SLIME User's Guide and Reference Manual

Chris Flatters
National Radio Astronomy Observatory
Array Operations Center
P.O. Box 0
Socorro, NM 87801

March 14, 1996

Contents

List of Figures

Preface

SLIME is an interactive model-fitting program that runs in the AIPS environment. The *SLIME User's Guide and Reference Manual* shows how **SLIME** may be used to construct an approximate model of a brightness distribution and how to use **SLIME** to adjust the model to best fit the data. It also contains a reference section and instructions for obtaining and installing **SLIME**.

Audience

This document is written for astronomers who wish to use **SLIME** to analyze VLBI data in AIPS. It assumes that the reader is already familiar with the AIPS system and with the OSF/Motif graphical user interface.

Applicability

This is Version 1.0 of this document. It applies to **SLIME** version 1.0 which is available for the 15JAN96 and 15OCT96 releases of AIPS.

Purpose

The purpose of this manual is to explain how to use the **SLIME** to create and optimize model brightness distributions.

Document Usage

This document is divided into two main sections and has two appendices.

- Part 1 is the User's Guide. This gives an overview of **SLIME** and provides a tutorial that explores the main features of the program. Potential users should read this section in its entirity.

- Part 2 is the Reference Manual. This provides details of the program that are not covered in the User's Guide.

- Appendix A gives instructions for obtaining and installing **SLIME**. This is intended for AIPS managers who must install **SLIME**.
- Appendix B describes some common problems that may arise while running **SLIME** and explains how to rectify them.

Related Documents

Consult the following documents for additional information about AIPS and OSF/Motif.

- The *AIPS Cookbook* explains how to use AIPS and outlines some typical data reduction procedures.
- The *OSF/Motif User's Guide* explains how to work with the OSF/Motif graphical user interface.

Typographic and Keying Conventions

This document uses the following typographic conventions.

Bold	**Bold** words or characters represent system elements that you must use literally, such as menu commands and the names of programs.
Italic	*Italic* words or characters represent variable values that you must supply.
⟨⟩	Angle brackets enclose the name of a key on the keyboard.
`Typewriter`	A `typewriter` font is used to represent text displayed in a terminal emulator.

Keyboard Conventions

Keyboard layouts vary from manufacturer to manufacturer and even within a single manufacturers product line (compare, for example, type 4 and type 5 keyboards from Sun). This makes it difficult to describe actions that are correct for every possible keyboard. This document follows the convention established by the OSF/Motif document set in describing keys according to a model keyboard that has an ideal set of keys.

In addition to the standard letter, number and character keys, the OSF/Motif keyboard has the following special keys.

- The special printing keys ⟨/⟩, ⟨\⟩ and ⟨!⟩.
- The standard modifier keys ⟨**Ctrl**⟩, ⟨**Alt**⟩ and ⟨**Shift**⟩.

- The ten function keys $\langle$**F1**$\rangle$ through $\langle$**F10**$\rangle$.
- The four arrow keys $\langle\downarrow\rangle$, $\langle\leftarrow\rangle$, $\langle\rightarrow\rangle$ and $\langle\uparrow\rangle$.
- $\langle$**Backspace**$\rangle$.
- $\langle$**Cancel**$\rangle$
- $\langle$**Delete**$\rangle$
- $\langle$**End**$\rangle$
- $\langle$**Escape**$\rangle$
- $\langle$**Help**$\rangle$
- $\langle$**Home**$\rangle$, $\langle$**Begin**$\rangle$ or both.
- $\langle$**Insert**$\rangle$
- $\langle$**Menu**$\rangle$
- $\langle$**PageDown**$\rangle$
- $\langle$**PageUp**$\rangle$
- $\langle$**Return**$\rangle$
- $\langle$**Space**$\rangle$
- $\langle$**Tab**$\rangle$

These keys are supplemented by a number of optional keys which, although useful, are either not necessary or correspond to combinations of the required keys.

- $\langle$**CapsLock**$\rangle$
- $\langle$**Copy**$\rangle$
- $\langle$**Cut**$\rangle$
- $\langle$**Enter**$\rangle$
- $\langle$**ModeSwitch**$\rangle$
- $\langle$**NumLock**$\rangle$
- $\langle$**PageLeft**$\rangle$
- $\langle$**PageRight**$\rangle$
- $\langle$**Paste**$\rangle$
- $\langle$**ScrollLock**$\rangle$

- ⟨**Select**⟩
- ⟨**Undo**⟩

If a key on the model keyboard is not available on your keyboard then there will be some combination of keys that will be equivalent to that key. A mapping between a set of actual keys and a key on the model keyboard is called a *key binding*. Some of the more important key bindings are listed here.

