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ST–ECF Newsletter

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CONTENTS

Software news

IRAF and AIPS at the ST–ECF

One of the purposes of the ST–ECF is to play a significant rôle in the development of software applicable to HST data. Some of this development will concentrate on new software running under the local system MIDAS. It is realized, of course, that there is also a considerable amount of useful software which runs under other systems. To be able to make a proper evaluation of application programs in such systems, two of them, IRAF and AIPS, have been fully installed on a VAX 8600 computer at ESO.

IRAF stands for the *Image Reduction and Analysis Facility* and was developed at the National Optical Astronomy Observatories (NOAO) in the USA. Obviously, the available application software in IRAF is meant for use with data obtained primarily in the optical domain. IRAF is a rather new system; the first limited public release took place in 1986. Nonetheless, the available application software already covers a fairly wide field and some of it would complement well the available MIDAS software, e.g., the APEXTRACT package which uses an optimum extraction method for use on two-dimensional spectra. Until recently, SDAS — the *Science Data and Analysis Software*, developed at the Space Telescope Science Institute, was expected to run as a rather independent IRAF sub-system using the so-called *standard interfaces*. It is certain now however that SDAS will move much closer to IRAF in the near future (*see the Meeting Report later in this issue*). This not only means relinquishing the concept of standard interfaces but also that SDAS software will be written in the IRAF SPP language. The major consequence of this is that ready exchange between IRAF and MIDAS software, such as foreseen between SDAS and MIDAS, will not be possible.

AIPS was developed by the National Radio Astronomy Observatory (NRAO), and stands for *Astronomical Image Processing System*. It has been in full operation for already more than half a decade and at the moment is exported to well over 100 institutions around the globe. As its origin indicates, AIPS is meant for use on data obtained in the radio domain with synthesis telescopes, in particular using the Very Large Array (VLA) and, more recently, Very Long Baseline Interferometry (VLBI). Nonetheless, it is to be expected that also for optical purposes some AIPS software may be useful. On one hand there are some of the more general utilities and concepts which are well developed in AIPS, such as the general question of coordinate systems. On the other hand there are the "typical" radioastronomical utilities like Fourier transformations and deconvolution techniques such as CLEAN and Maximum Entropy. Especially the latter group of software is very likely to be useful for data obtained with diffraction limited optical instruments like HST.

The availability of AIPS does not mean that here at the ST–ECF we have created a general purpose reduction facility for scientists who want to use it to reduce their data. It must be understood that the structure and organization of the image processing systems at ESO is wholly directed towards MIDAS. Use of other systems will have to take place during periods of low computer loading. Secondly, to use fully these other systems, not all facilities and hardware are present at ESO. When using CPU intensive software, one is severely hampered by the lack of an array processor. Furthermore, using the local joysticks instead of the trackballs supported by AIPS is cumbersome. Third, when using one of such a system, one cannot expect local support of an intensity and quality anywhere near those provided in the case of MIDAS.

Although the current IRAF installation still suffers from similar problems (e.g., one cannot yet use the local DeAnza image display devices nor

is it possible to make hard-copies of plots), the situation will change in the near future because the ST–ECF will support IRAF primarily for the analysis of HST calibration data.

Already, some software from IRAF and AIPS has been tested to see whether MIDAS could benefit from it. At the moment and in particular, the APEXTRACT package from IRAF is under study but it is realized that too much work might have to be invested to port it to MIDAS in view of the lack of standardisation of MIDAS and IRAF interface routines. Some tests to use the CLEAN method and the Maximum Entropy Method software in AIPS have been under way for almost half a year, but progress here has been slow because of the low local priority of AIPS combined with the long CPU times and enormous size of the data sets.

It is clear that porting external software into MIDAS can mean a considerable effort. The lack of standardisation of the interfaces means that only the algorithms can be ported and that the MIDAS application has to be written around it. In spite of these disadvantages, we still believe that it is essential to have other systems available and thus at least have an insider's view of the developments in other major image processing systems.

