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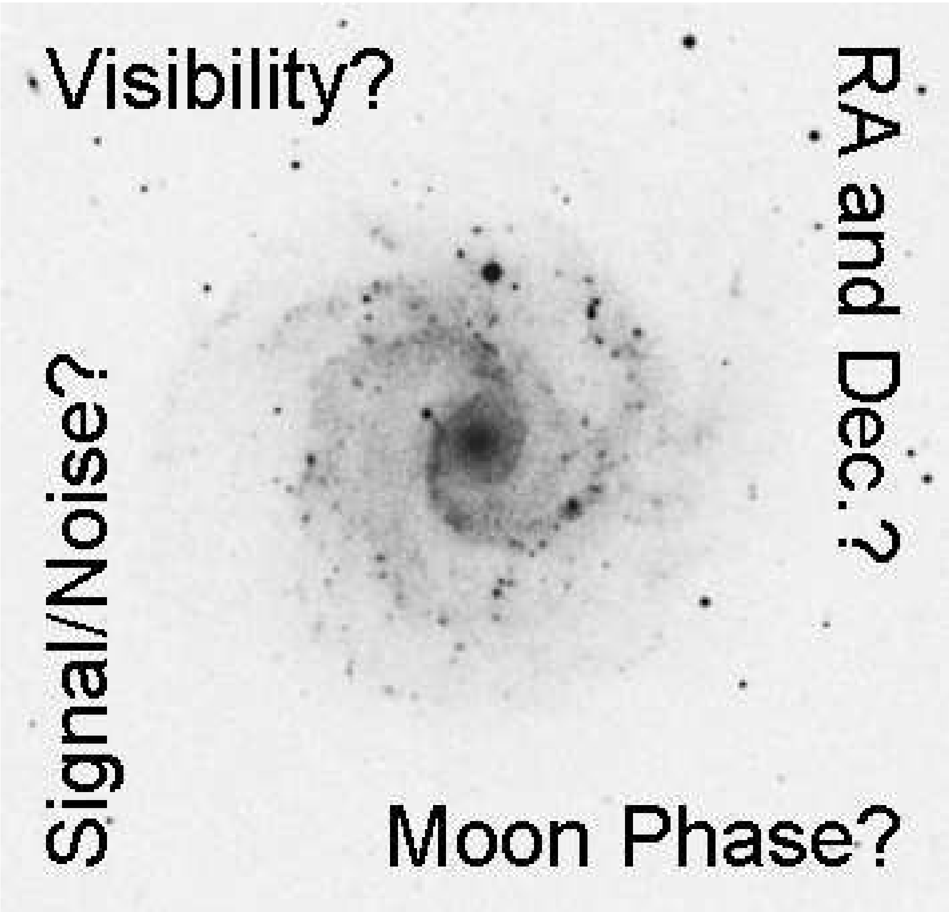
Preparing to Observe

Software and WWW-Based Resources



Abstract

This document identifies a number of software applications and packages that will prove useful to observers writing an observing application or preparing for an observing run. A brief description of the software is given.

WWW URLs are provided for WWW-based resources such a databases, catalogues and on-line atlases.

Contents

1 Introduction

One of the big problems with astronomy is that there are just not enough telescopes go round. Most significant observatories and satellites are in use virtually continuously, which means that competition for observing time is very intense.

Aware of the precious nature of telescope time, many observers (and would be observers) spend a lot of their time writing proposals requesting time, and planning observations in an attempt to squeeze the maximum possible information (and hence papers) out of a few brief nights atop some far flung mountain or a few precious orbits of satellite time. In addition, if time is awarded the ground-based applicant must then embark on the equally intense effort required to obtain information (such as finder charts) that will ensure that the run is success. Consequently, an enormous amount of work must be undertaken to get to the stage where you have your images/spectra/periodogram on a DAT or Exabyte tape. This time can be spent in a number of ways which will include some of the following:

While writing your application:

- Identifying potential target objects. See §4.4 and §11.
- Obtaining detailed up-to-date information on these objects. §11.0.6
- Identifying the time of year at which the targets are accessible from a given site. See §4.1.
- Calculating the phase of the moon during the usable parts of the year. See §4.1.
- Determining if a specific observatory/satellite and its equipment is suitable for your purpose. See §6.
- Determining the exposures required to obtain a suitable signal/noise ratio for the proposed observation. See §4.7.

Then later when preparing for your observing run:

- Identifying other objects in the vicinity of the targets. See §8.
- Creating suitable finder charts. See §4.6, §11 and §8.
- Finding suitable objects for calibrating your observations. See §11.

For the PhD student or the inexperienced potential observer this amount of work can be pretty daunting, requiring a steep learning curve between the moment you had your bright idea for some observations and acquiring the desired observations.

The aim of this document is to try to make life a little easier by providing pointers to existing resources that are generally available to users based at Starlink nodes. It is anticipated that other observers will also find some of the information useful.

2 Resources

Having mentioned one of the bad things about astronomy, it's good to know that there are nice things as well. One important thing to remember is that there are an enormous number of resources available to the prospective observer and that the number is increasing rapidly. When you hear older observers saying "In my day we used to have to write the reduction software ourselves and wind up the VAX every morning" they may not be exaggerating as much as you think. For example, the RGASP package, and a number of others, was a direct result of someone's PhD research programme.

The striking thing about this growth of resources is that they now appear in many forms, including: software, books, web pages, and information provided by the observatories.

It should not be forgotten that much useful information can be gained by simply asking your colleagues what they use. This process will not always identify the best, or even the most up-to-date resources, but it will at least provide some sort of starting point from which you can look around for others. A useful adage to get started with is "If it works and you like it – use it" but remember to keep your eyes open for better alternatives. It is very easy to stay with a piece of software you are familiar with even when it has long since been superseded by more modern, easier-to-use equivalents.