- If your keyboard does not have a ⟨**Cancel**⟩ key, you can use ⟨**Escape**⟩ in its place.
- If your keyboard does not have a ⟨**Help**⟩ key, you can use ⟨**F1**⟩ instead.
- If your keyboard does not have a ⟨**Menu**⟩ key, you can use ⟨**Shift**⟩⟨**F10**⟩ in its place.
- If ⟨**F10**⟩ does not exist, ⟨**Shift**⟩⟨**Menu** can be used in its place.
- If ⟨**Home**⟩ or ⟨**Begin**⟩ does not exist then ⟨**Alt**⟩⟨←⟩ can be used in its place.
- If your keyboard does not have a ⟨**End**⟩ key, you can use ⟨**Alt**⟩⟨→⟩ instead.
- Wherever ⟨**Select**⟩x and ⟨**Space**⟩ can be used for a selection action, ⟨**Ctrl**⟩⟨**Space**⟩ can be used as well.
- Wherever ⟨**Enter**⟩ and ⟨**Return**⟩ can be used for activation, ⟨**Ctrl**⟩⟨**Return**⟩ can be used as well.

Mouse Conventions

In the same way as a model keyboard is used to describe the program independent of various keyboards a virtual button convention is used to describe the behaviour of the program independently of the number of buttons on the mouse. This manual assumes a three-button mouse with the buttons being defined from left to right as **BSelect**, **BTransfer** and **BMenu**. By convention, **BSelect** is used to select objects, **BTransfer** is used for drag-and-drop operations and **BMenu** is used to bring up pop-up menus. Perhaps the most common variation in the assignment of mouse buttons is the reversal of the order for left-handed users.

I shall often refer to mouse operations without specifying a particular button in this guide. Whenever I do this you can safely assume that you should use **BSelect**.

Part I

Users Guide

Chapter 1

Introduction

SLIME is an interactive model-fitting program for AIPS. It allows you to create a model brightness distribution from a number of individual components each of which can be described by a simple mathematical function with a small number of parameters. Once you have created a model brightness distribution, you can use **SLIME** to automatically adjust the model parameters to obtain the best fit to the data.

Unlike other AIPS tasks, **SLIME** makes full use of the X Window System environment. The graphical user interface allows you to adjust model parameters by dragging elements in a graphical representation of the model and to see how your changes affect the model visibilities as you make them. These features are intended to help you construct a model that is in fairly good agreement with the data. This is important because most model-fitting procedures will only give good results if they are given a starting model that is a fair approximation of the model which best fits the data.

You can consider **SLIME** as a set of tools that you can use to assist you in constructing a model that fits the data. Each tool is used for a specific task but communicates with the others so that all of the tools present a consistent view of the model and the data to which it is to be fitted.

The principle tool is the model editor. This tool provides a graphical representation of the model. You can change the parameters of the model by dragging the graphical representations of the model components with the mouse or by typing parameter values into forms. The model editor also allows you to create new components or delete existing ones as well as allowing you to save the model to an AIPS clean-component table or to load the contents of an existing clean-component table as a new model. It is also the central point of control for the program: you start new tools or shut the program down from the model editor.

Baseline tools display measured visibilities together with ideal visibilities calculated from the model for designated baselines. The model visibilities are updated whenever you make a change to the model so that you can monitor whether your changes improve the fit to the data or not. You may create as many baseline tools as you want.

The least-squares fitting tool will take your model and adjust it to minimize the χ^2 statistic. The model editor display and the model visibilities in the baseline tools will be updated after every iteration of the fitting process so that you can see what is happening to the model and interrupt the procedure if it appears to be converging on an implausible set of model parameters.

Future releases of **SLIME** will include other tools for displaying closure phase and, perhaps, for using stochastic algorithms such as simulated annealing for fitting model parameters to the data. Stochastic algorithms do not generally require good starting models but are much slower than non-linear function-minimization techniques such as that used in the least-squares fitting tool. The increased time-cost of a stochastic fitting algorithm might be worth-while if you are finding it difficult to construct a good starting model.

The use of the existing tools will be illustrated in the next chapter which will walk you through a typical **SLIME** session.

Chapter 2

A Guided Tour of SLIME

This chapter will introduce the main features of the **SLIME** program by guiding you through the process of creating a model and fitting it to a data set. You will get the most from this tutorial if you follow along using your own data. **SLIME** is intended to be used to analyze observations of compact VLBI sources so I recommend that you use some observations of a calibrator from a VLBI experiment for this purpose.

If you encounter any problems while running **SLIME**, refer to Appendix B which contains a number of trouble-shooting hints.

2.1 Preparing Your Data for SLIME

SLIME expects its input data to be calibrated and to have weights that properly reflect the thermal noise. If you have not already done so, apply any *a priori* amplitude calibrations and fringe-fit the data. Run **FIXWT** on the data to make sure that the weights are realistic.

Although it is not essential to do so, it is a good idea to average you data in time before running **SLIME**. This will both reduce the amount of memory that **SLIME** needs and improve its responsiveness. **SLIME** will eventually be capable of time-averaging its own data but the current version does not support this. You will, therefore, have to run **UVAVG** to average your data.

When you have calibrated and averaged your data you are ready to start **SLIME**.

