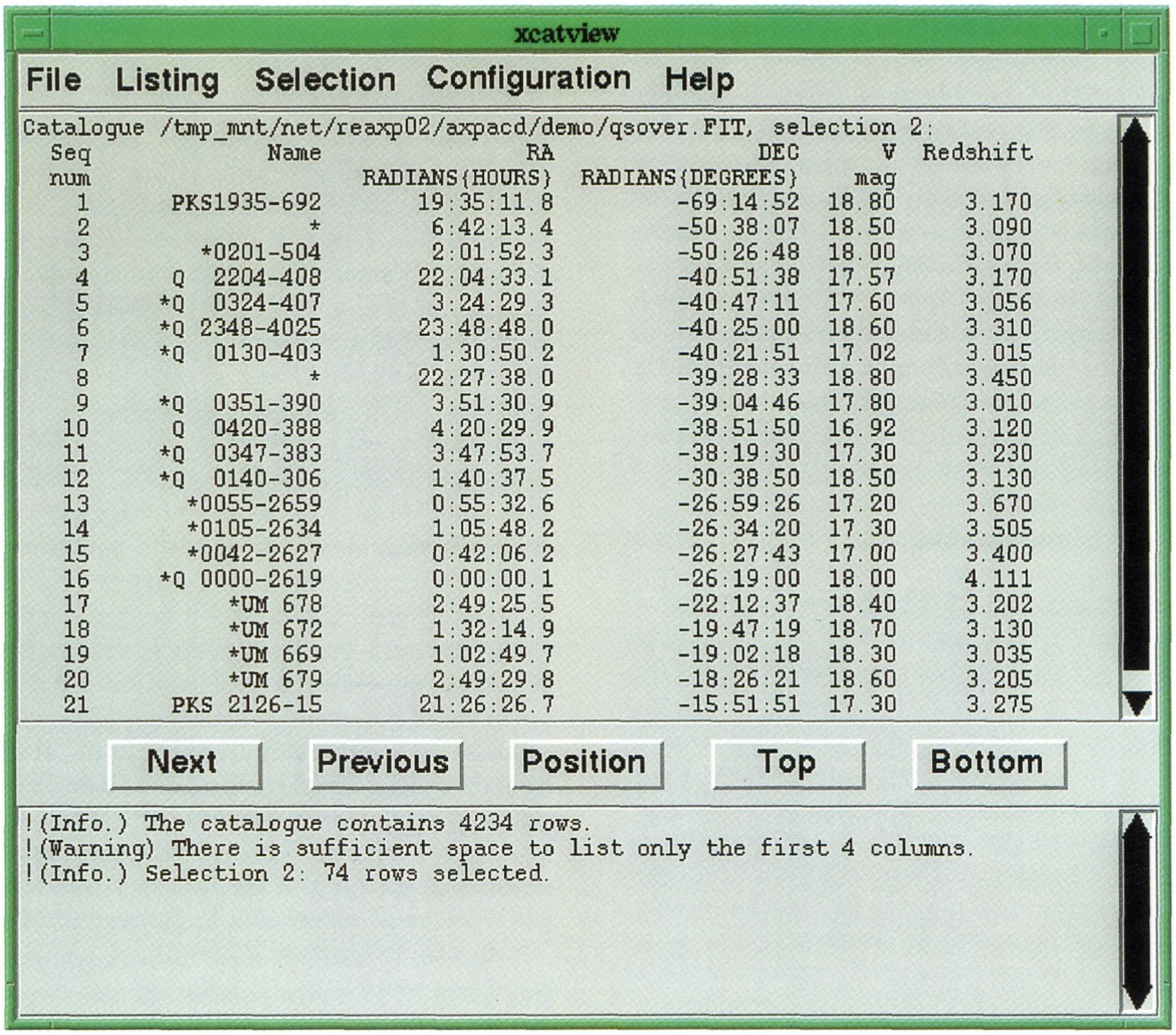

Figure 1. `xcatview` *listing a subset selected from the Veron-Cetty and Veron quasar catalogue. The row of menus across the top of the window control the operation of* `xcatview`*. The main portion of the window shows the first screen-full of objects in the selected subset. The row of buttons about three-quarters of the way down the window control navigation through the subset, allowing any portion to be displayed. Finally, informational, warning and error messages are displayed towards the bottom of the window.*

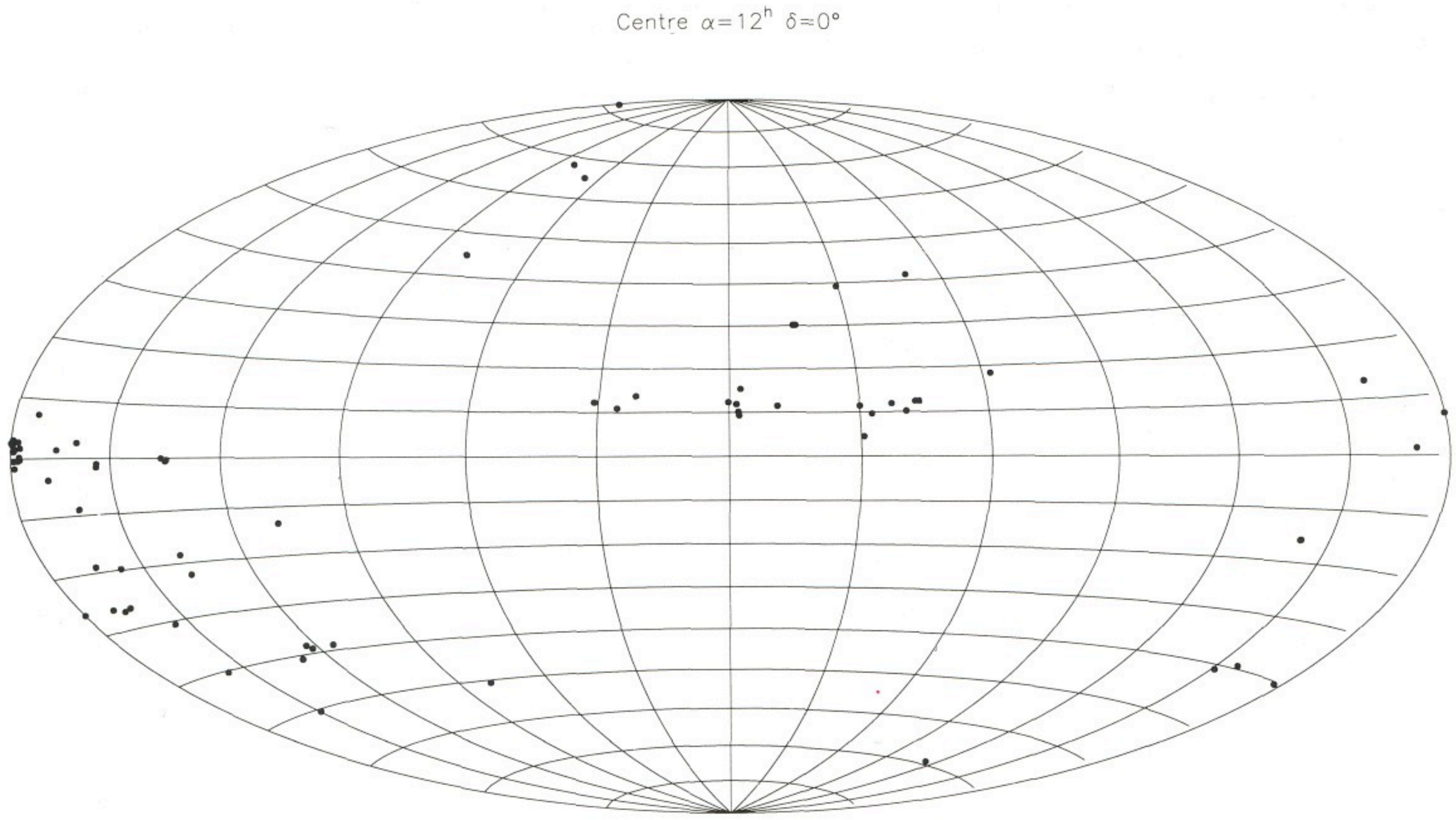

Figure 2. *An all-sky Hammer-Aitoff projection of quasars brighter than nineteenth magnitude and with a redshift greater than three, extracted from the Veron-Cetty and Veron quasar catalogue with* `xcatview` *and plotted with PONGO.*

Again see SUN/162[1] for further details of these institutions.

Although the FITS tables format is becoming common, many users will have catalogues which are not in this format. The fast microdensitometers operated as national facilities in the United Kingdom, such as the new SuperCOSMOS machine at the Royal Observatory Edinburgh, produce tabular data which it is relatively straightforward to convert to FITS tables. Similarly, old data from the original COSMOS machine can also be converted. Alternatively, you might want to access a catalogue from the old VAX/VMS SCAR catalogue collection, a private SCAR catalogue, or a catalogue in some other format. In all these cases, it is usually possible to convert the catalogue to a FITS table. I am happy to advise and assist, and in the first instance you should contact me (electronic mail: `acd@roe.ac.uk`).

As well as accessing FITS tables, CURSA can also read and write catalogues in the CHI/HDS format used by the CATPAC[6] package. Thus CURSA and CATPAC can inter-operate.

