Appendixes

- Appendixes

Appendix A
IRAF Primer

In This Chapter...

The Image Reduction and Analysis Facility (IRAF), developed by the National Optical Astronomy Observatories (NOAO), forms the basis of the Space Telescope Science Data Analysis System (STSDAS). IRAF contains numerous packages of programs, called *tasks*, that perform a wide range of functions from reading data tapes to producing plots and images. Most astronomers will already be familiar with IRAF, but we provide this tutorial for HST observers who are beginners with IRAF. It includes information on:

- How to set up IRAF the first time you use the software.
- How to start and stop an IRAF session.
- Basic concepts, such as loading packages, setting parameters, etc.
- How to use the on-line help facility.

Additional information on IRAF, in particular *A Beginner's Guide to Using IRAF*, is available through the NOAO IRAF Home Page at:

`http://iraf.noao.edu`

A.1 Initiating IRAF

This section explains:

- How to set up your IRAF working environment.
- How to start and logout of the IRAF program.

We assume that your site has IRAF and STSDAS installed. If not, you must obtain and install the software. See "Getting IRAF and STSDAS" on page A-13 for details.

A.1.1 Setting Up IRAF

Before running IRAF for the first time you need to follow these three steps:

1. Create your IRAF root directory
2. Move to that directory and set the necessary environment variables or system logicals and symbols.
3. Run **mkiraf** to create a `login.cl` file and a `uparm` subdirectory

Users generally name their IRAF home directory `iraf` (also referred to as your IRAF *root* directory) and set it up in their account's root directory (i.e., the default directory that you are in when you log in to the system). The IRAF home directory doesn't need to be in your account's root directory, nor does it need to be called `iraf`, but you should *not* put it on a scratch disk that is periodically erased.

If you call your root IRAF directory "`iraf`", you can set up IRAF as follows:

Under Unix:

```
% mkdir iraf
% cd iraf
% setenv iraf /usr/stsci/iraf/
% source $iraf/unix/hlib/irafuser.csh
% mkiraf
```

Can be placed in .login file → (lines 3–4)

The directory name is site-dependent—check with your system staff ← (line 3)

Under VMS:

```
$ CREATE/DIR [.IRAF]
$ SET DEFAULT [.IRAF]
$ IRAF
$ MKIRAF
```

Can be placed in LOGIN.COM file → (lines 3–4)

The **mkiraf** command initializes IRAF by creating a `login.cl` file and a subdirectory called `uparm`. After typing the **mkiraf** command, you will see the following:

```
% mkiraf
-- creating a new uparm directory
Terminal types: gterm=ttysw+graphics,vt640...
Enter terminal type:
```

Enter the type of terminal or workstation you will most often use with IRAF. [1] Generic terminal types that will work for most users are:

- `vt100` for most terminals.
- `xtermjhs` for most workstations running under X-Windows.
- `xgterm` for sites that have installed X11 IRAF and IRAF v2.10.3 BETA or later.

You can change your terminal type at any time by typing `set term=`*new_type* during an IRAF session. You can also change your default type by editing the appropriate line in your `login.cl` file.

After you enter your terminal type, you will see the following output before getting your regular prompt:

```
A new LOGIN.CL file has been created in the current ...
You may wish to review and edit this file to change ...
```

The `login.cl` file is the *startup file* used by the IRAF command language (CL). It is similar to the `LOGIN.COM` file used by VMS or the `.login` file used by Unix. Whenever IRAF starts, it looks at the `login.cl` file. You can edit this file to customize your IRAF environment. In fact, you should look at it to make sure that everything in it is correct. In particular, there is a line starting with `set home =` that tells IRAF where to find your IRAF home directory. You should verify that this statement does, in fact, point to your IRAF directory. If you will be working with standard IRAF format images you should also insert a line saying `set imdir = "HDR$"`. The `imdir` setting is ignored when working with GEIS format images.

The `uparm` directory will contain your own copies of IRAF task parameters. This directory allows you to customize your IRAF environment by setting certain parameter values as defaults. Once you set up IRAF, you should rarely need to do it again, expect when updated version of IRAF are installed.