2.2 Starting SLIME

SLIME is, in essence, just another AIPS task and, just like any other AIPS task, has a set of input adverbs. If you review these inputs (**INPUTS SLIME**), you will see that they allow you to specify an input file, some data selection criteria and (for multisource inputs files) a set of calibration options. These inputs specify the data the **SLIME** will fit a model to. Note that **SLIME** can only work with one source at a time and that the name of this source should be given as the value of **SOURCES(1)**. The other elements of the **SOURCES** array will be ignored. The current version of **SLIME** is overly pedantic about the source selection and will require you to give a value to **SOURCES(1)** when the input file is a single-source data file although this is obviously pointless. If you are using a single-source file the name given in **SOURCES(1)** is not actually used but **SLIME** will insist that it is not left blank; this quirk will be removed in future versions.

If your input data is taken from a multisource file, you should, of course, make sure that all of the necessary calibrations will be applied.

When you are satisfied with your inputs, you can start **SLIME** in the normal way (textbfGO SLIME). You should see the usual AIPS start-up message

```
SLIME1: Task SLIME  (release of 15OCT96) begins
AIPS 1: Resumes
```

as **SLIME** launches itself and restarts the AIPS command interpreter.

If you did not make any mistakes in setting up the inputs, the main window of the **SLIME** graphical user interface will appear followed by a dialogue that shows that **SLIME** is loading the data specified by the AIPS inputs as shown in Figure 2.1. Don't worry if it takes a few seconds for these to appear: a short delay is normal.

You should see the icon on the left side of the dialogue rotating like the sweep-hand of a watch as the data is loaded. It will turn quite fast if you are only loading a single channel but may be rather slow and jerky if you are averaging several channels and IFs together. The dialogue will also show the number of data points loaded so far and the approximate amount of memory that they take up. **SLIME** has no hard limits on the amount of data it can hold but is limited by the amount of virtual memory available on your machine. Nevertheless, I would advise you to abort the data loading if the amount of data goes much over a megabyte. You can do this by clicking on the **Abort** button: **SLIME** will respond by ceasing to load data and dismissing the dialogue. You can continue to work with the data that was loaded up to this point but it will be more sensible in most cases to shut down **SLIME** and change the data selection parameters or average the data some more.

If you do not abort the data loading, **SLIME** will automatically dismiss the dialogue when it has loaded all of the data. If you get fed up with looking at the dialogue before then you can get rid of it by clicking on the **OK** button: **SLIME** will continue to load data and inform you when all of it has been loaded.

2.3 Using the Model Editing Tool

The main window is the model editing tool (Figure 2.2). The main part of the tool is taken up by a scale diagram of the current model. The different types of components are represented by different glyphs: points are small red crosses, optically-thin spheres are green circles with magenta edges and elliptical

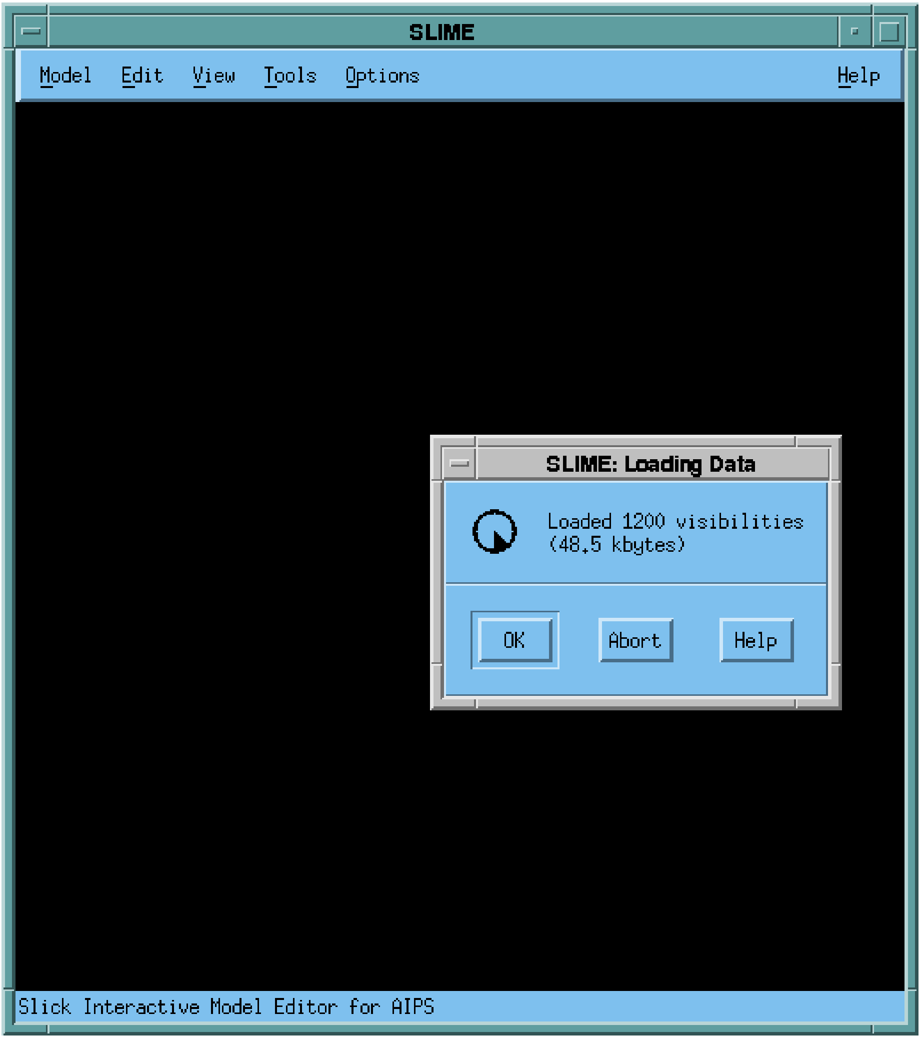

Figure 2.1: The SLIME main window with the loading progess meter.