Finding out more

CURSA is fully described in SUN/190[3]. Also, there is a 'home page' for CURSA accessible via the World Wide Web. It gives access to a deal of useful information, including answers to frequently asked questions. Its URL is:

`http://www.roe.ac.uk/acdwww/cursa/home.html`

The CAT subroutine library for manipulating catalogues and tables augments the standard CURSA applications. Using CAT, it is straightforward to write your own programs to perform specialised tasks not covered by the more general CURSA applications. Programs written with CAT are fully inter-operable with the standard CURSA applications (in fact the CURSA applications themselves use CAT). CAT is comprehensively documented in SUN/181[2]. As a further aid to using CAT, a set of example programs are included with it. These are fully integrated with the tutorial section of SUN/181.

Finally, in case you were wondering, CURSA is a slightly contrived acronym for 'Catalogue Utilities for Reporting, Selecting and Arithmetic'. It is borrowed from the common name for β Eridanus. CURSA and CAT are new Starlink packages. If you have any suggestions about how they could be enhanced, run into problems using them, or would like assistance in converting catalogues to FITS tables format, then please do not hesitate to contact me.

References

[1] A.C. Davenhall, 1993, SUN/162.1, *A Guide to Astronomical Catalogues, Databases and Archives available through Starlink* (Starlink).

[2] A.C. Davenhall, 1995, SUN/181.1, *CAT - Catalogue and Table Manipulation Library: Programmer's Manual* (Starlink).

[3] A.C. Davenhall, 1995, SUN/190.1, *CURSA - Catalogue and Table Manipulation Applications: User's Manual* (Starlink).

[4] P. Harrison, P. Rees and P. Draper, 1994, SUN/137.2, *PONGO - A Set of Applications for Interactive Data Plotting* (Starlink).

[5] M.P. Veron-Cetty and P. Veron, 1989, *Catalogue of Quasars and Active Galactic Nuclei* fourth edition (ESO Science Report 7).

[6] A.R. Wood, 1994, SUN/120.3, *CATPAC - Catalogue Applications Package on UNIX* (Starlink).

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Names, acronyms, logotypes, pictograms A user's guide, Part 2

In the last issue I described some changes which had taken place in Starlink's organisational environment. I emphasised that the correct abbreviation for the *Council for the Central Laboratory of the Research Councils* was CCL, and that CCLRC was invalid and not to be used; CLRC was also an invalid abbreviation.

Things have now changed.

Firstly, the only permitted abbreviation for the Council is now **CCLRC**. The abbreviation CCL must no longer be used to refer to the Council because it clashes with "Cambridge Consultants Ltd."

Secondly, the abbreviation **CLRC** may now be used to refer to the *Central Laboratory of the Research Councils.*

Fortunately, no change has been made to the Council's logotype (which appears in the top left corner of the front page of this Bulletin).

To sum up:

- The Starlink Project is funded by PPARC (Particle Physics and Astronomy Research Council).
- Its administrative centre is at RAL (Rutherford Appleton Laboratory).
- RAL is one of the constituent laboratories of CLRC (The Central Laboratory of the Research Councils). The other is Daresbury Lab.
- CLRC is run by CCLRC (Council for the Central Laboratory of the Research Councils).

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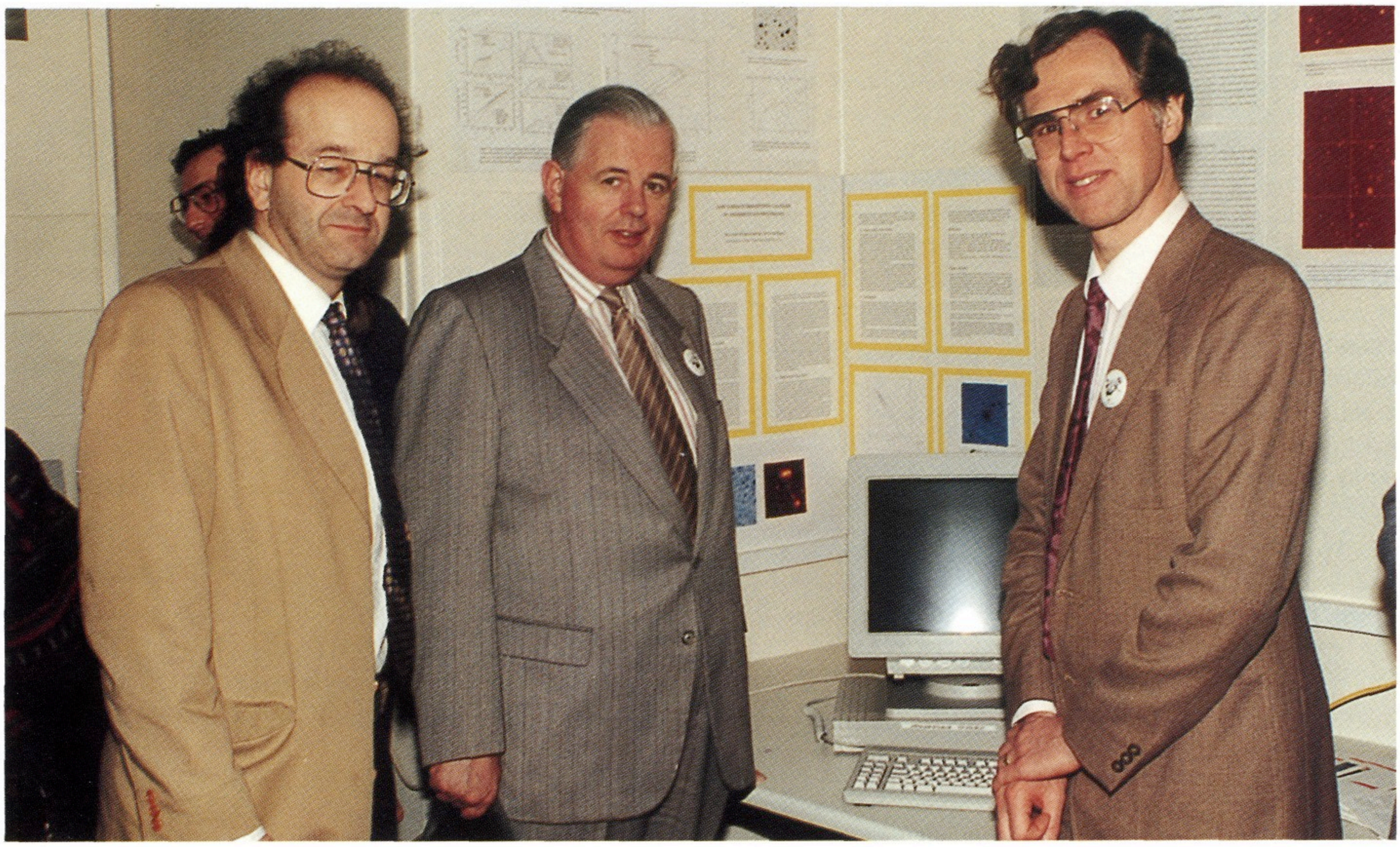
Opening of new Starlink node at Bristol



Starlink's latest node was opened at the Department of Physics, Bristol, on 20th November 1995 by Sir John Kingman FRS, Vice Chancellor of Bristol University. To open the node Sir John used a special WWW page. When he first clicked the mouse, nothing happened for what seemed to be a long time, sufficiently long that Murphy's Law came to mind. A firmer click prodded the Web into life, however, and Bristol changed from blue on the map of Starlink sites (RUG) to red (node), as intended. The universe started with a big bang and, after a pause, Bristol started with a big click.

Sir John had first come across Starlink when he was Chairman of SERC (from 1981 to 1985). He noted how important it was for investments in data gathering to be complemented by adequate data analysis, how impressed he had been by the efforts of astronomers to extract every drop of science from their observations, and how he was especially pleased, therefore, to be opening the Bristol node. He wished the Bristol users good luck in their use of the node to process and interpret astronomical data. Sir John was presented with a Captain Starlink mouse mat and a Captain Starlink badge.

The origins of the Bristol node go back to 1989 when Dr Mike Masheder founded a Remote User Group (RUG) there. A grant application to establish a Starlink node at Bristol was made to PPARC earlier this year and a successful outcome was announced in August. From then on the pace of events accelerated – two weeks before the opening, building work was still in progress; one week before, the Starlink room was full of boxes but very little worked; minutes before the opening ceremony, the new chairs were delivered!

The Bristol users in the Department of Physics are headed by Prof Mark Birkinshaw (ex MRAO and the CfA, a new member of the Starlink Panel), while Dr David Field heads the users in the Department of Chemistry. The astrophysicists will use the node to support their high-sensitivity CO and Hα surveys of the Galaxy, large-area deep surveys of distant galaxies, radio, optical, and X-ray studies of active galaxies, work on galaxy and cluster dynamics, and analysis of microwave background data on primordial anisotropies and the Sunyaev-Zel'dovich effect. The astrochemists will use the node to make high spectral and spatial resolution data-cubes that test their theoretical treatments of OH, H_2O, SiO, and other masers and their work on the formation of H_2 molecules. Collaborative work between the groups continues in a number of these areas. The recent growth in the number of Starlink users at Bristol is expected to continue for the next few years.

The photo shows Dr David Field (left), Sir John Kingman (centre, wearing his new Captain Starlink badge), and Prof Mark Birkinshaw (right) in front of the X-terminal used to open the node.