The sections that follow will identify examples from some of the resource types mentioned above.

2.1 The Starlink Software Collection

One of the core activities of Starlink is identifying good software and making it available to the UK astronomical community. The most visible manifestation of this effort is the Starlink Software Collection (SSC) which is managed, distributed and supported by the Starlink Project. A large amount of the software was written by members of the Project, but some of it comes from outside sources. Briefly put, it exists to provide the UK astronomy community with the tools they need to get the job done.

By providing the software within a stable computing environment, Starlink saves its users from the need to acquire an in-depth knowledge of source code, compilers or linking. They just sit down at a terminal and everything is virtually ready to go.

Clearly, at Starlink nodes the most important resource is the SSC and you will find that most nodes have a large proportion of it installed. However, if you find an item that you need is missing from your system, just ask the system manager to add it.

The SSC is extensive, providing packages for a wide variety of purposes including:

- Image processing – KAPPA (SUN/95), ESP (SUN/180), DAOPHOT (SUN/42), PHOTOM (SUN/45), PISA (SUN/109) and CCDPACK (SUN/139).
- Spectroscopy – DIPSO (SUN/50), ECHOMOP (SUN/152), FIGARO (SUN/86) and SPECDRE (SUN/140).
- Time series analysis – PERIOD (SUN/169).
- Polarimetry – POLMAP (SUN/204) and TSP (SUN/66).

- X-ray data processing – ASTERIX (SUN/86).
- Millimetre wave band – SPECX (SUN/17).
- Specific instruments – IRAS90 (SUN/161), JCMTDR (SUN/132), IUEDR (SUN/37) and CGS4DR (SUN/27).
- Image format conversion – CONVERT (SUN/55).
- Graphics – MONGO (MUD/54), SM, PONGO (SUN/137).
- Catalogue manipulation – CURSA (SUN/190) and CATPAC (SUN/120).

2.2 Starlink Software Collection – Documentation

Starlink software is documented in over 200 Starlink User Notes, hypertext documents and the Starlink WWW pages. Assistance is available via email to `ussc@star.rl.ac.uk`. A comprehensive description of the Starlink Software Collection is available in Starlink document SUN/1. It can be browsed on Starlink supported systems by typing "`showme sun1`" or via the Starlink WWW pages at URL `http://star-www.rl.ac.uk/`

Getting information about a package is easy. If you want to find out the name of Starlink documents relating to a piece of software (say PISA) you need only type the following:

```
% docfind PISA
```

(where % denotes the UNIX prompt) and the name of the document will be displayed thus:

```
Searching for the keyword pisa in the titles of documents ...

SUN                       STARLINK USER NOTES                          SUN
109.07  PISA - Position, intensity and shape analysis
```

Once you have that you will be able to display the document by typing:

```
% showme sun109
```

This will generate an Xmosaic or Netscape browser that will display a WWW version of the document.

If the browser fails to appear, you can find the LaTeX source of SUN/109 and all the other Starlink documents in directory "`/star/docs`".

3 IRAF Too!

As most of you are aware, the SSC (see §2.2) is not a unique attempt to provide a complete set of astronomical utilities and some Starlink sites also have the NOAO (National Optical Astronomical Observatories) supported IRAF (Image Reduction and Analysis Facility) system installed alongside the home-grown SSC items. IRAF is available as an item in the SSC but is written and updated by NOAO. This is not true of the Starlink FIGARO which is directly maintained by the Project.

The presence of both systems allows users to "pick-and-mix" their software usage (Starlink provides the image format conversion utilities CONVERT to convert between the data formats used by the systems) thereby obtaining the best of both worlds. In the context of preparing to observe you will probably find the IRAF ASTUTIL (see §5.1) and XEPHEM (see §5.11) packages of most use.

Other systems (AIPS, MIDAS, XANADU) may be available at some nodes, but most install only the SSC and/or IRAF. Your system manager will be able to advise you on what is available at your site.

4 Software Packages and Utilities

A list of software packages commonly used while writing proposals is given below under subject headings and then by program name. It is far from exhaustive, but it does provide a basis from which to construct your own set of favourite tools.

4.1 Air mass/altitude/hour angle/visibility

Once you have determined what it is that you intend to observe, the next consideration is its visibility. If you are trying to observe a source near the galactic centre in Sagittarius from La Palma, there is little point in applying for ground-based visible light telescope time in December, since it will only be above the horizon during the day time. Similar considerations apply to satellites, with applications attempting to image within 50 or so degrees of the sun being dismissed. Consequently, there is a plethora of programs that tell you how high an object is (normally objects are only observed when less than 60 degrees from the zenith) or when the object culminates.

Perhaps the easiest of these programs to use is OBSERVE (see §5.5) which generates graphs and/or tables showing object rise/set times. An example of the text and graphical output is shown in the section describing OBSERVE. It is trivial to use and can generate data for most the world's major observatories.

Those of you more familiar with IRAF may find you prefer to employ the tools provided by the IRAF ASTUTIL utilities (see §5.1).

If these do not provide exactly what you require, try SKYCAL (see §5.7). While the interface is rather clumsy, it does provide a lot of information.

4.2 Bright/grey/dark time

As observers of very faint objects quickly come to realise, the Moon is a real nuisance. If a bright Moon is present in the sky, even at remote clean air sites, it scatters light across the whole sky adding substantially to the sky background count and making really faint objects increasingly difficult to observe. Because of this, observations are broken up into targets requiring really dark skies, those only needing fairly dark skies, and those where the sky background is not important at all.

Those of you wanting to know about the Moon will find that the information is available by using OBSERVE (see §5.5), with SKYCAL and PREDICT (see §5.7 or §5.6 respectively) offering other sources of information.

4.3 Binary star predictions

Those of you interested in predictions of the phase of binary stars will probably find what you want supplied by the PREDICT package (see §5.6).