Gaussian brightness distributions are blue ellipses with yellow edges and yellow lines marking the axes of the ellipse. This area will initially be empty apart from a reference grid of white lines on a black background. You will see a menu bar above the diagram and a message area below it.

Unless you have set the application resources to override the program defaults (see Chapter 3) the model editor will use a scale of 1 milliarcsecond to 1 centimeter and the lines in the reference grid will be spaced 1 milliarcsecond apart. You can change both the scale and the grid spacing using commands from the **View** menu. This menu also contains a toggle button that controls the display of the reference grid.

You will create the model by using commands from the **Edit** menu and by manipulating the glyphs representing the model components in the editing area.

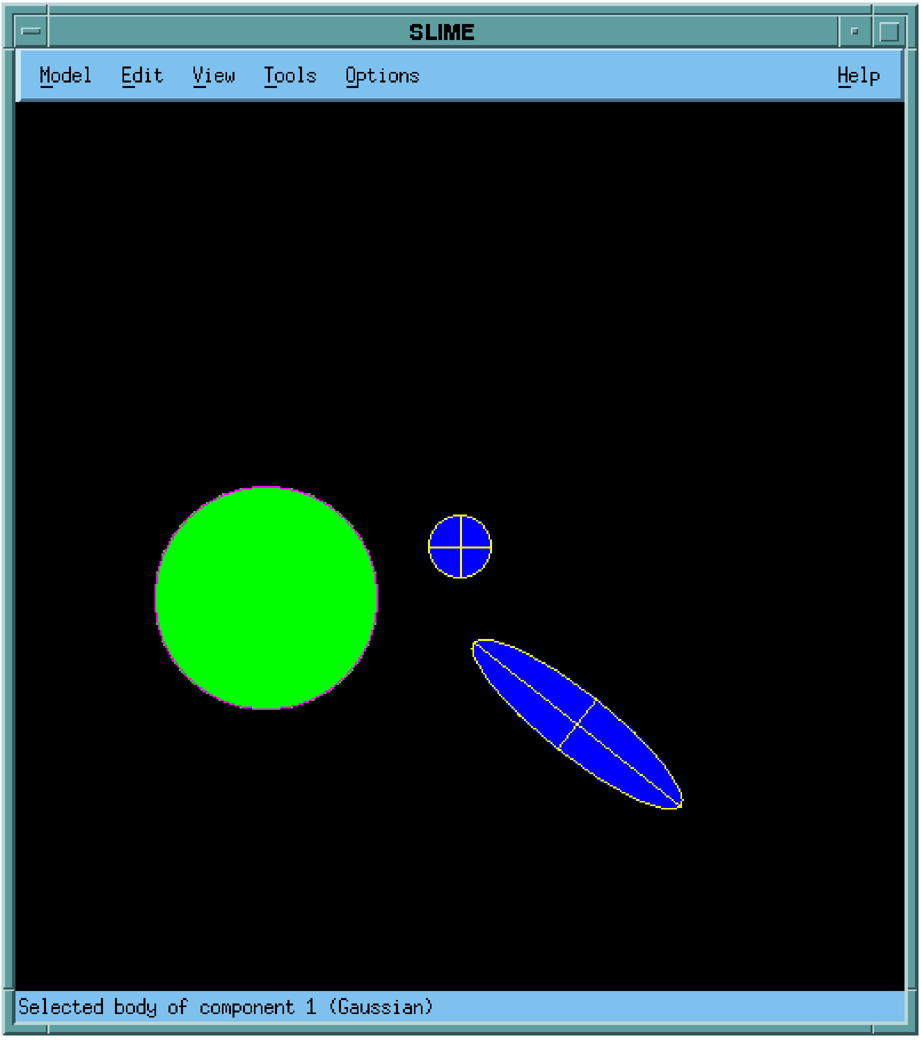

Figure 2.2: The Model Editing Tool.

2.3.1 Creating New Components

The first step is to create some model components.

Move the pointer over the black background of the editing area and press the **BMenu** button. Select the **Add Component** command from this menu (all of the other commands should be "greyed out" to show that they are not available at this time. You will get the **Add Component** dialogue as shown in Figure 2.3.