Mark Birkinshaw, Bristol — *mark.birkinshaw@bristol.ac.uk*
John Sherman, Starlink, RAL — *jcs@star.rl.ac.uk*

Opening of new Observatory at Preston

Starlink software was on show at the official opening of the University of Central Lancashire's Alston Observatory buildings, on 16th June 1995. The new Observatory is one of two outstations of the University's *Centre for Astrophysics* at Preston, and is situated on the slopes of Longridge Fell above the Ribble Valley. It provides ultra-modern teaching facilities for undergraduates, as well as research facilities for the Centre's astronomers (including an Alpha workstation funded by the Department and maintained by Starlink).

Professor Sir Arnold Wolfendale, President of the Institute of Physics and Hon Fellow of the University, unveiled the plaque, recalling Preston's long association with astronomy dating back to Jeremiah Horrocks in 1639, and the recent expansion and successes of the University.

David Terrett (Starlink, RAL) demonstrated some of the Project's image processing software capabilities to the distinguished guests and visitors, on one of the Node's Alphas located at Alston. Preston's Starlink Node was created in 1986. The research Centre was established in 1993 and now has over 20 staff astronomers and research students working in solar-stellar, galactic and extragalactic astrophysics groups, all of which make heavy demands on the Starlink Node's resources.

The montage above shows various events at the Observatory Opening Day.

Gordon Bromage, Preston *g.e.bromage@uclan.ac.uk*

Starlink documentation advances

In the last issue, Rodney Warren-Smith[1] described the new challenges faced by Starlink in trying to satisfy the needs and requests of its users. He also described our plans to respond to these needs.

Under the heading of *Documentation* he listed three projects which were due for attention in 1995:

- New version of LaTeX.
- Cookbooks.
- Hypertext documentation.

The new version of LaTeX (version 2e) has been released and was described in the last issue.

A new series of documents called "Starlink Cookbooks" (SC) has been created, and the first one (SC/1) has been released. Others are in the pipeline. SC/1 is a cookbook for the JCMTDR software. Also, a number of existing documents, for example the FIGARO User's Guide (SUN/86), have been revised and reissued in a more tutorial style.

However, the most revolutionary of these projects is the introduction of Starlink documents in hypertext form. This not only enables them to be read on-line using browsers for the World Wide Web (called the 'web' from now on), but also allows them to be cross-linked so that the individual documents become part of one large "hyper document." Once in hypertext form, documents may be used in a variety of new ways to make access to on-line information far easier.

The introduction of Starlink hypertext documentation is the main subject of this article.

Progress

Advances in Starlink's hypertext documentation which are of particular relevance to users of Starlink software are the following:

- Hypertext versions of some Starlink documents.
- Better ways to search for information.
- Software support index on the web.

Document writers and maintainers will also appreciate the following advances:

- Programs to convert LaTeX documents to hypertext (HTML) format.
- A hypertext linker to maintain links between the evolving set of Starlink hypertext documents.

These advances will now be described in greater detail.

[1] "The future of Starlink software"

Where to find Starlink documents on the web

There is a great deal of information about Starlink on the web. Every Starlink site has its own web pages and these contain many links to Starlink documents. There is also a central Starlink web home page which has the URL:

`http://star-www.rl.ac.uk/`

Starting here will give you access to the most up-to-date versions of Starlink documents.

When you are looking for a document, the two main entry points are the *Documentation* and *Software* links on this central home page. These are complementary, and are maintained by different people to serve different purposes.

If you follow the *Documentation* link, you will gain access to classified lists of all the Starlink documents that have been officially released. The document set you see will be complete, up to date, and will correspond with the currently released versions of software.

If you follow the *Software* link, the route to documentation is via the *Starlink Software Support Index* link. This is the path to follow if you want the latest in-depth information about a particular software item. The pages appearing in this index are more detailed than the *Documentation* pages (and contain other things besides released Starlink documents), but not every software item has an entry.

These support pages are maintained by software developers, who may install documents (or versions of documents) which have not yet gone through the release process, and these may refer to pre-release versions of software. Copies of the software may also be available through these pages.

Starlink hypertext documents

Many Starlink documents – currently over 40 – are now available in hypertext form and can therefore be read using web browsers such as Mosaic or Netscape. (Documents that are not yet in hypertext form can still be located using a web browser, but the browser will have to start up a separate viewer to display the document.)

As an example, try going to the central Starlink home page (`http://star-www.rl.ac.uk/`) and follow the links *Documentation, Published Series, Code, SUN,* to the list of Starlink User Notes. Then pick one of the hypertext documents, for example SUN/86 on FIGARO (other examples are SUN/188 on the new hypertext utilities, SUN/199 on **star2html**, and SGP/42 on the Starlink Software Strategy).

You can begin to get a feel for the capabilities of the new system by reading these documents on the web. Note how following a link that refers to somewhere in another Starlink document lets you jump to view that document immediately – no more walking to the filing cabinet to find a paper copy! As the system matures, individual documents will increasingly cross-reference each other and become part of one large whole. Note, also, how graphics and images such as screen dumps can easily be incorporated.

You can find out which documents are available in hypertext form using the command:

```
ls -dl *.htx
```

from the directory holding the documents (normally `/star/docs`). You will not normally need to do this, however, because if a document is available in hypertext form, it will be presented to you in that form. Otherwise you will see the unconverted form.

Viewing local documents

If you access documents through the Starlink web pages at RAL, you will probably be seeing text taken from the central Starlink document store. This source is complete and up-to-date, but there may be a short delay while the text is sent from RAL to your site. (Unfortunately, if you are outside the UK, the delay might not be all that short!)

If there is a local copy of the document at your site, it will normally be faster to access that instead. This is easily done with the new **showme** command which simply displays a named document. For example:

```
showme sc1
```

displays SC/1 (Starlink Cookbook 1) on your web browser, starting a new browser if necessary.

You will find that following links to other document pages (and to other documents) is much faster if you use your local copy in this way. If any of the documents you want to read happen not to be installed at your site, they will still be obtained automatically from the central Starlink document store at RAL. You might not even notice this happening.

The **showme** command has a number of options which allow you to view a particular document section and to specify where to search for documents. To find out more, you might try the command:

```
showme sun188 showme
```

which uses **showme** to show the section in SUN/188 where the **showme** command is described.

Searching for information

The **findme** command complements **showme** in cases where you don't know where to find the information you want. It also operates on *local* documents, but searches them for the keyword that you specify. For example, if you wanted to know about flat-fielding your data, you might try:

```
findme flat
```

which will search the document set for the string "flat" and use your web browser to display a list of the documents found. Each list entry will be a link to the corresponding document. The depth of search can be controlled, so you can have a fast shallow search or a slower deeper search. By default, progressively deeper searches are tried until a match is found.

There are many other options to **findme** to give you control over the search. To find out more, you could try the command:

```
findme findme
```

which uses **findme** to locate information on itself.

On-line help

Hypertext offers a great improvement over more traditional "help" systems. Not only is it easy to read on-line, but you are free to explore the links and discover the information you really need. By using links between documents, you can potentially access the entire documentation set from within the help system of any particular package.

If you are a FIGARO user, you may already have discovered the on-line hypertext documentation, which is available by typing:

```
figwww
```

This largely replaces the traditional help system, even though it simply displays the updated SUN/86. Similar facilities have also been added to other packages. Users of the latest graphical interface to CCDPACK (see page 6) also have access to context-sensitive hypertext help. This is available by pressing the **F1** key, and takes you straight to the hypertext page describing the task you are performing.

What about hard copy?

Does all this hypertext mean the end of paper documents? We think not, so most new Starlink documents will continue to be produced in LaTeX form and converted into hypertext for on-line use. This means that paper copies will still be available and, for those who need them, LaTeX source files will be stored on-line alongside the hypertext versions of documents.

This is fine, except that with the web you can access Starlink documents that may not be installed locally at your site, so how do you get a hard copy of these? There are two ways...

The simplest is to use your web browser to print a copy of the individual page you are reading. Most browsers allow you to do this, but the format will be dictated by the browser.

Alternatively, on the title page of each Starlink hypertext document you will find a "Retrieve Hardcopy" button. If you click on this, you will be given the option of choosing several possible file formats, and will then be sent a copy of the one you choose from the central document store at RAL. You can produce a paper copy of the document from this, which will retain all the original formatting information.

Converting documents into hypertext

Most existing Starlink documents are in LaTeX form, and (as mentioned above) this is also how most new documents will be produced. A new command called **star2html** has therefore been introduced to convert such documents into hypertext form (see SUN/199). **star2html** is based on **latex2html**, which was written by Nikos Drakos of the Computer Based Learning Unit at the University of Leeds.

There is also a new set of document templates which define standard formatting and layout, and enable you to use the same source file to produce both a hypertext version and a paper version of a document. These templates can be found in directory `/star/docs` with names such as `sun.tex`.

Maintaining hypertext document sets

star2html lets you define internal and external hyperlinks in your document, as well as labels that can be linked to from other documents. This ability to cross-link documents will enable Starlink gradually to transform its document set into a single interconnected hypertext system.

One problem, of course, is the need to maintain references between documents as new documents are added and old ones are revised. This is done by a hypertext linker, **hlink**, which is one of the HTX set of hypertext utilities described in SUN/188 along with the **showme** and **findme** commands. This document describes the Starlink hypertext document system in much more detail than is possible in this article.

The future

Now that the tools for supporting hypertext documents are available, Starlink's documentation effort will shift to completing the conversion of existing documents to hypertext form, and improving their structure. We will also generate new cookbook-type documents both in the new "Starlink Cookbook" (SC) document series, and by revising existing SUNs into a more tutorial style.