A.1.2 Starting and Stopping an IRAF Session

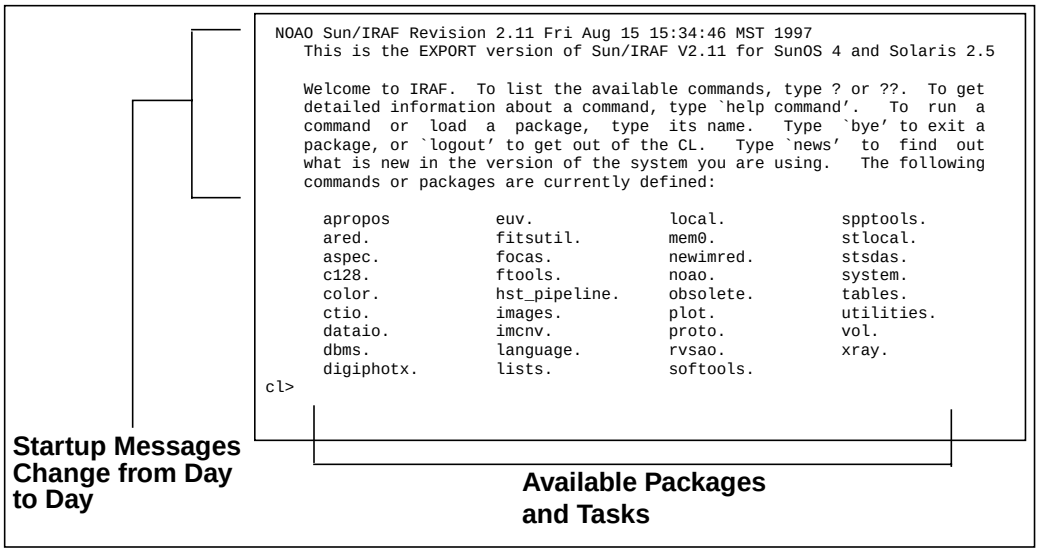
To start an IRAF session:

1. Move to your IRAF home directory.
2. Type `cl`.

1. Users at STScI should consult the *STScI Site Guide for IRAF and STSDAS*.

IRAF starts by displaying several lines of introductory text and then puts a prompt at the bottom of the screen. Figure A.1 is a sample IRAF startup screen.

Figure A.1: IRAF Startup Screen



To quit an IRAF session:

1. Type `logout`.

A.2 IRAF Basics

This section describes basic IRAF techniques such as:

- Loading packages (below).
- Running tasks and commands.
- Getting online help.
- Viewing and setting parameters (page A-8).
- Setting and using environment variables (page A-10).
- File management
- Troubleshooting

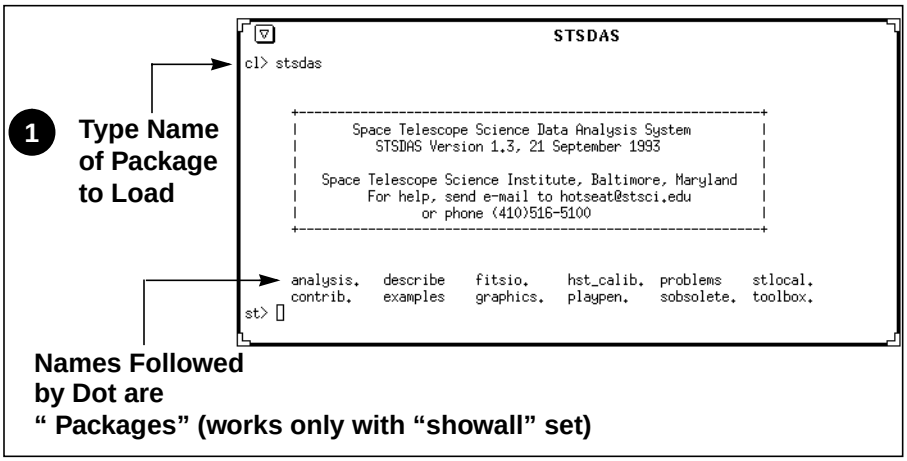
A.2.1 Loading Packages

In IRAF jargon, an application is called a *task* and logically related tasks are grouped together in a *package*. Before you can use a task, you must load the package containing that task. To load a package, type the name of the package.

The prompt will then change to the first two letters of the package name, and the screen will display the names of all the newly available tasks and subpackages. Even though the prompt has changed, previously loaded packages remain loaded, and all their tasks remain available.

Note that the standard way to specify a path through the IRAF package hierarchy to a task in a particular subpackage is to separate the package names with periods (e.g., **stsdas.hst_calib.foc.focgeom.newgeom**).