All dialogues in **SLIME** follow the conventional OSF/Motif pattern. There is a work area where you enter the information necessary for the dialogue to do

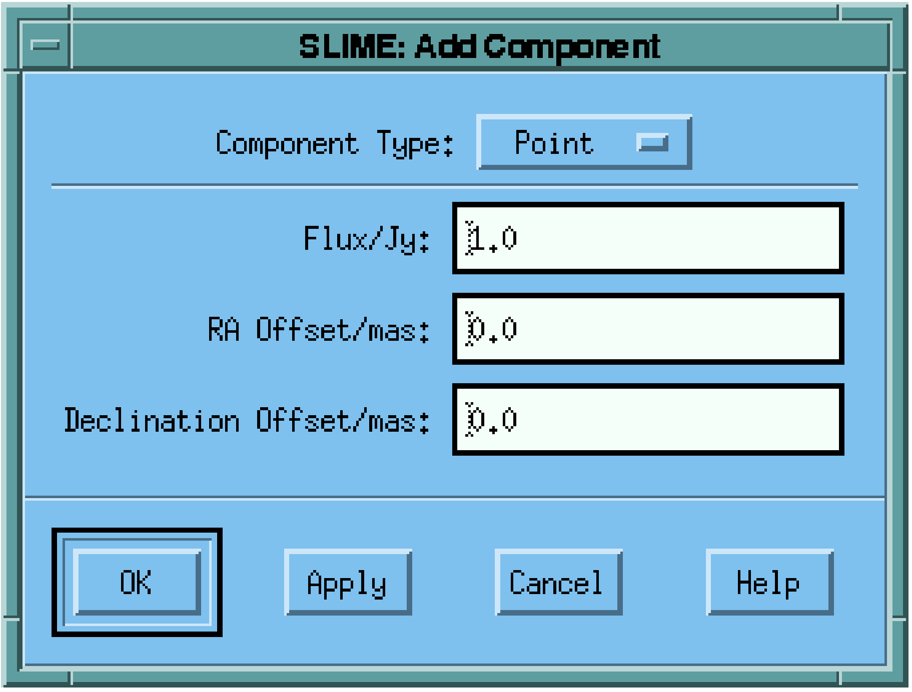

Figure 2.3: The Add Component Dialogue.

its task and an action area that contains a number of buttons. You can click on either the **OK** button or the **Apply** button to make the dialogue complete its task. These buttons differ in that the dialogue will be dismissed when you click on the **OK** button but will stay up if you click on the **Apply** button. In some cases it might be confusing to retain the dialogue after taking the action it specifies: these dialogues will not have an **Apply** button. If you change your mind about performing the action controlled by the dialogue you can dismiss the dialogue without taking any other action by clicking on the **Cancel** button. You can also click on the **Help** button to request help on using the dialogue.

The work area of the **Add Component** dialogue contains an option menu that is used to select the type of the component that you can add and a set of type-in fields that specify the parameters of the model. You may create point components, which have negligable extent, optically thin spheres and elliptical, Gaussian brightness distributions. Note the fields change as you change the component type since some parameters are only applicable to certain types of component. The full set of parameters is listed below.

Flux The flux density of the component in Jy.

RA Offset The RA offset of the peak of the component from the phase centre in millarcseconds, increasing to the right (West).

Declination Offset The declination offset of the peak of the component from the phase centre in milliarcseconds, increasing towards the top (North).

Diameter The diameter of the component in milliarcseconds (spheres only).

Primary Axis The full-width to half-maximum of the component in milliarcseconds along its primary axis (Gaussian components only). The two axes of an elliptical Gaussian are arbitrarily labelled as the primary and secondary axis so that they may be distinguished without reference to their relative lengths.

Secondary Axis The full-width to half-maximum of the component in milliarcseconds along its primary axis (Gaussian components only).

Position Angle The position angle of the primary axis in degrees (Gaussian components only).

The **Add Component** dialogue will create a new component with the specified parameters every time you click the **OK** or **Apply** buttons. Use this dialogue to create a point component, a sphere and a Gaussian component in that order, all with zero offsets from the centre of the field.

You will see each component appear in the centre of the editing area. Each successive component will appear on top of the existing components, probably obscuring them. The next two sections will show you how to move them around.

2.3.2 Changing Component Parameters with the Mouse

Move the cursor to a point near the centre of the Gaussian component (within the blue disc) and press and hold down **BSelect**. The component will change colour to indicate that it has been selected for editing. Move the cursor while keeping the button pressed. The component will move with the cursor. When you have moved the component to a place where it does not overlap the spherical component. Do the same with the sphere. You should now be able to see all three components. Dragging the components with the mouse is the easiest way to move them around within the model.

You can also use the mouse to change the sizes and shapes of components. Press **BSelect** while pointing at the edge of the spherical component and move the mouse. You should see the sphere change size so that its edge always lies under the cursor. Release the button to finish modifying the component. If you have trouble hitting the edge of the component, try changing the model editor's scale to make the component larger.

Now move the pointer to one end of one of the lines marking the axes of the elliptical, Gaussian component. Press **BSelect** again and move the mouse. This time you change the size and orientation of the axis you have chosen. The other axis will, of course, remain perpendicular to it. As before, if you have trouble hitting the end of the axis, try changing the model editor's scale.

These methods for changing component parameters are convenient but are not particularly precise. Nor do they allow you to change the flux density of a component (which would require a three-dimensional representation of the model). The next section will show you how to get around these limitations.