New documents should appear in both conventional and hypertext forms. You should find it increasingly easy to search for and read Starlink information using these new facilities.

Mike Lawden, Starlink, RAL *mdl@star.rl.ac.uk*
Rodney Warren-Smith, Starlink, RAL *rfws@star.rl.ac.uk*

Ten years ago

Ten years ago was a time of great significance in the history of Starlink. The Project was wrestling with two great problems – inadequate resources and software environments. (I believe the fashionable term for *problem* in today's world is *challenge and opportunity*; I'll allow *challenge*, but to pretend that inadequate resources means anything other than a *loss* of opportunity is pure mendacity.)

Software environments

In a nutshell, the original Starlink Environment (INTERIM) was perceived as inadequate, while the new one (SSE) was too slow and complicated and did not have enough development effort available for satisfactory progress to be made.

The Project had come to the conclusion that the most promising way forward was to adopt IRAF, which was then under development at NOAO (Tucson) and had been adopted by STScI, and published a recommendation to the community for IRAF to be adopted for future Starlink use. Astronomers were invited to a meeting at RAL in November 1985, which concluded that no decision could be made until the ADAM environment, being developed at ROE, had been studied as a possible line of development. A second meeting was held in January 1986 at which it was decided to adopt ADAM as the future Starlink environment and adapt it to our requirements. This decision determined the course of Starlink's software effort for many years.

Documents

Two new documents were released ten years ago which had big developments ahead of them.

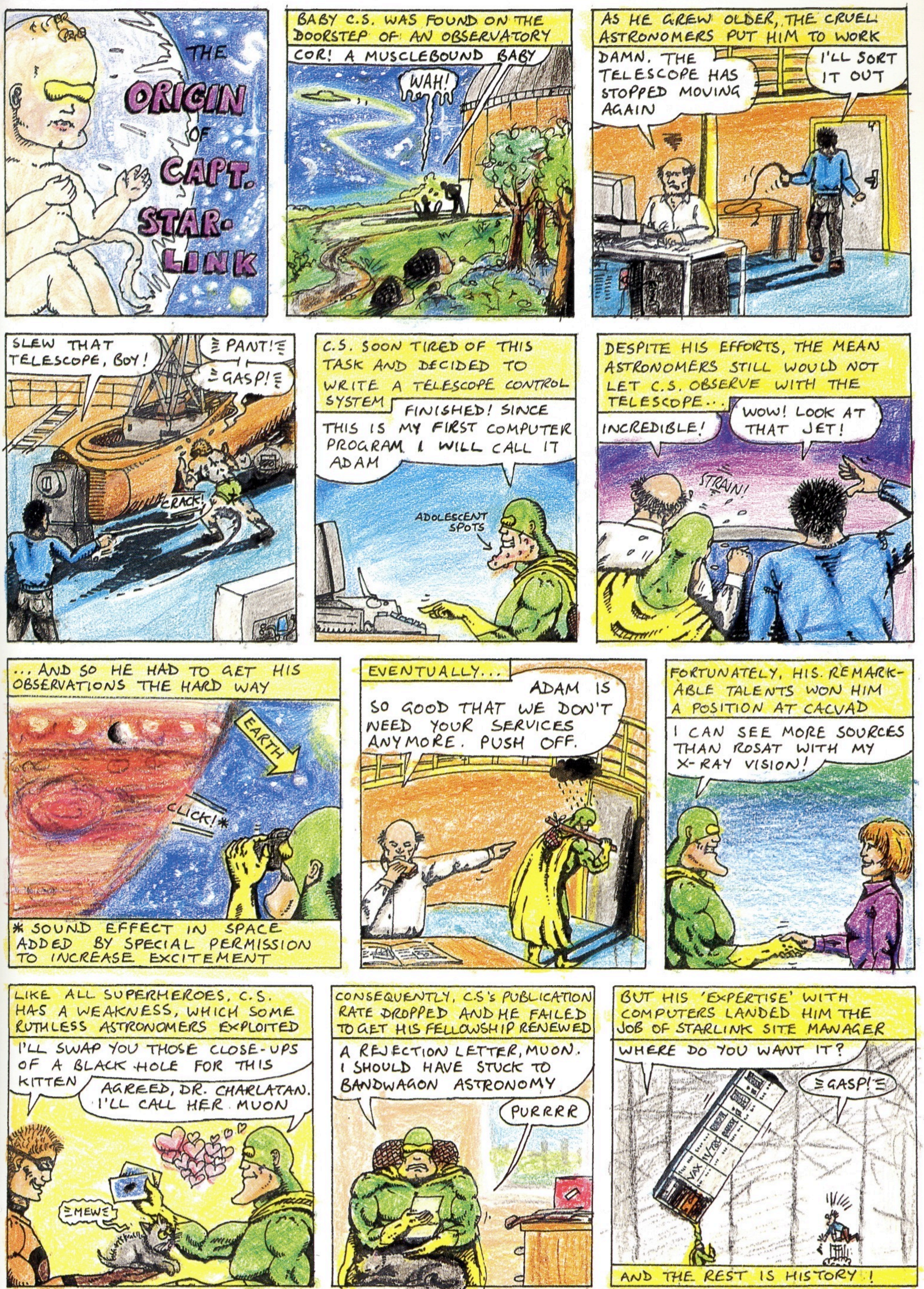
One was Jim Peden's SUN/84 on the ASTERIX X-ray data processing package. This started as a modest note of 10 pages but has since grown (and changed identity) into the massive SUN/98 of today which, at 342 pages, is Starlink's largest document.

The other was Mike Lawden's SGP/31 entitled "The Starlink Astronomical Network" which filled the need for a brief overview and introduction to the Starlink Project. Its latest incarnation (version 10) has Captain Starlink on the front cover, and its title has been efficiently downsized for the 90s to "Starlink" – no excess fat there. It also sits in hypertext form on the web with its own *Project Description* link on Starlink's home page.

Site Managers

Finally, two Site Managers joined us in October 1985 who have now celebrated their 10th anniversary with the Project: John Barrow at ROE and Stuart Keir at RGO. Stuart, of course, subsequently moved to our Sussex node, having stayed in the area when RGO moved to Cambridge.

Mike Lawden, Starlink, RAL *mdl@star.rl.ac.uk*


THE ORIGIN OF CAPT. STAR-LINK
BABY C.S. WAS FOUND ON THE DOORSTEP OF AN OBSERVATORY
COR! A MUSCLEBOUND BABY
WAH!
AS HE GREW OLDER, THE CRUEL ASTRONOMERS PUT HIM TO WORK
DAMN. THE TELESCOPE HAS STOPPED MOVING AGAIN
I'LL SORT IT OUT
SLEW THAT TELESCOPE, BOY!
PANT!
GASP!
CRACK!
C.S. SOON TIRED OF THIS TASK AND DECIDED TO WRITE A TELESCOPE CONTROL SYSTEM
FINISHED! SINCE THIS IS MY FIRST COMPUTER PROGRAM I WILL CALL IT ADAM
ADOLESCENT SPOTS
DESPITE HIS EFFORTS, THE MEAN ASTRONOMERS STILL WOULD NOT LET C.S. OBSERVE WITH THE TELESCOPE...
INCREDIBLE!
WOW! LOOK AT THAT JET!
STRAIN!
...AND SO HE HAD TO GET HIS OBSERVATIONS THE HARD WAY
EARTH
CLICK!*
* SOUND EFFECT IN SPACE ADDED BY SPECIAL PERMISSION TO INCREASE EXCITEMENT
EVENTUALLY...
ADAM IS SO GOOD THAT WE DON'T NEED YOUR SERVICES ANYMORE. PUSH OFF.
FORTUNATELY, HIS REMARKABLE TALENTS WON HIM A POSITION AT CACVAD
I CAN SEE MORE SOURCES THAN ROSAT WITH MY X-RAY VISION!
LIKE ALL SUPERHEROES, C.S. HAS A WEAKNESS, WHICH SOME RUTHLESS ASTRONOMERS EXPLOITED
I'LL SWAP YOU THOSE CLOSE-UPS OF A BLACK HOLE FOR THIS KITTEN
AGREED, DR. CHARLATAN. I'LL CALL HER MUON
MEW
CONSEQUENTLY, C.S's PUBLICATION RATE DROPPED AND HE FAILED TO GET HIS FELLOWSHIP RENEWED
A REJECTION LETTER, MUON. I SHOULD HAVE STUCK TO BANDWAGON ASTRONOMY
PURRRR
BUT HIS 'EXPERTISE' WITH COMPUTERS LANDED HIM THE JOB OF STARLINK SITE MANAGER
WHERE DO YOU WANT IT?
GASP!
VAX
AND THE REST IS HISTORY!

Echelle data reduction

One of the projects given a high priority by the Spectroscopy SSG and Starlink last year was an extensive review of échelle data reduction provisions. The fruits of this work are summarised below:

- Fixes for ECHOMOP problems.
- Two new échelle data reduction documents.
- A major upgrade of ECHOMOP documents.
- New WWW support pages for échelle reduction.
- A review of échelle data reduction software.

A new version of the échelle reduction package ECHOMOP contains some bug fixes. It also includes some important improvements for Digital Unix users who can expect the software to run at least *five* times faster than before. A couple of debilitating bugs have also been removed.

The three figures on this page show sample screen dumps taken while ECHOMOP was being used to analyse a spectrum.