Figure A.2: Loading Packages



Some helpful commands for managing packages are:

- `?` - Lists tasks in the most recently-loaded package.
- `??` - Lists all tasks loaded, regardless of package.
- `package` - Lists names of all loaded packages.
- `bye` - Exits the current package.

A.2.2 Running Tasks

This section explains how to run tasks, background tasks, and system-level commands, and how to use piping and redirection.

Running a Task

The simplest way to run a task is to type its name or any unambiguous abbreviation of it. The task will then prompt you for the values of any required *parameters*, such as the names of input files. Alternatively, you can specify the values for the required *parameters* on the command line when you run the task. For example, if you want the task `imheader` to print header information on the file `myfile.hhh`, you can type

```
st> imhead myfile.hhh
```

IRAF does not require you to type the complete command name—only enough of it to make it unique. For example, **dir** is sufficient for **directory**.

Escaping System-Level Commands

To run an operating system-level command (i.e., Unix or VMS commands) from within the IRAF CL, precede the command with an exclamation point (!). This procedure is called *escaping* the command. For example:

```
st> !system_command
```

Piping and Redirection

You can run tasks in sequence if you desire, with the output of one task being used as the input for another. This procedure, called *piping*, and is done by separating commands with a vertical bar (|), using the following syntax:

```
st> task1 filename | task2
```

For example, if a particular task prints a large volume of textual output to the screen, you will often want to pipe it to `page`, which allows you to read the output one page at a time:

```
st> task1 filename | page
```

You can also redirect output from any task or command to a file by using the greater-than symbol (>) as follows:

```
st> command > outputfile
```

Background Tasks

To run a task as a background job, freeing your workstation window for other work, add an ampersand (&) to the end of the command line, like this:

```
st> taskname &
```

A.2.3 Getting Help

This section describes:

- How to use IRAF's on-line help facility.
- How to find a task that does what you want (page A-7).

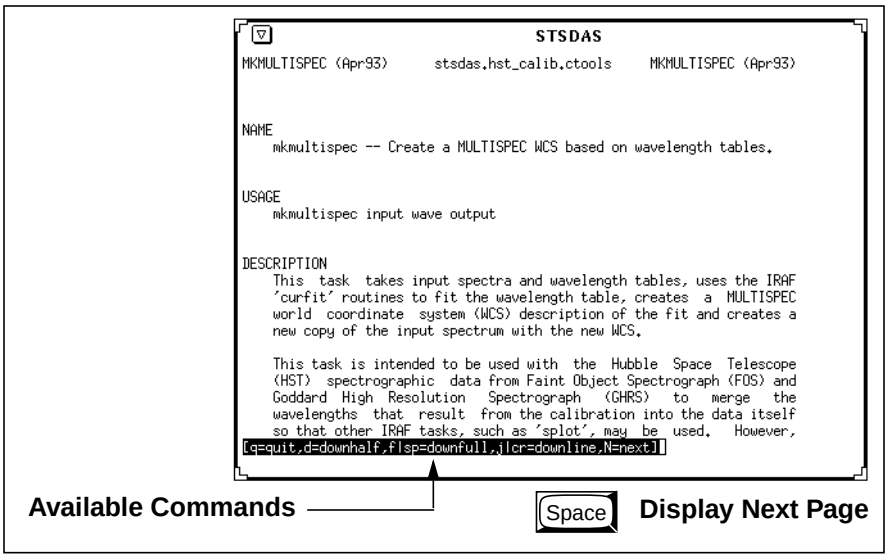
On-Line Help

You can get on-line help with any IRAF task or package by using the **help** command,[2] which takes as an argument the task or package name about which you want help. Wildcards are supported. For example, to display the on-line help for the STSDAS **mkmultispec** task, you would type:

```
fi> help mkmultispec
```

2. There is an optional *paging* front-end for help called **phelp**. For more information, type `help phelp` from within IRAF.

Figure A.3: Displaying On-line Help



Two STSDAS tasks that display only certain sections of the help file are also available:

- **examples** - Displays only the examples for a task.
- **describe** - Displays only the description of the task.