Gustaaf van Moorsel

Image Sharpening Package

The ST–ECF, in collaboration with the Laboratoire d'Astronomie Spatiale (Marseille), the Observatoire de Toulouse, the Royal Greenwich Observatory (Herstmonceux and La Palma) and the Instituto de Astrofisica de Canarias (Tenerife), has been carrying out experiments in *post-detection* image sharpening techniques with several groundbased telescopes using photon counting detectors in a *photon tagging* mode. Special purpose software for re-centring and selecting the resulting time-resolved frames is being assembled to run in the MIDAS system. A preliminary User's Guide for the RGO software (for specialists only!) already exists and there are plans to integrate the Marseille software in June/July. We welcome contact from people interested in and willing to contribute to the subject.

Bob Fosbury

Photometric Packages: some current developments

Fionn Murtagh and Rein H. Warmels (ESO)

Photometric packages

Much development work is currently under way in relation to widely used photometry reduction systems. Additionally, a number of these systems are being (or will be) incorporated into MIDAS. Comparisons will therefore be necessary in order to provide advice to the user and to ensure best possible complementarity.

The following is not an exhaustive list of packages in this area; much work currently in progress would soon render such a list out of date. The objective, instead, is to cover briefly some of the more widely used systems. The cat-

egorization used — stellar and galaxy photometry — is necessarily approximate. In most cases, the packages described can be used for all types of objects. However, different strategies and different uses associated with the packages lead to this first order separation.

1. Galaxy photometry packages.

1.1. INVENTORY (MIDAS, 1987) has been available for some years in the MIDAS system. Developed by A. Kruszewski, it was designed for the fast detection of objects on large plates. It has been used for Schmidt plates, CCD and electronographic data. For blended objects, it produces a fast but not necessarily an optimal solution.

INVENTORY does not provide the extraction precision of other packages but is very suitable for the quick scanning of large images. It was originally designed for detecting faint, distant clusters of galaxies and it may be noted that many hundreds of complementary routines are in use (in the MIDAS environment) for the Southern Sky survey being carried out by A. Lauberts of ESO. The package is to be upgraded by the author over the coming months.

1.2. COSMOS (which stands for *Coordinates, Size, Magnitude, Orientation and Shape*, Stobie 1986, MacGillivray *et al.* 1976) is an integrated system for the scanning and analysis of photographic plates, incorporating a high speed scanning microdensitometer. It was developed and is maintained at the Royal Observatory Edinburgh (ROE). It has been used for large photographic plates, including non–astronomical applications such as aerial photographs and radar pictures.

COSMOS is particularly useful for quick-scan processing of large plates. It is however currently integrated in a non-portable hardware – software system. It has been described extensively in the literature, and much experience has been built up over more than a decade of use. The system is soon to be made available at ESO in the context of the HST Survey Project.

1.3. IRAF (see Tody, 1986) will have a number of packages in the area of digital image photometry: DIGIPHOT is under development and the implementation of FOCAS (*Faint Object Classification and Analysis System*, Tyson, 1984) is planned. DIGIPHOT will automatically generate lists of objects, perform synthetic aperture photometry, and allow PSF fitting. FOCAS is designed to provide a faint object handling capability for photographic and CCD images.

1.4. Other discrete object systems include:

(a) Many algorithms which are available in the highly modular system produced and maintained by A. Bijaoui, Centre de Dépouillement des Clichés Astronomiques (CDCA), Nice.

(b) A system for faint object detection produced in Rome by G. Pittella and D. Trevese has the name ROMA (but is distinct from the ROMAFOT package described below).

(c) Herzog and Illingworth (1977) describe a COSMOS–like system for photographic plates, where blended objects are sought for as *bumps* in smooth intensity gradients defining objects.

(d) Kron (1980) uses a similar approach to the foregoing, stating however that blended objects are not of great importance in his study.

(e) Malagnini *et al.* (1985) describe FODS (*Faint Object Detection and Classification System*) which contains a range of options for object detection as well as a star/galaxy classifier.

2. Stellar photometry packages.

2.1. DAOPHOT (Stetson, 1986) was developed and is maintained by P. Stetson (Dominion Astrophysical Observatory, B.C.), and can handle all types of frames (including crowded fields).

ALLSTAR is a new system, independent of DAOPHOT. It allows multiple and simultaneous PSF fitting for any number of objects. For crowded fields, it requires the degree of object overlap that is acceptable by the user. Additional software is in use at the DAO which takes

into account systematic (linear) variations in the PSF across the field.