4.4 Catalogue manipulation

During the object selection phase you may want to take a catalogue of possible objects and derive a subset with properties within range bounds you have specified. This can be easily achieved using CURSA (see SUN/190).

Using software like SKYCAT (see §5.8) it is also possible to view a FITS image and overlay on the image the locations of objects identified from personal catalogues.

Information on Internet sources of catalogue information may be found in §11.

4.5 Co-ordinate system conversions

One of the perennial problems encountered in astronomy is the need to convert between astronomical co-ordinate systems. The calculation of such transformations is tedious but requires care. Probably the simplest way to avoid this problem is to use the COCO package (see §5.4) which combines a range of possibilities with a simple-to-use, no-nonsense interface.

Alternatively, you may care to try the ASTUTIL program GALACTIC (see §5.1.4).

4.6 Finder charts

Finder charts are an important tool for ground-based observing since they give you the chance to examine the rest of the field and identify nearby stars that may cause intrusive glare. This task can be performed in two obvious ways:

- Use packages like CHART, SKYMAP(PC) or SKYMAP(UNIX) (see §5.10 and §5.9 respectively).
- Download images of the region using on-line atlases or finder charts created from the APM survey (see §8).

The three packages named will all provide good finder charts. You will find that SKYMAP(PC) is an IBM PC/Windows based package. This has been included because it is very cheap, highly accurate and self-installs.

The on-line atlas approach is dealt with in §8.

4.7 Signal/Noise

Calculating the time required to obtain a strong signal/noise detection for a given object using a specific instrument usually requires an in-depth knowledge of the instrument characteristics and other parameters such as the local sky brightness. This calculation is probably best undertaken using software supplied by the observatory in question, but if that is not available the ASTUTIL CCDTIME program (see §5.1.3) may be of some assistance. The La Palma INT group supply two packages (see §6.1) dealing with this problem.

4.8 Ephemeris calculation

For most purposes (no more accurate than an arcsecond or two) a satisfactory planetary, lunar and solar ephemeris can be obtained using the FLUXES package from Starlink. However, if you wish to determine values more accurately you would be well advised to access the JPL ephemeris using a couple of simple SLALIB calls – it really is very simple and is described fully in SUN/87 and SUN/67. Alternatively, you might care to try the SKYMAP(PC) or XEPHEM packages (see §5.10 and §5.11 respectively).

5 Descriptions of Software Mentioned

The descriptions that follow borrow unashamedly from those provided by the authors. This has been done to try to avoid inadvertently misrepresenting the capabilities of any of the packages.

5.1 ASTUTIL – IRAF

This is an astronomical utilities package supplied by IRAF as a layered package. It contains a number of useful programs of which the more relevant are:

5.1.1 AIR MASS

Compute the air mass at a given elevation above horizon.

5.1.2 ASTTIMES

The astronomical quantities of universal time, J2000 Julian epoch, Julian day, and local mean sidereal time at the specified observatory are computed and printed for the given dates and times. The input dates and times may be taken from files containing the year, month, day, and local time in the specified time zone or, if no files are specified, then task parameters are used. The output consists of a printed table with optional header, a copy of the input data, and derived astronomical data.

5.1.3 CCDTIME

A telescope, CCD detector, and list of filters is selected from a database to define the expected photon/electron count rates. These rates, along with a specified seeing and air mass, are used to estimate the signal-to-noise ratio for a stellar observation in each filter. The output provides three results per filter: the exposure time to achieve a desired signal-to-noise ratio for a given magnitude, the magnitude to achieve a desired signal-to-noise ratio in a given time, and the signal-to-noise ratio at a specified magnitude and exposure time.

5.1.4 GALACTIC

GALACTIC is used to convert between equatorial and galactic coordinates or vice versa. Co-ordinates are read from the input file as Right Ascension and Declination or galactic longitude and latitude pairs. Each co-ordinate pair may optionally be followed by the epoch of the equatorial co-ordinates, in which case the co-ordinates are precessed to 1950.0 before conversion for equatorial to galactic or to the specified epoch for galactic to equatorial.

5.1.5 PRECESS

Co-ordinates are read from the input file as Right Ascension and Declination pairs, one pair per input line. Each co-ordinate pair may optionally be followed by the equinox of the input co-ordinates (if different from the default) and the epoch of the output co-ordinates. Co-ordinates may be entered in either decimal or sexagesimal notation. The given co-ordinates are rotated according to the precession rates to the requested year and printed on the standard output. Basic data is taken from the Explanation to the American Ephemeris.

5.2 CURSA – Starlink

CURSA is a set of Starlink programs for manipulating astronomical catalogues and similar tabular datasets. It provides facilities for: browsing or examining catalogues, selecting subsets from a catalogue, sorting catalogues, copying catalogues and pairing two catalogues. Subsets can be extracted from a catalogue in a format suitable for plotting using other Starlink packages, such as PONGO (see SUN/137). CURSA can access catalogues held in the popular FITS table format, as ASCII text, or in the CHI/HDS format used by the CATPAC catalogue manipulating programs.

CURSA will also handle small(ish) catalogues or private tables of the user's favourite objects, selecting those objects which match the constraints of a given observing programme.

5.3 CHART – Starlink

The CHART package extracts positions, magnitudes and other data from certain stellar and non-stellar astronomical catalogues. The results may be listed on a terminal or printer, or used to plot finding charts or perform astrometric reductions.