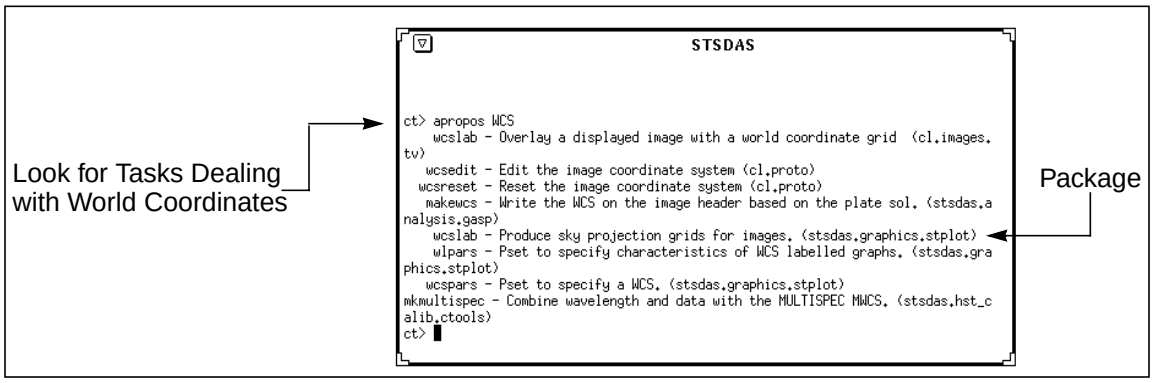
Typing `help` *package* will produce one-line descriptions of each task in the package.

Finding Tasks

There are several ways to find a task that does what you need:

- Use `help` *package* to search through the IRAF/STSDAS package structure.
- Use the **apropos** task as shown in Figure A.4 to search the online help database. This task looks through a list of IRAF and STSDAS package menus to find tasks that match a specified keyword. Note that the name of the package containing the task is shown in parentheses.
- Ask more experienced user, who can usually point you in the right direction.

Figure A.4: The **apropos** task Using apropos



A.2.4 Setting Parameters

Parameters specify the input information for IRAF tasks. They can be the names of input or output files, particular pixel numbers, keyword settings, or many other types of information that control the behavior of the task.

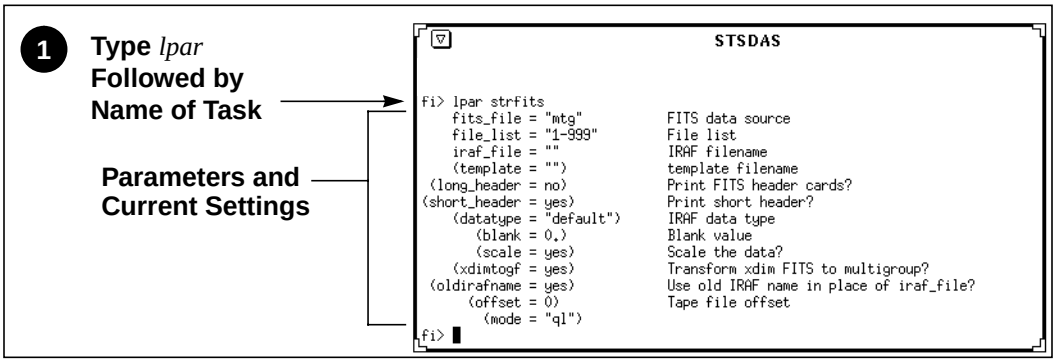
The two most useful commands for handling parameters are:

- **lparam** to display the current parameter settings (often abbreviated **lpar**).
- **eparam** to edit parameters (often abbreviated **epar**).

Viewing Parameters with lparam

The **lpar** command lists the current parameter settings for a given task (Figure A.5).