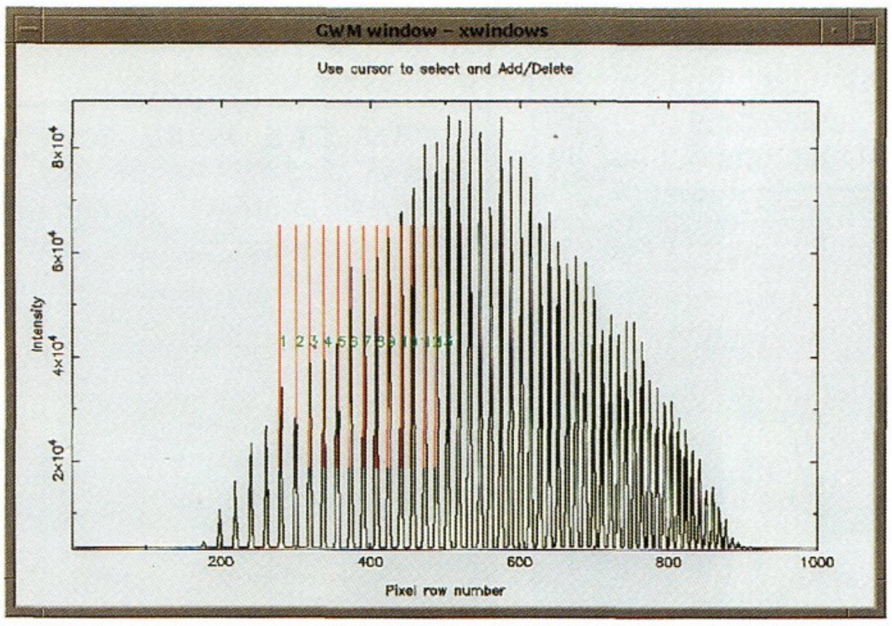


Figure 1. *Selecting Orders from an echellogramme to be extracted.*

The new documents are: *Introduction to Echelle Spectroscopy* (SG/9), an introduction in the most general sense, aimed at new échelle data users; and the *Echelle Data Reduction Cookbook* (SC/3) which contains a set of example scripts ranging from common reduction tasks to automated bulk data reductions.

The ECHOMOP document (SUN/152) has been restructured and made easier to access. All the detailed information previously available only via the online Help facility is now included in a reference section. The on-line Help text itself has been tidied up and is much simpler to navigate. All documentation is available in hypertext form.

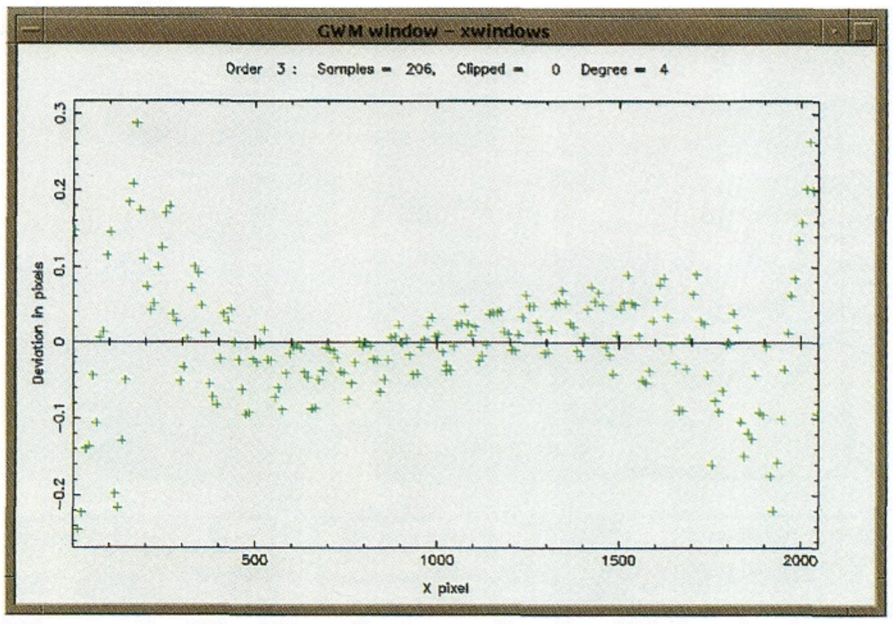


Figure 2. *Checking the trace for the third order in an echellogramme.*

As part of the introduction of on-line support using the WWW, all the new documents and the latest version of the hypertext ECHOMOP Help have been made available in my own web pages at:

`http://www.star.ucl.ac.uk/~mjc/echelle/`

You can also find links to other web resources related to échelle instruments, data and software in these pages.

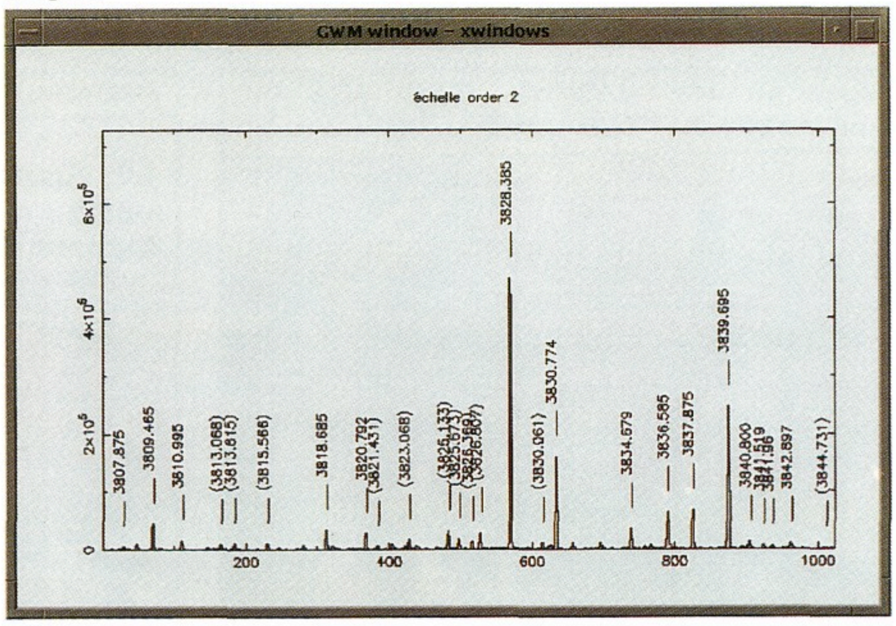


Figure 3. *Identifying lines in an (order of an echelle) arc spectrum.*

What next?

Although some ECHOMOP bugs have been fixed, there are still a few lurking in there. During 1996 you are invited to try the program and report back any problems you have or suggestions for improvements: a gripe 'blitz.' Feedback is important – the suggestions made and problems reported will be acted upon, so if you want something done let me know! You can e-mail me directly, or use the 'Comments and Suggestions' form which lives in the échelle reduction web pages.