An example of the graphical output is shown in Figure 1. The stars may be identified via a text table supplied by the program. An example would be something like:

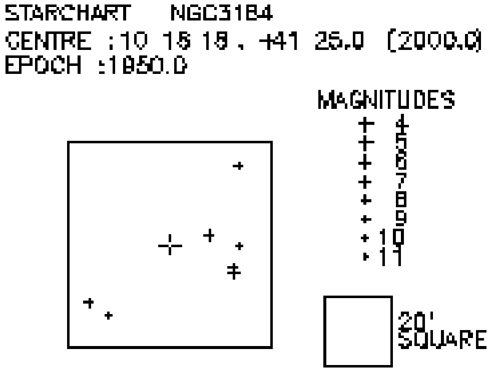


Figure 1: Example CHART output.

```
 Input Field Centre  10 18 18.000    + 41 24 58.00  Equinox 2000.00
    Equivalent to  10 15 18.554    + 41 40  0.14  Equinox 1950.00

    Galactic Coordinates:            b  =  55.64      l  = 178.35
    Ecliptic Coordinates (1950.00):Lat. =  28.61    Long. = 139.79

       Output positions for Equinox 1950.00    Epoch 1950.00

       *****************************************************
       * Approximate Field Centre Location on Sky Survey(s) *
       *****************************************************
           Survey      Field Centre          X        Y
           Palomar     +42  10H  0M          82      187

             Number of CSI Catalogue stars found =  25
    HD           DM       Spec   V      B        R.A.       Dec.        Offsets
                               Mag   Mag          (1950.00)          From Centre
                                                                      "       "     Idents
1  88513   BD +42  2100   F2    8.2    8.6     10 10 27.1    +42  7 52    -3242   1695    AGK,SAO
2  88577   BD +42  2102   G5    8.4    9.8     10 10 51.7    +42  3 45    -2972   1444    AGK,SAO
3          BD +42  2103   K2 ( 9.5) 10.7      10 11 23.3    +42 20 31    -2609   2446    AGK,SAO
4  88785   BD +42  2104   F2    8.2    8.6     10 12 25.6    +42  7 26    -1924   1654    AGK,GCRV
5          ** +42 10124   K0 (10.8) 12.0      10 12 28.7    +42 38  7    -1875   3495    AGK
```

The following catalogues are available within CHART.

5.3.1 CSI

Stars can be selected from the Catalogue of Stellar Identifications (CSI) 1979 edition, prepared by the "Centre de Donnees astronomiques de Strasbourg" (CDS). This is a compilation of 434,927 stars, extracted from a wide range of original source catalogues. Approximate positions are available for each star, together with cross references into the original source catalogues. Magnitudes are available for most of the stars. Used in this mode, the program can act as a stellar data retrieval system to find, for example, which stars are (or are not) in a particular catalogue, or what information is known about the stars in a particular field. This is also the normal mode of use when preparing overlays or finding charts.

5.3.2 Astrometric

Stars can be selected from a merged astrometric catalogue (prepared at RGO by W. Nicholson). This contains the whole of the AGK3 catalogue (extending down to Dec -3 degrees), the SAO stars south of the celestial equator, and the complete PERTH70 catalogue. This catalogue contains fewer stars than the CSI catalogue, but includes accurate positions and proper motions as well as magnitudes and spectral types. This mode is most useful when preparing to carry out astrometry.

5.3.3 Non-Stellar

Nonstellar objects can be selected from the Dixon 'Master List of Nonstellar Objects'. This was formed by a simple merging of many catalogues and lists. The total number is about 185,000. Approximate angular sizes and magnitudes are given for many objects.

5.3.4 Private

Stars can be selected from any catalogue that has been produced in the form that CHART expects for 'ASTROMETRIC' mode.

You can select which of these four modes to work in and specify a series of search areas. In CSI, ASTROMETRIC or PRIVATE modes you can also place magnitude or total number limits on the search and choose which source catalogues to include or exclude. A series of field centres may be input at the terminal or read from a previously prepared file.

After the search is made, you may list the results at a terminal or on the printer. Positional information may be precessed to a specified equinox.

You may also plot the results in the form of an overlay or finding chart.

5.4 COCO – Starlink

The COCO program converts star co-ordinates from one system to another. Both the improved IAU system, post-1976, and the old pre-1976 system are supported. COCO can perform accurate transformations between the following co-ordinate systems:

- mean RA and Dec., old system, with E-terms (loosely FK4, usually B1950)
- mean RA and Dec., old system, no E-terms (some radio positions)
- mean RA and Dec., new system (loosely FK5, usually J2000)
- geocentric apparent RA and Dec., new system
- ecliptic co-ordinates $[\lambda, \beta]$, new system (mean of date)
- galactic co-ordinates $[l^{II}, b^{II}]$, IAU 1958 system

COCO's user-interface is spartan but efficient. The program offers control over report resolution, and has a simple online help facility. All input is free-format, and defaults are provided where this is meaningful.

The input/output arrangements of COCO are flexible, to allow a variety of operating styles – interactive, input from a file, report to a file, batch, *etc.* Also, in addition to the report which is produced, the results of the conversions are also available in a raw form, to a fixed resolution and free from extraneous formatting. This file is intended to be read easily by other programs.

In order to comply with the IAU 1976 recommendations, all position data published from 1984 on should be given in the new system, using equinox J2000.0. However, positions are still frequently given in the old system, using equinox B1950.0. COCO can perform the necessary conversion.

5.5 OBSERVE – Starlink

The program OBSERVE is designed to allow you to get a quick overview of the observability of a star through the year from the geographical location selected. You will be prompted for the Right Ascension and Declination of the star/object, the telescope employed, and the year. On the selected graphics device a plot will be drawn that tells you, for all dates of the year, the star rising and setting times and the times that it is 30 degrees above the horizon (air mass less than 2), the times of astronomical twilight, the phase and rising and setting times of the Moon as well as its distance from the star in question.