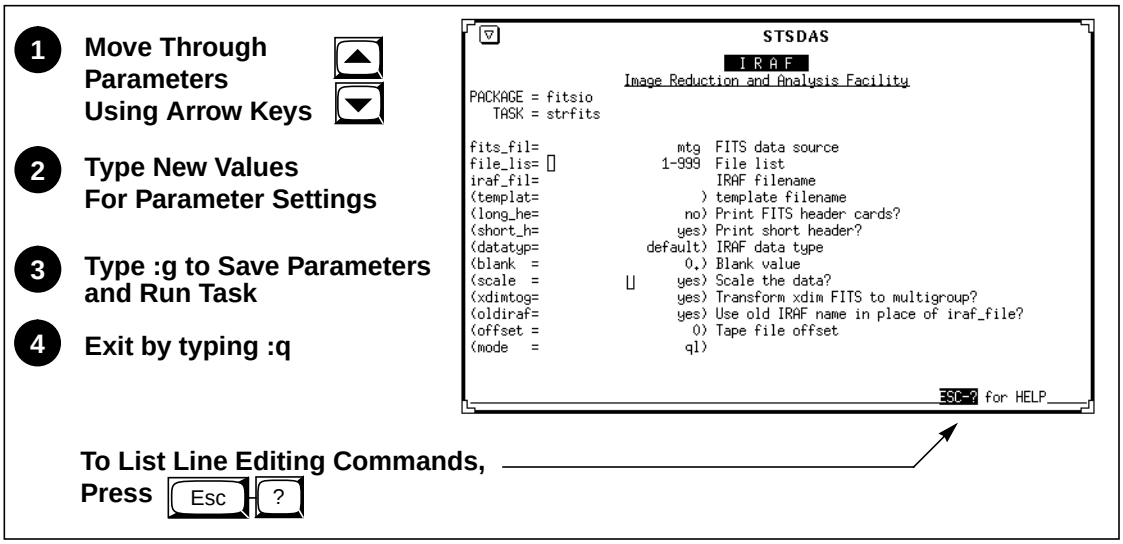
Figure A.5: Displaying Parameter Settings with lpar



Setting parameters with eparam

The **epar** command is an interactive parameter set editor. It displays all of the parameters and their current settings on the screen. You can move around the screen using the arrow keys (also called *cursor* keys) and type new settings for any parameters you wish to change. Figure A.6 shows a sample of the **epar** editor at work (invoked by typing `epar strfits`).

Figure A.6: Editing Parameters with epar



Parameter Data Types—What to Specify

Parameters are either *required* or *hidden*, and each parameter expects information of a certain *type*. Usually, the first parameter is required, and very often it expects a file name. Parameters are described in the online help for each task [include reference to help]. Hidden parameters, shown in parentheses in the online help and the **lpar** and **epar** listings, need not be specified at each execution because their default values frequently suffice.

Wise IRAF users will check the values of hidden parameters, as they often govern important aspects of a task's behavior.

If you specify the wrong type of information for a parameter, **epar** will usually display an error message saying something like "Parameter Value is Out of Range." The message is displayed when you move to another parameter or if you press Return. Table A.1 lists the different parameter types.

Table A.1: Parameter Data Types

Type	Description
`File Name`	Full name of the file. Wild card characters (* and ?) are often allowed. Some tasks allow you to use special features when specifying file names, including "@" lists, IRAF networking syntax, and image section or group syntax. (See "File Management" below).
`Integer`	Whole number. Often the task will specify minimum or maximum values (see the help pages).
`Real`	Floating point numbers, can be expressed in exponential notation. Often will have minimum and maximum values.
`Boolean`	Logical "yes" or "no" values.
`String`	Any characters. Sometimes file names are specified as string.
`Pset`	Parameter set.

Restoring Parameter Default Values

Occasionally, IRAF (or you) will get confused by your parameter values. To alleviate this confusion, you can restore the default parameters with the **unlearn** command. You can use **unlearn** on either a task or on an entire package.

The **unlearn** command generally will restore the parameters to reasonable values, a big help if you are no longer sure which parameter values you have changed in a complicated task.

A.2.5 Setting Environment Variables

IRAF uses *environment variables* to define which devices are used for certain operations. For example, your terminal type, default printer, and the disk and directory used for storing images are all defined through environment variables. Environment variables are set using the **set** command and are displayed using the **show** command. Table A.2 lists some of the environment variables that you might want to customize.

Table A.2: Environment Variables

Variable	Description	Example of Setting
`printer`	Default printer for text	`set printer = lp2`
`terminal`	Terminal type	`set term = xterm`
`stdplot`	Default printer for all graphics output	`set stdplot = ps2`
`stdimage`	Default terminal display setting for image output (most users will want this set to either imt512 or imt800)	`set stdimage = imt800`
`stdgraph`	Default graphics device	`set stdgraph = xterm`
`clobber`	Allow or prevent overwriting of files	`set clobber = yes`
`imtype`	Default image type for output images. “imh” is original IRAF format, “hhh” is STSDAS GEIS format.	`set imtype = “hhh”`

If you are working with GEIS files, you should set `imtype` to “`hhh`”. If you are working with STIS and NICMOS data in FITS files, you can set `imtype` to “`fits`”

You can set your environment variables automatically each time you login to IRAF by adding the appropriate commands to your `login.cl` file. Use your favorite text editor to specify each variable on its own line. The **show** command with no arguments prints the names and current values of all environment variables.