2.3.3 Using the Modify Component Dialogue

Click on the point component to select it then press the **BMenu** button to display the pop-up menu and select the **Modify Component** command. This will cause the **Modify Component** dialogue to appear. This is almost identical to the **Add Component** dialogue shown in Figure 2.3 except that the option menu is missing since you can not change the type of an existing component. Note that the fields contain the current values of the component's parameters.

Change the RA and declination offsets and then click on **Apply**. You will see the point component move in the editing area as the new offsets take effect. Now drag the point component to a new location with the mouse. Note that the values in the fields of the **Modify Component Dialogue** are updated to reflect the new position after you release the mouse button.

Now click on the other components in turn to select them. You will see the **Modify Component** dialogue change to reflect the parameters of the selected component. If you click on the background of the model-editing area all of the components will be deselected and the work area of the **Modify Component** dialogue will be greyed out to show that the fields are invalid.

2.3.4 Deleting Components and Undoing Changes

Select any of the three components by clicking on it. Now bring up the pop-up menu as before and select the **Delete Component** command. The selected component will be deleted and will disappear from the model editing area.

Bring up the pop-up menu again and this time select the **Undo** command. This will restore the component that you just deleted. You can almost always use the **Undo** command to reverse a change you made to the model. On the rare occasions that **Undo** is not available the **Undo** command will be made insensitive and will be greyed out on the menu.

2.4 Examining Your Data

Now that you have created a model, it is time to see how well it matches your data.

Pull down the **Tools** menu and select the **Baseline Tool** command. This will cause the **New Baseline Tool** dialogue (Figure 2.4) to appear. This is a standard OSF/Motif selection dialogue that presents you with a list of baselines to choose from. Every baseline that was allowed by the combination of the **ANTENNAS** and **BASELINE** adverbs that you used when you started **SLIME** is shown in a scrolling list.

Select a baseline by clicking on it and click on the **Apply** button to create a baseline tool for the selected baseline. If you get an error message that tells

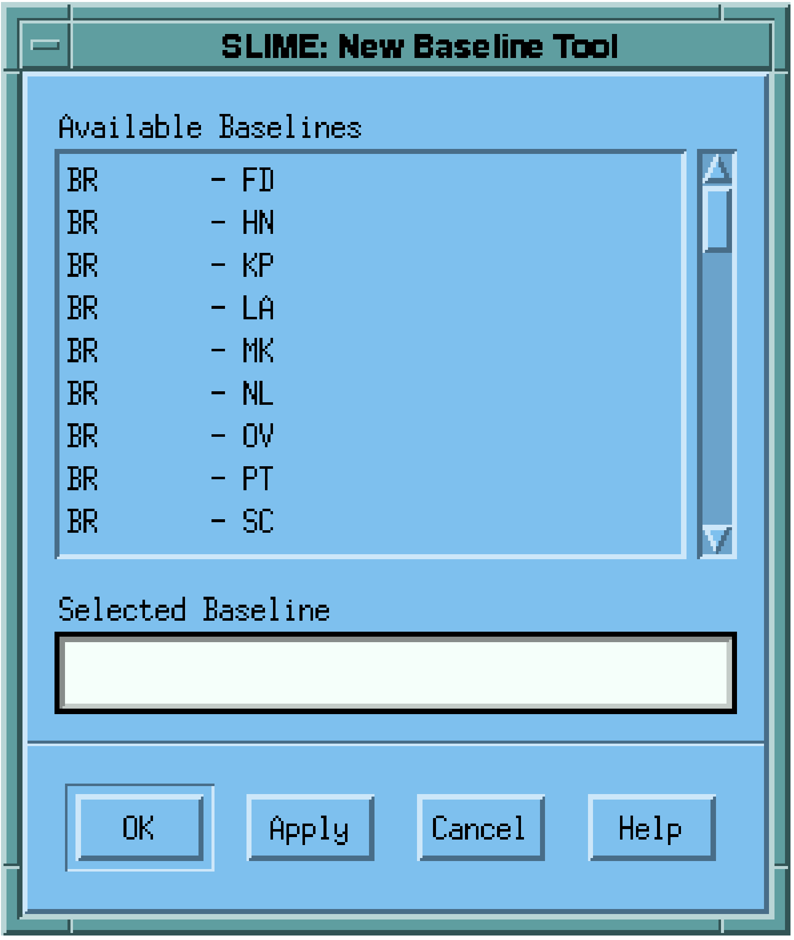

Figure 2.4: The New Baseline Tool dialogue.

you that there were no data for the selected baseline, try again until you find a baseline that has data.

The baseline tool displays the data for the selected baseline, as shown in Figure 2.5. Amplitude and phase data are plotted in green and the visibilities expected from the current model are plotted in red (Jodrell Bank *alumni* will recognize the colour scheme used in the OLAF **PLOT** program). The error bars are calculated from the data weights, which is one reason why it is important to run **FIXWT** on your data before using **SLIME**.