The algorithms used in calculating these times, positions and phases come from the book 'Practical Astronomy with your calculator' by P. Duffett-Smith (3rd ed. CUP 1988), and are used with permission. These algorithms are not designed for very high precision calculations, a fact which is to some extent conveyed by the program output. Nevertheless, it has been verified that the routines are good for their purpose. As mentioned above, all standard Starlink graphics devices are supported. The data generated by OBSERVE can also be output to a text file.

The format of the text file is shown below:

```
Object selected was: NGC3184

Located at RA:       10h18m18. 0
Located at Dec:      +41d24m58. 0

From:                Mauna Kea 88 inch
During:              1997

January

Day    Rise     Set      Above 30 Below 30  Twi. beg Twi end   Moon ris Moon set Moon dist  Moon %
01   06:42:10 21:08:09  09:27:53 18:22:26  15:35:46 05:11:31  10:43:52 22:08:22 15:07:03     60
02   06:38:14 21:04:13  09:23:57 18:18:30  15:36:08 05:12:05  11:34:52 22:47:07 15:42:22     51
03   06:34:18 21:00:17  09:20:01 18:14:34  15:36:29 05:12:38  11:35:28 23:28:06 16:21:27     41
04   06:30:22 20:56:21  09:16:05 18:10:38  15:36:50 05:13:12  12:28:57 00:12:20 17:03:24     31
05   06:26:26 20:52:25  09:12:09 18:06:42  15:37:10 05:13:46  13:24:50 01:00:45 17:47:37     22
```

5.6 PREDICT – RGO

Predict was designed for those observers wishing to get data on binary stars in particular. It gives data for the Moon and programme stars in the form of a listing for every 15 minutes from

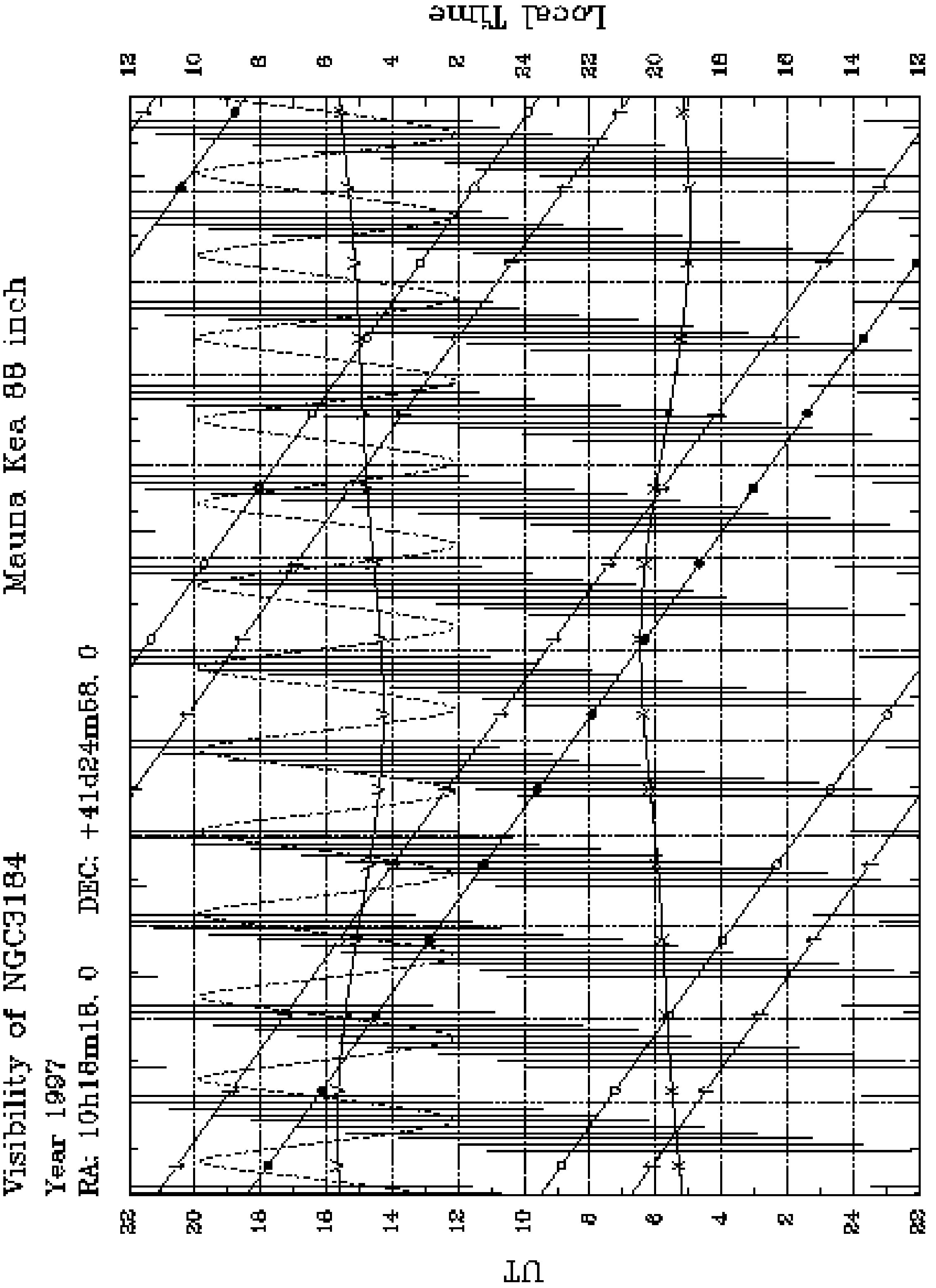


Figure 2: Example OBSERVE output.

the end of evening nautical twilight to the start of morning nautical twilight. This listing would include orbital phase, given a time of minimum and period for the programme star, its altitude, azimuth, air mass and angular separation from the moon. Times of twilight are calculated as well as moonrise/set object rise/set. A simple phase diagram showing the observable phase can also be produced. At the moment it runs on a VAX, but it is being ported to the Linux system and upgraded with more accurate Sun/Moon algorithms.