2.2. ROMAFOT (Buonanno *et al.*, 1983) is currently being upgraded by R. Buonanno and his colleagues. It was developed at Rome Observatory, and it is currently being implemented in ESO's MIDAS system. In the past, it relied heavily on interactive use for the analysis of crowded fields, but non-interactive options will be available in the MIDAS implementation.

2.3. Other crowded field systems include:

(a) Penny and Dickens (1986) briefly describe a system similar to ROMAFOT. A PSF is used which is a mixture of a Lorentzian and a Gaussian. The system is interactive, with user specification of a subimage to be analysed, and with visual assessment.

(b) Lupton and Gunn (1986) describe another iterative star-subtraction procedure, using an empirically defined PSF derived from stars specified by the user.

(c) Irwin (1985) describes a package for the analysis of crowded fields in CCD data. A maximum likelihood approach is used for PSF fitting. The approach aims at being entirely automated.

(d) The CAPELLA package, developed at Laboratoire d'Astronomie Spatiale in Marseille, focusses also on PSF handling for stellar images.

Comparative Studies

Areas of difficulty, which have been studied or are currently under investigation, include the following:

1. Problems relating to the form of the PSF expected from Hubble Space Telescope data are described in Bendinelli *et al.* (1985), Rosa and Baade (1986), STECF (1987) and Bragaglia *et al.* (1987). In this case it might be simpler to work with a well-defined empirical PSF rather than an analytical one.

2. Crowded fields with blended and perhaps saturated objects are often inherently intractable. Other related problems concern stars superimposed on galaxies (the latter cannot be subtracted using a PSF), and very non-uniform backgrounds.

Few comparative studies have been carried out to date (mention may be made, however, of Ortolani, 1986 and 1987). Packages for object detection and analysis are currently lacking in interoperability standards, and comprehensive documentation. Most often the package is a one-person creation, arising out of specific objectives. With the burgeoning interest in software in this area, it is hoped that current difficulties faced by a user will be resolved within the coming period.

Acknowledgements

Apart from package creators, discussions with S. Ortolani contributed to the material presented here.

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Experience with Optical Disks

Guido Russo

The ST–ECF has started during 1986 to gain experience with digital Optical Disks. The interest is directed towards the so-called *WORM* devices (Write-Once, Read Many times) which will be used to archive HST data, as opposed to the well-known *CD–ROM* devices. The main difference between the two is that *CD–ROM* need to be written in a factory, while *WORM* devices can be written with your computer. After they have been written, both are read-only. There are two separate aspects to address when talking of Optical Disks and these are of course the hardware and software.

Most of these devices have an *SCSI* interface and therefore hardware connection to the computer may be accomplished either directly, if *SCSI* is the protocol used on your machine (e.g. SUN and Apollo workstations) or via an adapter if your computer adheres to a different standard. For VAX and micro–VAX, which use the *MSCP* protocol, adapters are available from EMULEX Corp. (models UC14 and UC04, respectively) and from U. S. Design Corp. (models 1158 and 1108).

The units evaluated, together with ESO and STScI, are three: the *GIGADISC* (manufactured by Alcatel-Thomson in France), the *OPTIMEM 1000* (by Optimem, in the USA) and the *LaserDrive 1200* (by OSI, a joint Philips–Control Data venture). All these drives use removable 12–inch disks, with a capacity of 1 Gbyte per side (but with only one reading head in the drive). The *GIGADISC* and the *OPTIMEM* are media compatible.

Concerning the software aspects, the three parties involved (ST–ECF, ESO and STScI) are adhering to a common structure with *header*, *directory* and *data files*; this structure is operating system independent to allow portability to other sites and to be able to read disks several years from now. Details on the proposed standard can be obtained by writing to G. Russo at ST–ECF.

The implementation we have now is on a VAX VMS system and has two different approaches: an easy-to-use command interface which allows commands like `INIT`, `MOUNT`, `DIR` and `COPY` at the DCL level and a more sophisticated message driven file handler (developed mostly at STScI by T. McGlynn and F. Romelfanger) which handles queues of requests and several optical disk drives. The first kind of software, written in FORTRAN, is available for free distribution to qualified institutions.

An advanced prototype of the software is now operational, and the basic tests on the hardware reliability have been performed.