Martin Clayton, Starlink, UCL *mjc@star.ucl.ac.uk*

Comings and goings

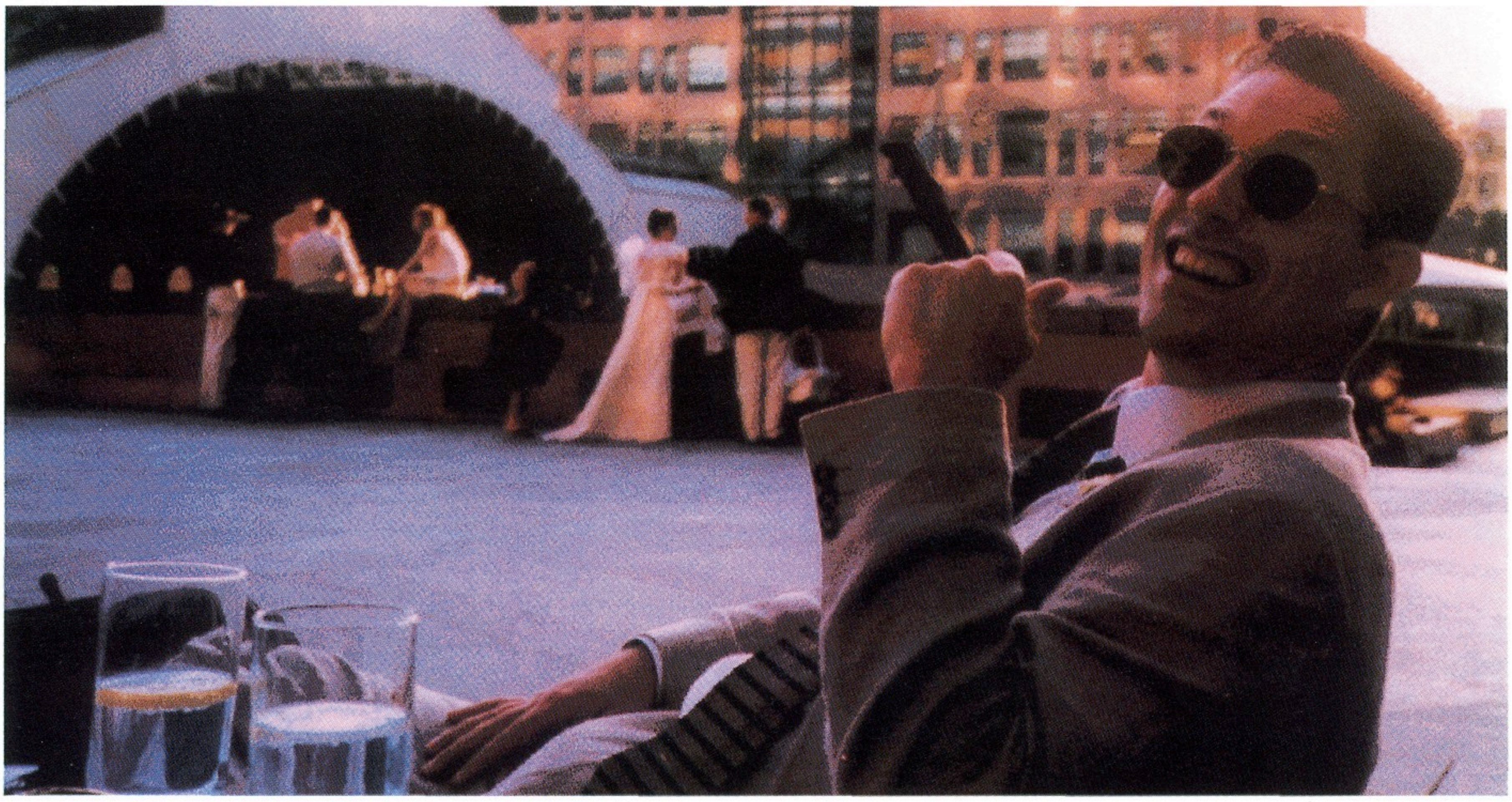


Figure 1. *Ex-UCL Starlink Site Manager, Adrian Fish, contemplates the loss of his academic remuneration-package and career prospects.*

During the period May to November 1995 there have been 7 comings and 3 goings.

Comings

John Palmer is the new part-time manager of the Manchester node, replacing Michael Bang.

Clive Davenhall has taken up his post as a contract programmer at ROE.

Simon Harris has become the first assistant site manager at Southampton.

Jackie Moon is the new administrative assistant within the Project staff at RAL, replacing Les Evans.

Hitendra Patel has joined the Project staff at RAL, working with Dave Rawlinson on operations.

Steff Watkins has become the first manager of the new Starlink node at the University of Bristol.

Andrew Batey has joined the Cambridge node as an additional Site Manager.

Goings

Geraint Lewis has finished his term as a user support assistant at our Cambridge site.

Les Evans completed a short period as a temporary administrative assistant with the Project staff at RAL.

Adrian Fish has left his post of Site Manager at the UCL node. Adrian was one of our most dynamic managers. Memorials to his enthusiasm and initiative are the **staradmin** utility and Starlink Forum (see page 22).

Mike Lawden, Starlink, RAL *mdl@star.rl.ac.uk*

US Internet connection

It is clear to everyone that JANET's link(s) to the USA are not performing satisfactorily. What may be less clear is that the situation isn't simple – there are a number of problems which are each making a contribution to the overall inadequate level of performance.

Firstly, and probably most significantly, there is clearly insufficient capacity in the actual transatlantic links to meet user requirements. The capacity currently available is 4 Mbit/s and we have been negotiating with our present supplier for some time now for a further 8.5 Mbit/s. Although I cannot give you a definite time for this at present, it should be delivered fairly shortly if agreement can be reached. We regard even this upgrade as a temporary holding arrangement, and we have set ourselves a target of raising our aggregate capacity to at least 34 Mbit/s as quickly as possible. There are, however, a number of obstacles to this course, not the least of which is the high cost of commercial offerings.

But this is not the only problem.

The transatlantic fibre, PTAT, has been broken on a number of occasions in the last 18 months. Although we get restoration by other routes, a certain amount of disruption occurs while this is being implemented. In addition, over the last few weeks the Sprint network in the USA, to which our transatlantic connections are made, has experienced a number of problems.

Processor capacity requirements

At the heart of these difficulties is the ever-growing processor load required to deal with the absolute number of IP networks on the Internet. Any outage of a component on the main part of the net is leading to serious overloading of CPUs on routers (as they attempt to restore connectivity by available alternative routes). The CPU overload can result in loss of peering with adjacent routers, further exacerbating the problems. A return to stability can take some time.

Rectification of this problem is completely outside our control and rests with the major networks in the USA and their router suppliers, who are working extremely hard to find a solution. It is difficult to foresee how long this situation may continue. In order to reduce the scale of the problem, aggregation of route announcements is being strongly encouraged. In the meantime, we are looking at other options.

The US Internet is no longer based on a single (NSFnet) backbone, but is, in fact, a number of parallel (interconnected) backbones. It seems sensible, therefore, to seek to diversify our connectivity, both to cut down our requirement for transitting one network to get to another and to provide additional resilience against failure.

As an aside, I should add that the number of cable failures worldwide is quite high, and the cable repair ships are being kept very busy.

In addition, there is a project in hand to develop a 'network' of WWW caches in the UK, to reduce the requirement for scarce and expensive external links.

Access to Australia

I should also say something about access to Australia. The Australian academic institutions now subscribe to a commercial backbone, which we reach through the USA. We no longer receive routing information for them over the NASA link which also terminates at ULCC, and so traffic to and from Australia shares the capacity on the 'open' links.

Part of a possible diversification might be to look for a direct route to the Western Pacific Rim, which of course covers countries like Japan, China, Hong Kong, Singapore and Korea, as well as Australia and New Zealand. This will only be worthwhile, however, if these nations are building their own interconnects and not simply relying on interconnection via the USA.

(This article was produced by UKERNA's Network Operations Manager in response to Starlink's queries about the speed of Internet links to the USA and Australia – Ed.)

Ian L Smith, UKERNA *I.Smith@ukerna.ac.uk*

FORUM – Starlink conferencing software

In ancient times, when Starlink ran VMS, we used DEC conferencing software called VAXnotes. (Conferencing software is like a Usenet newsgroup with restricted access. It enables discussions to take place remotely.)

The system was invaluable to Site Managers and Programmers. It was also used, to a lesser but nonetheless important degree, by astronomers for their own discussions and general gossip.

Requirement for a VAXnotes replacement

When Starlink moved from VMS to Unix it was recognized that the requirement for something like VAXnotes would remain, but there was no obvious replacement available. Some similar commercial systems were investigated, but they were found to be either too costly or did not do what we wanted.

Usenet newsgroups are well known and have been tried, but they fall short of our requirements in two important respects:

- The items posted are deleted after a few weeks, so the system cannot be used as an archive of information.
- Access cannot be restricted.

The latter point is important for some Site Manager conferences, for example conferences on Unix security or on maintenance (dull, but commercial-in-confidence).

Development of Forum

The requirement for a system similar to VAXnotes was also felt at Leicester for ROSAT archive work. To meet this requirement, Richard West used the World Wide Web and a Perl script to write the original version of Forum. Geoff Mellor, Site Manager at Leicester, brought it to the Project's attention and a copy was installed at RAL in May 1995.

Trials soon showed that Starlink's requirements were somewhat different from Leicester's so the system was re-implemented by Adrian Fish, at the time Starlink's Site Manager at UCL. It has been used by Site Managers and Programmers since June, resulting in many enhancements and revisions.

Access restrictions

As noted previously, our requirements include access restrictions and Forum provides this capability, conference by conference.

During the summer trials we disabled all access restrictions on a `Demo` conference but, unfortunately, this proved too much of a temptation to some people (outside the UK) who abused it. We have therefore reluctantly decided to retain a log of all accesses to the system, even when access is available to all users. We hope this log will deter abuse, but a penalty is that it causes a delay of a few seconds per page.

Available conferences

There are several conferences which are restricted to Site Managers *etc* and, so far, three which are available to all users. Please send any requests for further conferences, or help, to Dave Rawlinson, RAL (`djr@star.rl.ac.uk`).

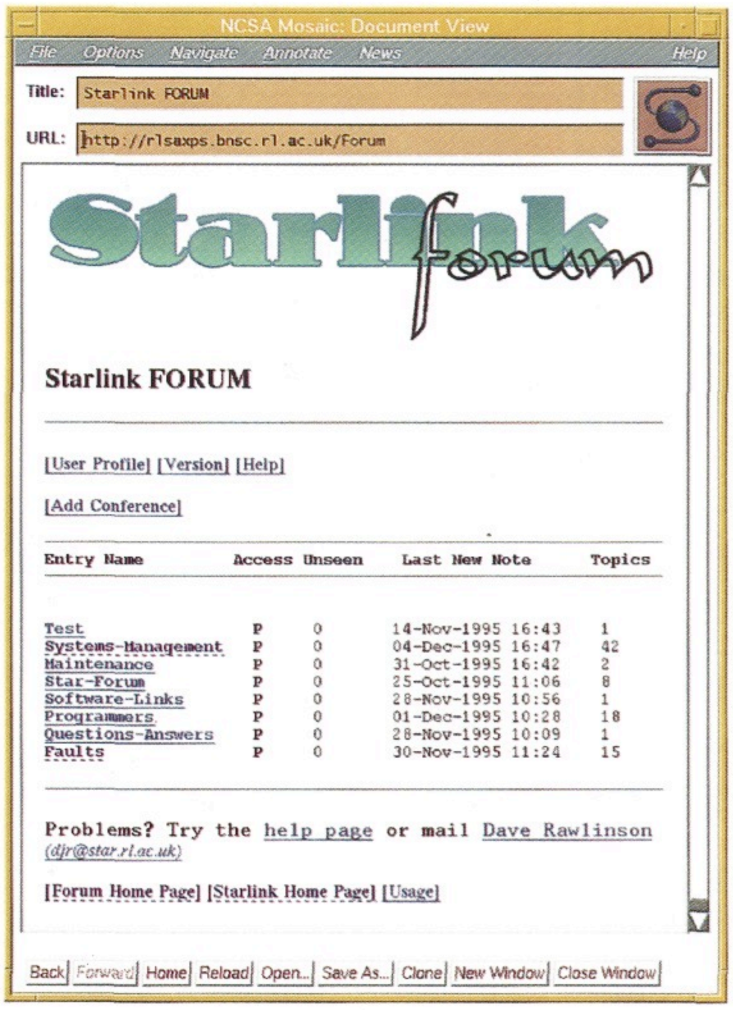


Figure 1. *This is the first screen that you see when you open Starlink Forum.*

The three generally available conferences are:

- `Test`
- `Software-Links`
- `Questions-Answers`

The `Test` conference is for new users to try out techniques, for example uploading GIF files or embedding HTML in notes.