5.7 SKYCAL – John Thorstensen

This consists of two programs, SKYCALC and SKYCALENDAR.

SKYCALC is an "Interactive Almanac." It helps you plan and execute observing runs, and allows easy calculation of air masses, twilight, lunar interference, co-ordinate transformations and such – nearly everything except the weather.

SKYCALENDAR is a "Nighttime Astronomical Calendar" to calculate and print astronomical calendars.

Both programs have several preset Observatory locations to choose from. You can also specify your own.

A copy of the SKYCAL code can be obtained via Starlink, together with the document SUN/187.

5.8 SKYCAT – ESO

SKYCAT allows you to open and visualise a variety of FITS images including support for World Co-ordinate System (WCS), interactive measurement of offsets, and other standard visualization functions (SAOimage-like). It is possible to access and load an image from a network server of the Digitized Sky Survey scans and access catalogue information from a number of popular astronomical catalogues like the "HST Guide Star Catalog" (GSC) and others.

It is also possible to access the observations catalogue from the NTT, HST and CFHT Science Archives, and use SIMBADref or NED both as name resolvers as well as for information on known objects.

5.9 SKYMAP – SAO

SKYMAP is a sophisticated interactive display program which can be used to create finder charts at any particular plate scale. The package can plot any two catalogues from its list, plus stars from the GSC. The planetary positions are taken from the current JPL ephemeris.

All-sky maps can also be produced to show large structures or the position of a catalogue in the big picture. All of the IRAS plate projections are included so objects can be plotted against contoured IR sky flux. Catalogue objects may be identified by plotting a catalogue over an image.

The package runs on Tektronix-compatible devices and is fairly sophisticated.

5.10 SKYMAP(PC) – Chris Marriott

This versatile PC-based package allows you to create finder charts showing the area around your target object and all stars in the GSC and SAO catalogues together with objects from the NGC and IC catalogues overlaid.

SKYMAP(PC) is available from it's own home page at URL `http://www.skymap.com`. Versions exist for Windows, Windows NT and Windows 95. The software is inexpensive shareware (£30) at the time of writing. It runs best on 386s (or better CPUs) with more than 4Mb of RAM available.

5.10.1 Stars

The 1990 machine-readable version of the SAO star catalogue is the source of star data. The evaluation version of SKYMAP(PC) comes with stars to magnitude 7; the commercial version of the program is supplied with the complete SAO catalogue of stars – this is reasonably complete down to magnitude 9.5.

The commercial version of SKYMAP(PC) can also display stars (and other objects) read from the GSC CD-ROM database.

5.10.2 Solar system

The positions of the planets Mercury to Pluto plus the Sun and Moon are shown, with a mean error of less than an arcsecond. The Moon is drawn with the correct phase and orientation in the sky. Clicking on any planet displays extensive positional and physical information (position, distance, phase, visual magnitude, light time, etc). Planetary positions are rigorously reduced for the topocentric position of the observer. The program is supplied with a catalogue of asteroids and comets.

5.10.3 Galaxies etc

SKYMAP(PC) is supplied with the complete Saguaro Astronomy Club (SAC) v6 database of 10,700 deep sky objects. This contains the complete Messier, Revised NGC, and IC catalogues, together with the brighter objects from more than 80 other object catalogues. Extensive information about any object can be displayed.

5.11 XEPHEM – IRAF

XEPHEM version 2.6 is an interactive astronomical ephemeris program for X Windows systems. It computes heliocentric, geocentric and topocentric information for celestial objects. It has built-in support for all planets: the moons of Jupiter, Saturn and Earth, and Mars' central meridian longitude. Xephem supports objects in heliocentric or Earth orbit, given the appropriate elements. Sample databases of over 16000 objects are included in the release kit.

XEPHEM generates data in configurable tabular forms and in several detailed graphical formats. It can plot and list all data fields and can be programmed to search for arbitrary circumstances.

6 Observatories

Usually, the best place to look for information on the capabilities of the instruments and telescopes at an observatory is in the Web pages of the observatory that operates it. The URLs of some the observatories used by British observers:

- Anglo-Australian Observatory – `http://www.ast.cam.ac.uk/AAO/astronomers.ht`
- AAT 2DF – HTTPBCref
- CFHT – `http://cdsweb.u-strasbg.fr/cfht/cfht_manuals.html`
- Royal Observatory Edinburgh – `http://www.roe.ac.uk`
- Royal Greenwich Observatory – `http://www.ast.cam.ac.uk/RGO/RGO.html`
- ING La Palma (WHT/INT/JKT) – `http://ing.iac.es/`
- ING Software – `http://ing.iac.es/`
- JAC Hawaii (UKIRT/JCMT) – `http://www.jach.hawaii.edu/`
- JAC Software – `http://www.jach.hawaii.edu/#computing`
- SAAO – `http://www.saao.ac.za/`
- MERLIN – `http://www.jb.man.ac.uk/merlin/MERLIN.html`

6.1 SIGNAL and LIGHT_IN_SLIT

Those of you interested in using instruments at La Palma will find the SIGNAL and LIGHT_IN_SLIT packages provided by Chris Benn particularly useful.

6.1.1 SIGNAL

SIGNAL is a Fortran program for predicting the number of object and sky photons detected during an exposure with one of the common-user instruments of the Isaac Newton Group telescopes. The predictions are based on a combination of measured and estimated efficiencies for the telescopes, cameras, gratings and detectors.

6.1.2 LIGHT_IN_ SLIT

LIGHT_IN_SLIT calculates the refractive index at each wavelength for an arbitrary atmosphere, and uses this to calculate wavelength-dependent total of light entering slit (at arbitrary angle on sky) from a circularly symmetric Gaussian image at arbitrary zenith angle.