New Documentation Available

Fionn Murtagh

The ST–ECF Software Library is available for consultation through the STARCAT system. A hard-copy version of information available, together with all relevant ancillary details (how to access it outside of ESO, how to contribute material to it, and so on) is described in the document *ST–ECF O–04: Software Library Definition.*

For the visitor to the ST–ECF or to ESO, some prior familiarization with ESO's computer system cannot be wasted effort. An introduction to the main ESO system (which runs MIDAS) and an overview of the VMS operating system is to be found in: *ST–ECF O–05: Computer System Operations Manual. Volume 1. Computer System Users Guide.*

Over the last few months, the ST Model software has been more fully integrated into the MIDAS system and is availble on the ESO/ST–ECF computers as a "MIDAS Context". A new User's Guide is now available.

Copies of all of these documents are available on request (contact F. Murtagh, ST–ECF).

Second Announcement "Astronomy from Large Databases: Scientific Objectives and Methodological Approaches"

Fionn Murtagh

The aim of this conference, organized by the ST–ECF on 12–14 October 1987, is to review and analyse new possibilities offered to astronomers by the current and future availability of (and easy access to) large astronomical databases. The conference is focussed especially on methods applicable to such data collections and on the astronomical problems which are most intimately related to large amounts of data.

Topics will include:

Astronomical Databases – Current Trends; Statistical Analysis of Complex Databases; Expert Systems around Astronomical Databases; Object Classification Problems; and Astrophysics from Large Databases.

Invited speakers will present topical talks on these areas. The deadline for registration is 15th September 1987.

For further details, contact: F. Murtagh, ST–ECF (Computer addresses — EARN/Bitnet: `FIONN` at `DGAESO51`. `SPAN`: `ESOMC1::FIONN`.)

The fifth ST–ECF data analysis workshop

Rudolf Albrecht

The fifth ST–ECF Data Analysis Workshop was held at ESO in Garching on the 5th and 6th of May 1987. More than 40 scientists participated.

As was to be expected, the major issue discussed at the workshop was the recent divergence between SDAS and MIDAS caused by the decision on the part of the STScI to migrate SDAS much closer to IRAF. In his introduction, Piero Benvenuti summarized the reasons for the STScI decision which, while being technically justifiable, does lead to the undesirable result that what little compatibility had been achieved between SDAS and MIDAS is lost in the process: the ST interfaces will disappear and even compatibility on the FORTRAN level will be questionable, since IRAF is using its own high level language (SPP, subset pre-processor). Of course, the ST–ECF will continue to explore possibilities of continued software sharing, but there are presently grave concerns about being able to use IRAF–based HST calibration software in another environment.

In his presentation, Bob Hanisch of the STScI reiterated the reasons for the decision to 'IRAF-ize' SDAS: operational tests, especially on heavily loaded computer systems, have shown that IRAF based application software performs consistently better than the SDAS version by significant factors. Also, it was found that although people take easily to the SPP language, the STScI, realizing that scientists would still prefer FORTRAN, will now provide a FORTRAN interface to the IRAF virtual operating system (VOS). Within this interface it would be possible to accommodate the standard interfaces, which would make software portability from MIDAS to IRAF (*one-way only*) possible.

Doug Tody, head of the IRAF group at the National Optical Astronomy Observatories in the USA, gave a presentation on the IRAF system. IRAF has still only been released on an experimental basis since some important elements are still missing or have not been implemented in an optimum manner. The global design of IRAF, consisting of a kernel which does the communication with the local system together with a portable VOS, which provides a wide range of services to the application programs, was presented. IRAF, like MIDAS, is supported by a sizable group (systems and applications programmers), a distribution and update procedure exists, including a *hot-line* service.

Intensive discussions ensued and continued for both days. Since this was the first exposure to IRAF for most people present and also the first time an IRAF expert was available for consultations, a lot of technical questions concerning the design and the implementation were asked.

Portability was one of the major items of discussion. Opinions varied between IRAF having solved the portability problem through the use of the VOS and a portable, albeit non-standard, programming language and the observation that SPP written software will only port to systems running IRAF, thus their portability is, in actual fact, of a limited variety.

Dave Terrett answered the question why STARLINK decided to use ADAM after looking at IRAF. Apparently, STARLINK users felt that the availability of the Hierarchical Data Storage (HDS) used in ADAM was an overriding advantage. However, he pointed out that any comparison between systems is very difficult since all systems develop dynamically and comparisons done on the basis of past snapshots quickly become obsolete.