The `Software-Links` conference is intended for users to announce any public domain software package they have in use at their site and believe would be generally useful to UK astronomers. Such software can be made available by placing a link to it in the note.

The `Questions-Answers` conference is a forum for all Starlink users to raise questions and discuss problems on software and other Starlink matters. It is hoped that, in time, it will become a repository of information that users can search if they come across a problem.

Figure 1 shows the screen that appears when you first start Forum. Figure 2 shows a typical screen displayed by Forum when it is used to read notes submitted to a conference.

Using Starlink Forum

If you would like to try Forum then start up your usual WWW browser, for example Netscape or Mosaic, and open the URL:

`http://rlsaxps.bnsc.rl.ac.uk/Forum`

or use the link *Forum* from the central Starlink home page. If you find that access is denied to *all* conferences, then it may be that your system is not running the correct identity checking software. Please contact your site manager, who will install the software or direct you to a machine that is already configured.

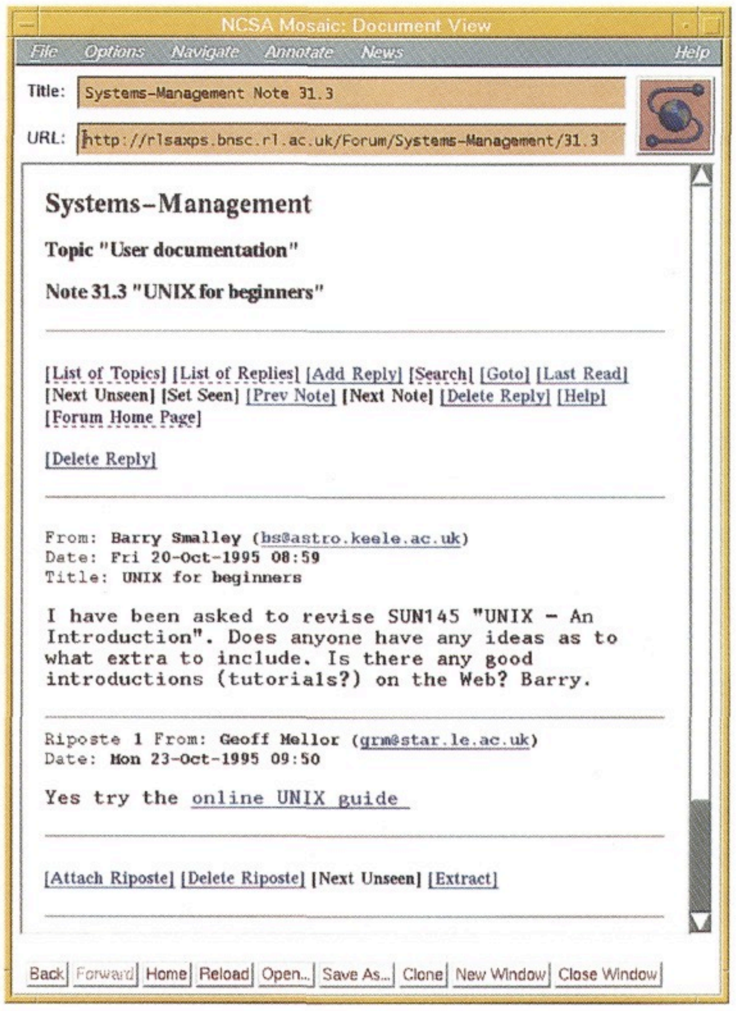


Figure 2. *This screen shows a typical use of Forum in which one of the replies to a topic within the Systems-Management conference is displayed.*

The system should be self-explanatory. There is a short [Help] page, and a brief *User Note* (SUN/205) is also available.

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John Sherman, Starlink, RAL *jcs@star.rl.ac.uk*

Instrument related software

Phase	Activity	Example Activity
Before observing (carried out at home institution)	Planning for observing	OBSERVE to check visibility
	Preparing detailed plans	Making tables of fibre positions
Whilst observing, or during scheduled observations (carried out at host institution or operations centre)	Changes to observing plans	Signal-to-noise simulations
	Recasting detailed plans	Making tables of fibre positions
	Instrument software	Inspection of an acquired spectrum
	Pipe-line calibration	Calibration of a night's CCD frames
	General data analysis	CGS4DR to reduce CGS4 data
After observing (carried out at home institution)	Pipe-line re-calibration	STSDAS tools for HST
	Access to calibration files	HST archive at ST-ECF
	General data analysis	SPECPLOT to plot multiple spectra

Table 1. *The chain of software which an astronomer deals with when obtaining and starting to analyse observations.*

Host institutions and instrument builders provide much software for the 'whilst observing' phase. Starlink, in its turn, tends to concentrate on the 'general data analysis after observing' activity, although to some extent it supports the 'before observing' phase and the 'general data analysis whilst observing' activity.

At its meeting on 19th July 1995, the Starlink Panel discussed the question of the chain of software which an astronomer deals with when obtaining and starting to analyse observations. This chain is illustrated schematically by the sample activities listed in Table 1.

The Starlink Panel suspects that there may be links in this chain which could be better served with software than they are at present. An example is further re-calibration pipelines for the 'after observing' phase. The Panel is in the process of building an up-to-date picture of the present state of the complete chain.

As part of building this picture, a list has been made of all the instruments that are, or will be, routinely available to UK astronomers, and thus whose output contribute to the routine part of the UK data reduction scene. Included in the list are instruments which are no longer operational, such as IRAS, but which nevertheless form a routine part of the UK scene through an active data archive.

These instruments are mainly those to which the UK has contributed financially. either directly or through its membership in such bodies as ESA.

The list in Table 2 shows that there are many such instruments, and also a wide range in type, requiring a correspondingly wide range of software. The information in this table has been compiled with help from many people, and this help is gratefully acknowledged. Corrections and information on further instruments with routine UK access would be welcomed.

The Panel will consider the final picture and what improvements Starlink might make. Any action would, of course, involve cooperation with others, such as host institutions and instrument builders, who also provide software for the chain.

Alan Penny, Starlink, RAL *alan.penny@rl.ac.uk*

SPACE INSTRUMENTS

ASCA	HST	IUE
GIS, SIS	FOC, FOS, HSP, WFPC, GHRS, WFPC-2, NICMOS, STIS, ACS	Spectrograph, FES
FIRST	**Integral**	**Jet-X**
FIR receiver, MFH receiver	IBIS, Optical monitor, SPI, JEM-X	Imaging spectrometer
Ginga	**IRAS**	**ROSAT**
LAC	Imager, LRS	WFC, HRI
Hipparcos	**ISO**	**XMM**
(Instrument integral with facility)	ISOCAM, ISOPHOT, LWS, SWS	EPIC, RGS, OM

GROUND-BASED INSTRUMENTS

AAO	INT	Ryle Telescope	SuperCOSMOS
Autofib, CCD imager, FORS, IRIS, LDSS, Photographic imager, RGO spectrograph, Taurus II, UCLES, UHRF, 2dF	CCD imager, FOS-1, IDS	(Instrument integral with facility)	(Instrument integral with facility)
APM	**JCMT**	**SAAO - 1.0m**	**UK Schmidt Telescope**
(Instrument integral with facility)	Spectroscopy receivers, JCMT-CSO interferometer, UKT14, SCUBA	CCD imager, St Andrews photometer	Flair, Photographic imager
Gemini-North	**JKT**	**SAAO - 0.75m**	**UKIRT**
1-5μm imager, 1-5μm spectrograph, Multi-object spectrograph, 8-30μm imager, CFHT fiber feed	CCD imager, P-PHOT, RBS	IR photometer, UCT photometer/polarimeter	Fabry-Perot, CGS3, CGS4, IRCAM3, IRPOL2, MIRAC2, Michelle, 10μm camera
Gemini-South	**Merlin**	**SAAO - 0.5m**	**WHT**
Multi-object spectrograph, Hi-res optical spectrograph, Phoenix, Shared CTIO instruments	(Instrument integral with facility)	Modular photometer	CCD imager, FOS2, ISIS, LDSS-2, Martini + WIRCAM, Taurus F-P, Taurus imager, UES, WIRCAM, WYFFOS

Table 2. *Instruments routinely available to UK astronomers. The instrument names are listed underneath the name of the facility with which they are associated.*

Captain Starlink escapes the heat

You may have experienced (or read about) the appallingly hot British summer this year. Unable to endure it any longer, Captain Starlink fled to the cool airs and cloudy skies of Tropical Queensland (The Sunshine State). Arriving in Cairns, he was delighted to find it enjoying its wettest August on record with the merciless sun hidden behind protective layers of condensation.