Copies of the current versions (for SUN workstations) are available from URL:

```
ftp://ftp.ast.cam.ac.uk/pub/pubinfo/signal/
```

7 FORMLOAD

As many of you are aware, applications for observing time on telescopes such as the AAT, INT or WHT must be submitted to the selection process in the proper format. The forms involved (such as PATT2) are quite complex and compactly laid out. They can be filled out by careful use of a typewriter (if you can still find such a thing) but are most conveniently filled out using a Starlink package named FORMLOAD, which was designed for the purpose.

The user of the package has to prepare a text file which provides the information that is embedded in the appropriate parts of the final application form. To make this easier, template files are provided for each of the forms. The associated document SUN/22 provides information on the details of the process.

Support is provided for:

- UK optical and infrared telescopes (PATT2).
- La Palma ING telescopes scheduling information.
- UK millimetre and submillimetre telescopes (PATT3).
- AAT telescopes scheduling.

The software runs under UNIX and VMS.

8 On-line Atlases – Finder Charts

One of the best ways to make a finder chart is by the use of an on-line atlas, the most famous of which are those provided by NASA, ESO and the STScI. They are very simple to use. You supply the Right Ascension and Declination values for the region of sky you are interested in, specify the dimensions of the chunk of sky you wish to examine, and the WWW site sends you an appropriate FITS or GIF file. The whole procedure takes about 3 minutes.

The image requested is supplied from a database containing the entire sky as generated by digitally sampling scans of Palomar, UK or ESO Schmidt survey plates. The resolution and accuracy of the data may vary slightly depending on the source of the plates employed and the scanner they were sampled with.

URLs for the four most popular on-line atlases are given below:

- CADC – `http://cadcwww.dao.nrc.ca/dss/`
- ESO – `http://arch-http.hq.eso.org/cgi-bin/dss`
- Skyview – `http://skyview.gsfc.nasa.gov/skyview.html`
- STScI – `http://stdatu.stsci.edu/dss`

An example of the quality of output can be seen on the front cover of this document. The image of NGC3184 was supplied by Skyview in its default setting.

Some of the sites also allow catalogue overlays onto the images provided (so that nearby objects can be readily identified) and co-ordinate/name resolution. You give the name (say) NGC4395 and it gives back the co-ordinates RA 12 25 53.0 Dec. 33 32 54 which it then employs as the target location.

Alternatively, you may be at a site that possesses the "Digitised Sky Survey" (supplied in the form of 102 CD-ROMs) or the more highly compressed "RealSky" (9 CD-ROMs). You will find that these come with software which allows you to choose a chunk of sky to look at, tells you which CD to place in the CD-ROM player, and then creates the image for you.

The APM Sky Catalogue also contains information gained from scanned survey plates, but stored in the form of a description database rather than as images. It is used in a very similar manner to the atlases. You go to the appropriate URL and after entering the co-ordinates, epoch and field size are provided with maps (B and R band) showing the locations of all objects detected in that field. The maps are provided as GIFs or Postscript files, together with a text file describing each object. The appearance of the maps is tidy, simple and uncluttered.

The APM survey can be found at:

```
http://www.ast.cam.ac.uk/~rgm/apm_catalogues.html
```

9 Books and Plates

In the rush to power-up your workstation and get a Web browser running, do not forget that other long established sources of information exist and can probably be found in your departmental library. For example:

- The British Astronomical Association Handbook. A source of much information, particularly pertaining to objects in the solar system, with some useful tables and information about time and time signals.
- Norton's 2000 Star Atlas and Reference Handbook, Editor Ian Ridpath, Longman Scientific, ISBN 0-582-03163-X. A good entry-level guide to the sky and observing.
- Uranometria, Will Tirion. A more complete atlas showing stars down to 10th magnitude and galaxies/nebulae considerably fainter.
- Nautical Almanac, HM Nautical Almanac Office, HMSO.
- Schmidt Survey Plate copies. Copies of the original plates on which the digitised sky surveys are based.

10 Internet Sources for the Software Described

A list of useful URLs is provided below, but some links may (as seems to be the way on the Web) be subject to change without notice. If you find any failing please tell us.

- ASTUTIL – http://iraf.noao.edu
- CURSA – http://www.roe.ac.uk/acdwww/cursa/home.html
- CHART – http://www.roe.ac.uk/acdwww/findchart/chart.html
- COCO – http://star-www.rl.ac.uk/
- OBSERVE – http://star-www.rl.ac.uk/
- PREDICT – Via Steve Bell. Email sab@ast.cam.ac.uk
- SKYCAL – http://star-www.rl.ac.uk/
- SKYCAT – http://arch-http.hq.eso.org/skycat/
- SKYMAP (PC) – http://www.skymap.com
- SKYMAP (UNIX) – http://tdc-www.harvard.edu/software/skymap.html
- XEPHEM – http://iraf.noao.edu

It is worth bearing in mind that the IRAF Web site is now mirrored in the UK at:

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

allowing the complete binaries to be downloaded in just a few minutes.

The STScI also maintain a very useful directory of astronomical software at:

- ASDS (STScI Astronomical Software Directory) – http://doright.stsci.edu/asds/

11 Internet Catalogues and Databases

If you are interested in looking at on-line astronomical databases you will find that the Starlink documents SUN/162 and SUN/174 provide a very full account. Some portions of SUN/162 are, inevitably, a little out-of-date, but much of the information it contains is still very useful. Another source of information is the "Network Resources for Astronomers" site at URL http://www.eso.org/online-resources.html.