If you can not see the model visibilities, you probably need to change the range of displayed amplitudes. Pull down the **View** menu belonging to the baseline tool and turn off the **Autoscale Plots** toggle. Then pull down the **View** menu and select the **Amplitude Range** command. You will get a dialogue with fields for the maximum and minimum amplitude to be plotted (the ini-

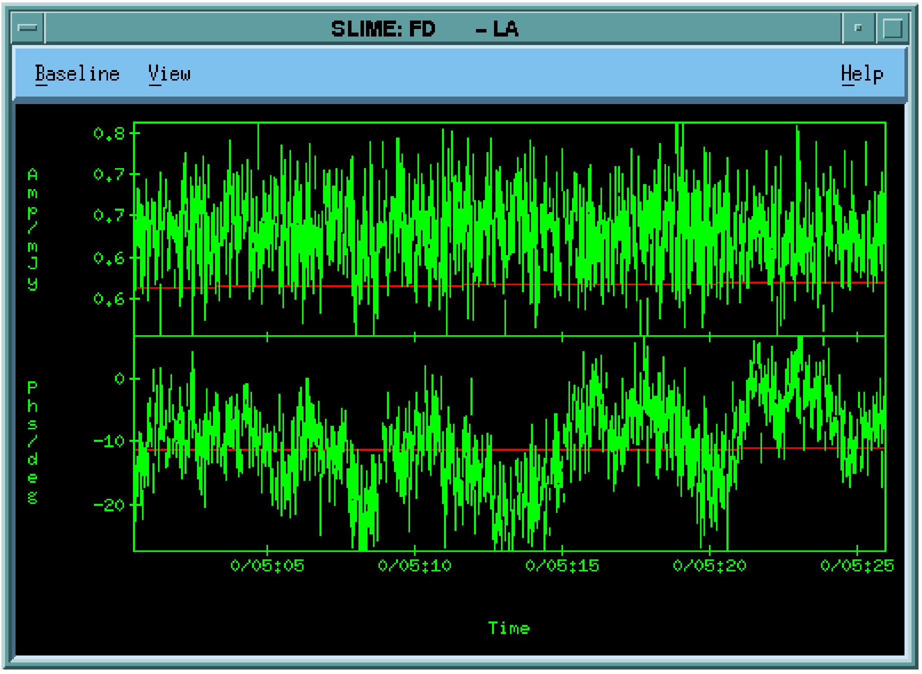

Figure 2.5: A Baseline Tool.

tial values reflect the current range): type the values you want into these fields and click on the **Apply** button. The plot will be rescaled to match the new amplitude range. The procedure for setting the phase range is almost identical.

You can open as many baseline tools as you want. Go back to the **New Baseline Tool** and create a few more, making sure that you pick baselines with a good range of u, v spacings. You will notice that your screen gets rather cluttered with more than 2 or 3 baseline tools open. You can get rid of the ones you don't want by pulling down the **Baseline** menu and selecting the **Close** command or you can iconize them.

Now go back to the model editing tool and make some changes to the model. Note that the model visibilities plotted in the baseline tools will change whenever you make a change. You may also notice that there is a slight delay as the model visibilities are updated. This delay will increase as you open more baseline tools. Individual baselines are plotted in separate tools to discourage you from opening so many baselines that **SLIME** can't keep up. If you keep the number of baseline tools small to avoid cluttering up your display, you will ensure that **SLIME** doesn't slow down to an intolerable level.

You should now simplify your model by deleting all of the components except for one sphere. Play around with it a little until the model visibilities are in rough agreement with the data. You don't have to worry about getting them very close since you will use **SLIME** to search for the set of model parameters that give the best fit to the data in the next section.

2.5 Using the Least-Squares Tool

Go back to the model editing tool, pull down the **Tools** menu and select the **Least-Squares Tool** command. This will start the least-squares tool shown in Figure 2.6. Move this to a place on your screen where you can see the least-squares tool, the model editing tool and at least one baseline tool.