Wandering north, he eventually reached Cape York, the northern-most point of mainland Australia. Fortunately, our hero's luck was in again, for cloud, wind and rain moderated the normally unpleasant warmth and sunshine to which this isolated abode of the Pajinka is subjected.

The actual top of Cape York is marked by a modest sign and edifice at which it is customary to have ones photograph taken. To this ritual, Captain Starlink subjected himself, and the result is shown above.

All good things come to an end, however, and soon our hero was suffering once more the fearful heat and sunshine of Oxfordshire, dreaming of the cool breezes and gentle mists of Cape York.

Captain Starlink *Captain.Starlink@rl.ac.uk*

Statistician's corner

One of the by-products of Starlink Reviews is the production of new statistics and graphs about various aspects of the Project. Somehow the existing statistics never quite answer the latest questions, so new analyses are called for and spreadsheet-fever breaks out afresh.

This phenomenon helps your author put together this regular feature as he can recycle the new graphs for a wider audience. A selection of graphs prepared for the latest review is shown in Figure 1 on page 27. These show various historical time-series which illustrate how the Project has developed over the years.

Site and user numbers

Top left: shows the changes in the number of users and sites since Starlink began in 1980.

Like everyone else in Starlink, when I use the word "site" it means what I want it to mean – in this case, a place which produces its own usernames file which I can use to count users. There are now 28 of these.

Since mid 1991 we have grouped users into various classes. Two of the most important are:

r – (UK-resident research astronomer)

t – (UK-resident technical support)

The sum of **r** and **t** users is plotted below the line showing the total of all users.

Central staff

Top right: shows the staff resources allocated to Starlink's administrative centre at RAL (measured in staff-years per year), divided by the total number of users supported by the Project. In general, this has decreased over the years and is now at an all-time low (less than 1 staff-year per year per 100 users). The cost-per-user of Starlink's central administration has halved in the last 10 years.

Software releases

Bottom left: shows the number of software releases issued in each year. You can see that the number has been reduced from an average of about one per week in the old VMS era to about one every 10 days in the new Unix era. This is in line with a recommendation of the Willmore Review which sought to decrease the load of software releases on Site Managers.

Item releases

Bottom right: shows the level of software activity over the years, measured in terms of "item releases." Here, an item release is defined as a part of a software release which affects one Starlink software item; maintenance and re-build activities are not included, only new releases, upgrades and bug-fixes.

You can see that software activity has remained high in the Unix era, in spite of the reduction in the rate of software releases. This is because, on average, more software items are included in each Unix release than was the case for VMS.

(The values for 1995 in the bottom two graphs have been extrapolated to cover a full year to make them comparable with the values for other years.)

Mike Lawden, Starlink, RAL *mdl@star.rl.ac.uk*

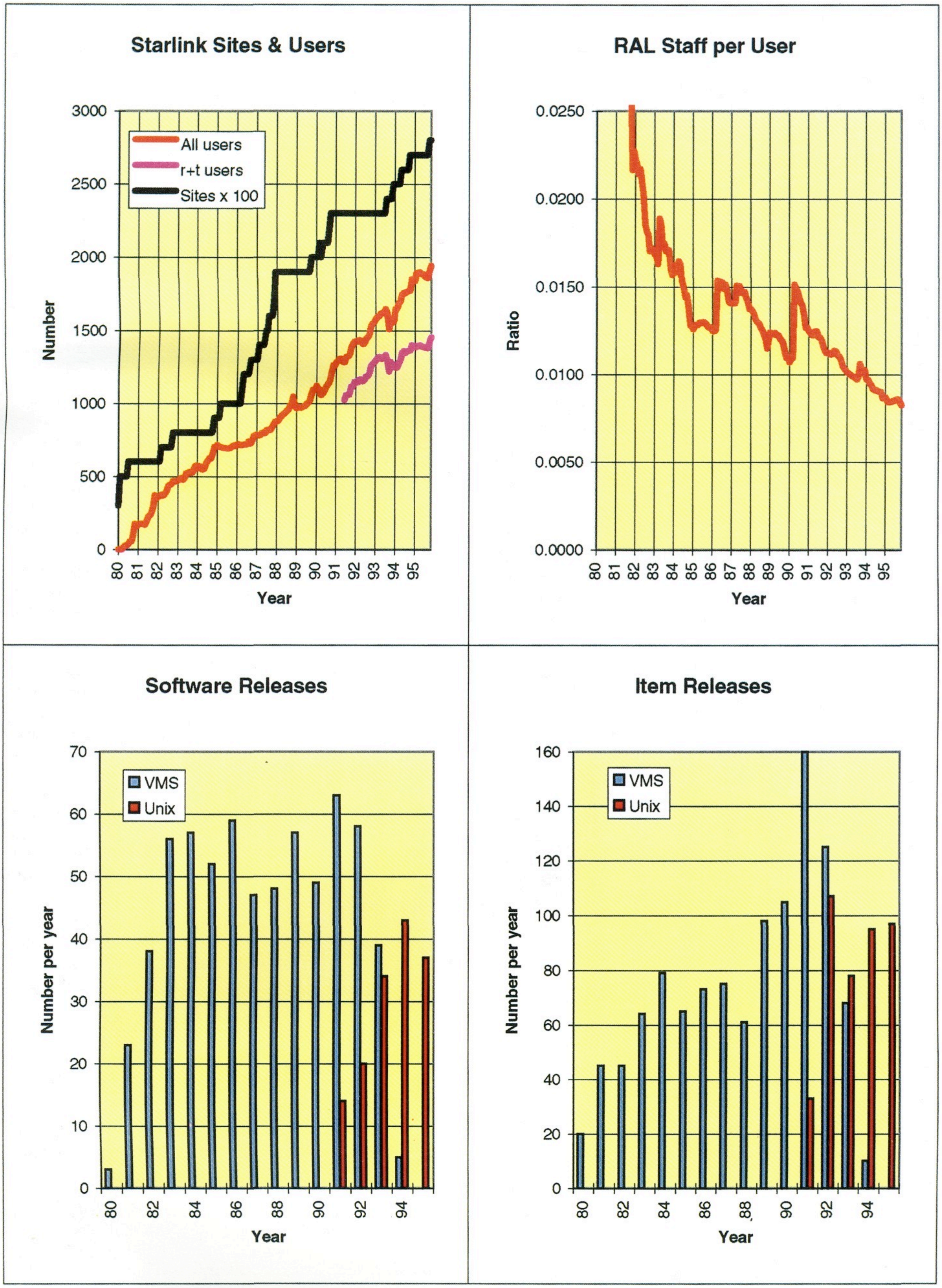

Figure 1. *Examples of various time-series prepared for the Review of RAL's role in Starlink which took place in the summer of 1995.*

STARLINK INFORMATION

Starlink sites & site managers:

BIRMINGHAM: School of Physics and Space Research, University of Birmingham, Edgbaston Park Road, BIRMINGHAM, B15 2TT. Tel: 0121-414-6447. *Bill Wilson.* star@star.sr.bham.ac.uk

BRISTOL: Dept of Physics, University of Bristol, Tyndall Avenue, BRISTOL, BS8 1TL. Tel: 0117-928-7869. *Steff Watkins.* Steff.Watkins@bristol.ac.uk

CAMBRIDGE: This is a single Starlink node serving three organisations:
(1) Royal Greenwich Observatory, Madingley Road, CAMBRIDGE, CB3 0EZ. Tel: 01223-374000.
(2) Institute of Astronomy, University of Cambridge, Madingley Road, CAMBRIDGE, CB3 0HA. Tel: 01223-337548.
(3) Mullard Radio Astronomy Observatory, Cavendish Laboratory, Madingley Road, CAMBRIDGE, CB3 0HE. Tel: 01223-337200.
Peter Bunclark, Phil Herridge, Steve Percival, Andrew Batey. star@ast.cam.ac.uk (1 & 2);
David Titterington. djt@mrao.cam.ac.uk (3).

CARDIFF: Dept of Physics & Astronomy, University of Wales College of Cardiff, PO Box 913, CARDIFF, CF2 3YB. Tel: 01222-874000 X5282. *Rodney Smith.* star@astro.cf.ac.uk

DURHAM: Dept of Physics, University of Durham, South Road, DURHAM, DH1 3LE. Tel: 0191-374-2131. *Alan Lotts, Pam Murray.* Oper.Starlink@durham.ac.uk

EDINBURGH: This is a single Starlink node serving two organisations:
(1) Royal Observatory Edinburgh.
(2) Institute for Astronomy, Dept of Physics and Astronomy, University of Edinburgh.
These share the same address: Blackford Hill, EDINBURGH, EH9 3HJ. Tel: 0131-668-8377. *John Barrow, Ewan Brown.* star@roe.ac.uk

GLASGOW: Dept of Physics & Astronomy, University of Glasgow, GLASGOW, G12 8QQ. Tel: 0141-339-8855 X4268.
Shashi Kanbur. star@astro.gla.ac.uk

HERTS: Dept of Physical Sciences, University of Hertfordshire, College Lane, HATFIELD, Herts, AL10 9AB.
Tel: 01707-284601. *Tim Gledhill.* star@star.herts.ac.uk

ICSTM: Astrophysics Group, Dept of Physics, Blackett Laboratory, ICSTM, Prince Consort Rd, LONDON, SW7 2BZ.
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