A.2.6 File Management

This section describes:

- File formats commonly used with STSDAS and IRAF.
- Specification of file names.
- Navigation through directories.

File Formats

IRAF recognizes a number of different file structures. Among them are the standard HST file formats known as GEIS and FITS (see Chapter 2), both of which differ from the original IRAF format (OIF). GEIS is closer to OIF, in that two files are *always* used together as a pair:

- A *header file*, which consists of descriptive information. IRAF header files are identified by the suffix .imh. GEIS header files are in ASCII text format and are identified by the suffix .hhh or another suffix ending in "h", such as .c0h or .q1h.
- A *binary data file*,[3] consisting of pixel information. IRAF data file names end with a .pix suffix. STSDAS data files end with an suffix of .hhd or another suffix that ends with "d", such as .c0d or .q0d.

STSDAS always expects both component files of a GEIS image to be kept together in the same directory. A single FITS file contains both the header information and the data.

When working with IRAF or STSDAS images, you need only specify the header file name—the tasks will automatically use the binary data file when necessary.

File Specification

Most tasks in IRAF and STSDAS operate on files and expect you to specify a file name for one or more parameters. Several types of special syntax can be used with certain tasks when specifying file names. These syntax features include:

- **Wild card characters**, often called *templates*, which are used to specify multiple files using pattern matching techniques. The wild cards are:
  - * Matches any number of characters, e.g.: z*.c0h
  - ? Matches any single character, e.g.: z01x23x.c?h

When using wildcards with image-processing tasks, be sure to exclude the binary pixel files by ending your file name specification with an "h", for example: y*.??h

- **List files**, often called *@-files*, which are ASCII file that contain lists of file names, one per line. If your task supports the list file feature, you would type the name of your list file, preceded by the "@" character. For example: @files.txt
- **Image section** specification. Tasks that work with image data will often let you specify that you want to work on only a small area of the image rather than the entire image. To extract a particular image section, specify each axis range in square brackets, for example: image.hhh[10:200,20:200]

3. The binary data file format is host-dependent and may require translation before it can be moved to a computer using a different architecture.

- **IRAF networking** specification. IRAF is capable of reading and writing files to and from remote systems on a network. This feature is often used with tasks in the **fitsio** and **convfile** packages, or with image display tasks. The *STSDAS Users Guide* and the online help (type `help networking`) describe how to enable this feature. To specify that you want to use the IRAF networking feature, type the remote host name followed by an exclamation point (!), followed by the file or device name. For example: `ra!mta`.

Directory Navigation

To navigate through directories, you can use the following commands:

- **path** or **pwd** - Lists the current working directory.
- **cd** *directory* - Move to the named directory.

A.2.7 Troubleshooting

There are a couple of easy things you can do to make sure that you don't have a simple memory or parameter conflict—common causes of problems.

- Look at the parameter settings and make sure that you have specified reasonable values for every parameter.
- When you run an IRAF task for the first time in a session, IRAF stores the executable file in its *process cache*. If IRAF appears not to be running your tasks properly, you may need to use the **flprcache** command to clear the process cache. To do this type: `flpr` Sometimes you will need to execute this command twice in succession.
- Occasionally, you may need to logout of the CL, restart IRAF, and try your command again.

If you still have a problem, contact the STScI Help Desk at `help@stsci.edu`

A.3 Getting IRAF and STSDAS

Both IRAF and STSDAS are provided free of charge to the astronomical community. You must have IRAF to run STSDAS. Detailed information about installing and retrieving STSDAS is found in the *STSDAS Site Manager's Installation Guide and Reference*. If you have any problems getting and installing STSDAS, TABLES, or any other packages or data described in this handbook, please contact the Help Desk by sending e-mail to: `help@stsci.edu`.

A complete description of how to install the **synphot** data files is provided on page A-15.

A.3.1 Retrieving the IRAF and STSDAS Software

There are three ways to get the software:

- Use the World Wide Web.
- Use anonymous FTP.
- Request a tape.

World Wide Web

The STSDAS World Wide Web page:

`http://ra.stsci.edu/STSDAS.html`

provides links and instructions for downloading the appropriate files to your local system or to display the software directory, from which you can select the series of smaller files.