The question of replacing MIDAS by IRAF was discussed briefly. In addition to the heavy

investment into MIDAS on the part of ESO and the fact that system support is best provided by the original authors, it was recognized that for continental European astronomers the most important source of astronomical data, even after the launch of HST, will be the observatory in Chile, which implies that MIDAS is required for the analysis of the data.

Concern was expressed about the availability of HST calibration software to European users who, by virtue of the limited resources of their institutions, are generally not in a position to run MIDAS and IRAF side-by-side. Experience with other space missions shows that significant changes of the calibration procedure will have to be expected during at least the first year after launch. Such updates of the calibration procedures will first be implemented in the Calibration Data Base software (CDBS) which, according to current planning, is to be written in SPP. A suggestion was made to agree that all such software should be written in FORTRAN 77 (plus some yet to be decided extensions) and with the FORTRAN interfaces to MIDAS currently under development at the STScI, and to support these interfaces in MIDAS. This strategy will be investigated in consultations between the ST–ECF and the STScI.

These discussions on the MIDAS–IRAF compatibility issues resulted in the cancellation or shortening of most of the other presentations. Guido Russo reported on the status of the ESO / HST science data archive, which has achieved operational readiness on schedule, while Preben Grosbøl discussed recent developments in the FITS area, the most important one being the definition of new standard keywords along with a provision to use site-specific keywords. Fabio Pasian addressed issues of software portability and standards in ASTRONET. Dave Terrett summarized recent developments in STARLINK (new nodes, most of them micro–VAX based mini-nodes, a decision to adopt the IKON device as the new standard image display and new ways to get electronic–mail into STARLINK). Peter Shames presented the current status of GASP (GSSS Archive Support Project), which will make the astrometric plate scans available on optical disks; and on network planning at the STScI, including NASA plans to introduce some coordination into the various current efforts.

Finally, Mark Johnston reported on recent developments in the ST–ECF Artificial Intelligence (AI) Pilot Project: the Data Analysis Assistant is capable of performing a standard CCD data calibration by making sure that all required data are available and then creating a suitable data reduction procedure in the MIDAS procedure language or in the IRAF script language, finally piping it off to the VAX where the operation can be performed.

The meeting was followed, on the 7th May by a MIDAS workshop.

Erratum

The editor wishes to retract an inadvertent reference to a *MIDAS Newsletter* in the last issue of the ST–ECF Newsletter (No. 6, page 9). Such a publication does not exist. Apologies are offered for any dashed hopes or fruitless requests.

Ed.

News

HST proposal deadline

For the currently scheduled HST launch date of 17th November 1988, the deadline for the receipt at STScI of completed HST observing proposals is 1st December 1987. The deadline will be extended following the announcement of any significant further delay in the launch date.

Ed.

New Proposal Forms

A simplified HST proposal system has been announced by the STScI (see *STScI Newsletter Vol.4, No.2* for details). The current versions of the *Target List* and *Exposure Logsheet* are to be replaced by a simplified *Observation Summary Form* with the former pair only being required once a proposal has been successfully reviewed by the time allocation committee. Copies of the new forms will be mailed from STScI to people on their mailing list for proposal information.

Ed.

New ESA fellows

We should like to welcome two new recruits to the ST–ECF who join us as ESA fellows. *Roberto Rampazzo* arrived in the middle of January from the University of Padova in Italy where he spent the previous three years completing his Ph.D. on the photometry and dynamics of early-type galaxies. While with us he is continuing his work on the dynamics of ellipticals and also participating in the Artificial Intelligence project where he exploits his knowledge of the *Lisp* language.

Clive Tadhunter arrives in the middle of June from the University of St. Andrews in Scotland where he has spent the last year after doing his D.Phil. at the University of Sussex — Royal Greenwich Observatory. His interests are both Galactic and extragalactic, having worked on the subjects of helium stars, planetary nebulæ and active early-type galaxies. In Garching, we expect him to concentrate, amongst other things, on the problems of long-slit spectral data reduction.

Ed.

We should like this Newsletter to reach as wide an audience of European astronomers as possible. If you are not on the mailing list but would like to receive future issues, please write to the editor stating your affiliation (Ed).

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