However, to allow you to quickly examine some of the most popular databases, some URL are given below:

- APS – http://isis.spa.umn.edu/homepage.aps.html
- CDS – http://cdsweb.u-strasbg.fr/
- CIO – http://iuewww.gsfc.nasa.gov/cio/cio_homepage.html
- NASA ADS – http://adswww.harvard.edu/
- NASA NED – http://ds.internic.net/cgi-bin/enthtml/database/ned.b
- SIMBAD (Europe) – http://cdsweb.u-strasbg.fr/Simbad.html
- SIMBAD (USA) – http://hea-www.harvard.edu/SIMBAD/simbad.home.html

Descriptions of the databases and catalogues are given in the next section.

11.0.3 APS image database

The APS Catalogue of the POSS I is the result of scans of glass duplicates of the blue (O) and red (E) plates of the original Palomar Observatory Sky Survey (POSS I) for 664 fields.

The object Catalogue entries include images, calibrated magnitudes in two colours, positions to 0.2 arcseconds and neural network image classifications.

11.0.4 CDS

The "Centre de Donnees astronomiques de Strasbourg" (CDS) collects and distributes astronomical data catalogues, related to observations of stars and galaxies, and other galactic and extragalactic objects. A few catalogues about the solar system bodies and atomic data are also included.

Importantly, this site hold copies of three papers by Landolt describing standard stars in the UBVRI wavelength bands.

The catalogues and tables managed by CDS can be summarized as follows:

- More than 1700 Catalogues available from CDS.
- More than 1290 are available on-line (as full ASCII or FITS files).
- More than 1090 are also available through the VizieR browser.

11.0.5 CIO

The Catalogue of Infrared Observations is a database of over 200,000 published infrared observations of more than 10,000 individual astronomical sources over the wavelength range from 1 to 1000 micron. The catalogue is available for downloading via ftp.

11.0.6 NASA ADS

The Astrophysics Data System (ADS) is a resource that provides astronomical data to the scientific user community. At present the main emphasis is on the Abstract Service, which includes three sets of abstracts:

- Astronomy and astrophysics, containing approximately 240,000 abstracts.
- Space instrumentation, containing approximately 410,000 abstracts.
- Physics and geophysics, containing approximately 220,000 abstracts.

The abstracts contain information on papers published in a number of refereed scientific publications. This should not be confused with databases that contain information derived from publications such as redshift or luminosity. Each dataset can be searched by author, object name, title, or abstract text words. In addition, the abstracts include links to scanned images of over 20,000 journal articles appearing in 'Astronomy and Astrophysics', 'ApJL' and 'AJ' since 1975, 'ApJ' since 1990, and 'PASP' since 1988.

In addition to the Abstract Service, the ADS provides access or pointers to NASA data catalogues and data archives, thereby making data collected by NASA missions available to astronomers.

11.0.7 NASA Extragalactic Database – NED/IPAC

The NASA/IPAC Extragalactic Database (NED) is built around a master list of extragalactic objects for which cross-identifications of names have been established, accurate positions and redshifts entered to the extent possible, and some basic data collected. Bibliographic references relevant to individual objects have been compiled, and abstracts of extragalactic interest are kept on line.

The most recently updated version of the NED database contains positions, basic data, and over 710,000 names for 375,000 extragalactic objects, as well as nearly 625,000 bibliographic references to 27,000 published papers, and 35,000 notes from catalogues and other publications. NED supports searches for objects and references, and offers browsing capabilities for more than 11,400 abstracts of articles of extragalactic interest that have appeared in Astronomy and Astrophysics, AJ, ApJ, MNRAS, and PASP since 1988, and in Publications of the Astronomical Society of Japan, Astronomy Reports and Astronomy Letters (formerly Soviet Astronomy and Soviet Astronomy Letters) since 1992.

Over 645,000 detailed photometric measurements, and 250,000 detailed position measurements, taken from catalogues and the published literature, are currently available through NED. Also on-line are selected IAU Circulars as well as thesis abstracts of doctoral dissertations on extragalactic topics. Title and abstract searches of the NED literature database can now be made by specifying author names. It is also possible to search the main NED database for objects selected by redshift (NED currently has over 45,000 velocities), in addition to the selection by name, by position, or by type.

11.0.8 SIMBAD

The SIMBAD astronomical database, created and maintained by the CDS, Strasbourg, brings together basic data, cross-identifications, observational measurements, and bibliography, for celestial objects outside the solar system: stars, galaxies, and nonstellar objects within our galaxy, or in external galaxies. In total, SIMBAD contains data for roughly 1,000,000 objects.

In some instances there is a charge for using SIMBAD, so a password may be needed. However, the charge is paid by the ESA for institutions in member states. Most Starlink sites will probably already have a password. Your site manager should be able to advise you on this.

A mirror site exists in the USA.

12 Internet Links to Astronomical Resources

When it comes to searching for a variety of resources the URLs below are pretty hard to beat. They are well maintained and provide a huge amount of information.

- NRAO Astronomy on the Web – `http://fits.cv.nrao.edu/www/astronomy.html`
- NRAO Astronomy Software Servers – `http://fits.cv.nrao.edu/www/yp_software.html`
- STScI Astronomical Resources – `http://www.stsci.edu/astroweb/net-www.html`
- STScI Astronomical Software Directory – `http://doright.stsci.edu/asds/`
- AstroWeb – `http://ecf.hq.eso.org/astro-resources.html`

13 Internet Software Archives

The sites listed below contain an enormous number of software packages (most of them non-astronomical). They are particularly well suited to finding planetarium software and databases.

- Imperial College Sunsite – `http://src.doc.ic.ac.uk:80/public/`
- HENSA (PC) – `http://micros.hensa.ac.uk/`
- HENSA (UNIX) – `http://www.hensa.ac.uk/hensa.unix.html`
- Oakland VSL – `http://castor.acs.oakland.edu/cgi-bin/vsl-front`

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1. 18 March 1997: Version 1 (GJP).
2. 30 January 1998: Version 2. Corrected the reference to CURSA in Section 4.4, *Catalogue manipulation* (ACD).