Anonymous FTP

- **IRAF**: `iraf.noao.edu` (140.252.1.1)
- **STSDAS**: `ftp.stsci.edu` (130.167.1.2)

There are two points to remember when using FTP to retrieve STSDAS:

- You must retrieve and install the TABLES package before STSDAS.
- You should retrieve the `README` file from the directory `/software/stsdas/v2.0` and read it to find out which files you should retrieve.

You must have IRAF installed on your system to install TABLES and STSDAS. When you retrieve STSDAS, you must also retrieve the TABLES package, and TABLES must be installed first.

Instructions for installing STSDAS are available in the `doc` subdirectory of the directory where you find STSDAS. The complete instructions for installing STSDAS, TABLES, and all of the supporting software and reference files (including instrument reference files and the **synphot** dataset) are found in the *STSDAS Site Manager's Installation Guide and Reference*.

Requesting Tapes

You can ask to have the software shipped to you on magnetic tape in a variety of formats. To do so, you will need to contact the Help Desk by sending e-mail to `help@stsci.edu`. The Help Desk staff will send you an ASCII text version of the STSDAS Software Request Form, which you can then complete and return via e-mail. The software can also be registered and requested using on-line forms available through World Wide Web at the following URL:

`http://ra.stsci.edu/RegistForm.html`

When you request the STSDAS software, you can also ask for the appropriate version of IRAF, which will be requested for you— simply check the appropriate

box on the form under “Do You Already Have IRAF Installed?” If you prefer to request the IRAF software independent of STSDAS, you can do so by sending e-mail to: `iraf@iraf.noao.edu`

A.3.2 Getting the Synphot Database

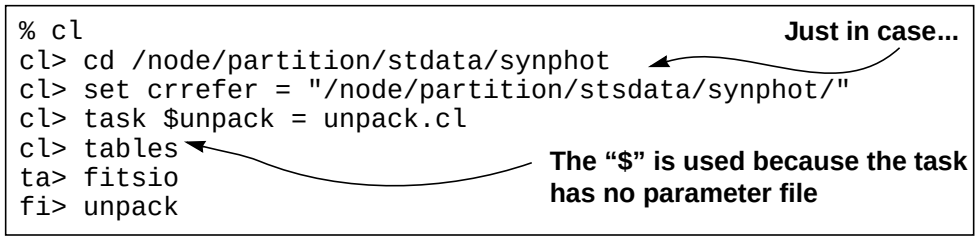
This manual sometimes refers to the **synphot** dataset, which must be available in order to run tasks in the STSDAS **synphot** package. These data files are not included with the STSDAS software and must be retrieved independently. To do this, you need to retrieve a series of compressed tar files from the STScI FTP site (ftp.stsci.edu) in the directory `software/stsdas/refdata/synphot`. After uncompressing and extracting the tar files (see below), you need to unpack the FITS files as described below.

The synthetic photometry data are read in similar way as the instrument datasets, using the script `unpack.cl` provided in the top directory. This script is run within IRAF to convert data from FITS format into the format used by the **synphot** task. This script assumes you have the logical `crrefer` set up in your `extern.pkg` file (which is in the directory `$iraf/unix/hlib` (Unix) or `$iraf/vms/hlib` (VMS)) or have it set up in your session. You do this by placing the command below in `extern.pkg` or by typing it on the command line:

```
set crrefer = "/node/partition/stdata/synphot/"
```

Figure A.7 shows how to convert the files.

Figure A.7: Unpacking Synthetic Photometry Files



Note that all three **synphot** files must be unloaded for the script to complete successfully.

A.3.3 Extracting the synphot Unix Tar Files

If you retrieved the **synphot** database as compressed tar files, you will need to copy them to an appropriate subdirectory and then expand and unpack the files. The tar and compress utilities that do this are are commonly available on most Unix systems, but are not standard in the VMS environment. The examples shown below reflect Unix usage. If you are on a VMS system, you should consult with

your systems support staff regarding the availability and usage of these commands. To process the files on a Unix system:

1. Get the compressed tar file that you want, as described in previous sections.
2. Make an appropriate subdirectory using the `mkdir` command.
3. Pipe the compressed tar file through the `uncompress` and `tar` files to expand and unpack the file.

The following example shows how to do this. The example assumes that you are putting the files in a subdirectory under `/usr/iraf/stdata` (note that the name of your file here is assumed to be `XXX.tar.Z`).

```
% pwd
/usr/iraf/stdata
% mkdir XXX
% mv XXX.tar.Z XXX/
% cd XXX
% cat XXX.tar.Z | uncompress | tar -xf -
```