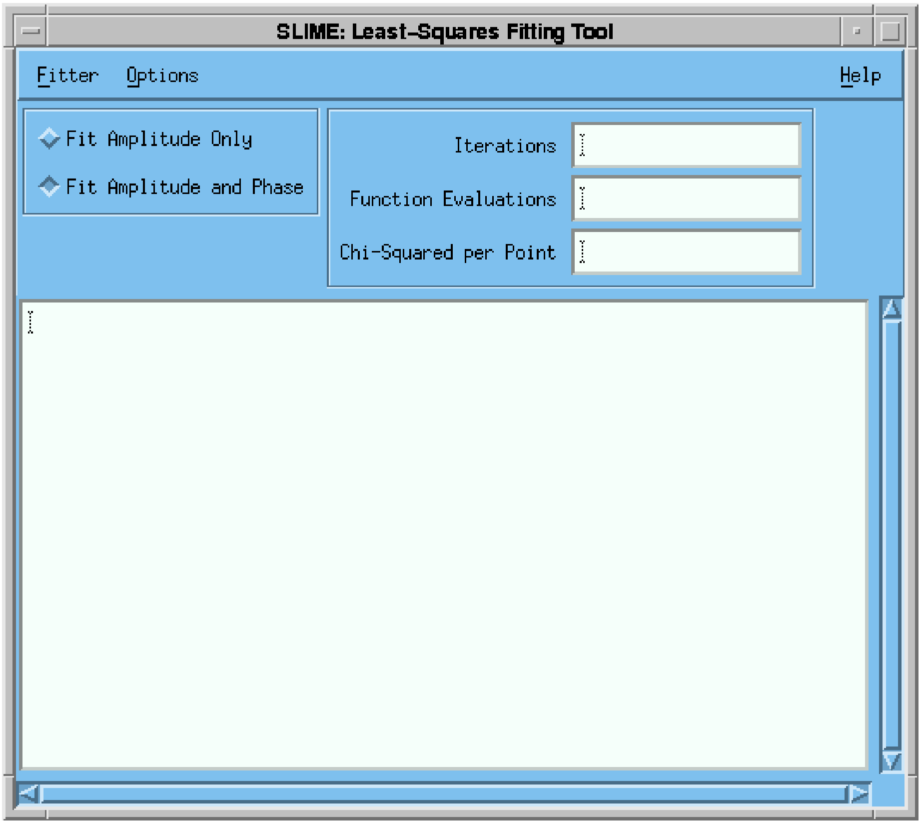

Figure 2.6: The Least-Squares Tool.

All you need to do now is to pull down the **Fitter** menu and click on the **Fit Data** command. You will see a working dialogue that tells you that the model is being optimized and values will appear in the fields to the upper right of the tool. The model shown in the model editor and the model visibilities will be updated every time the least-squares tool completes an iteration. Some of the changes may be too small for you to see them, however.

Each iteration may take several minutes. This time will increase with the number of data points and the number of model parameters. The application will be comatose durinf each iteration.

If all goes well, you will eventually see a display like that in Figure 2.7. This shows that the least-squares fit has converged on a good solution. You will see the final parameters of the component parameters together with their estimated standard errors and the final value of the χ^2 statistic divided by the number of datapoints. If the χ^2 value per point is about one, you have an exceptionally good fit with the data deviating from the model visibilities by about one standard error on average. Realistically, a χ^2 value around 10 or less indicates a pretty good fit.

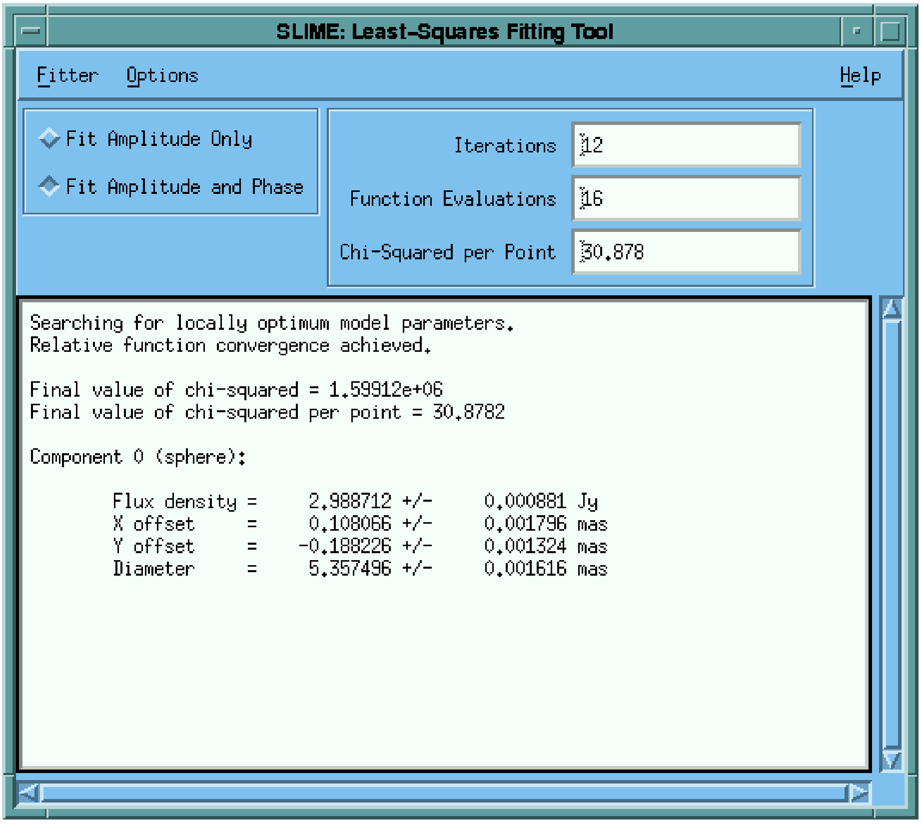

Figure 2.7: The Results of a Good Least-Squares Fit.

It is unlikely that the fitting algorithm will fail with such a simpel model. If it does, consult the reference manual for an explanation of the failure.

If you don't like the model that the least-squares tool gives you, you can use the **Undo** command in the model editing tool to reset the model back to the way it was before you attempted the fit.

2.6 Saving Your Model

When you have a model that you like, you will probably want to save it. You can save models in AIPS clean-component tables.

Go back the the model editing tool, pull down the **Model** menu and select the **Save As** command. You will see a dialogue similar to that shown in Figure 2.8.

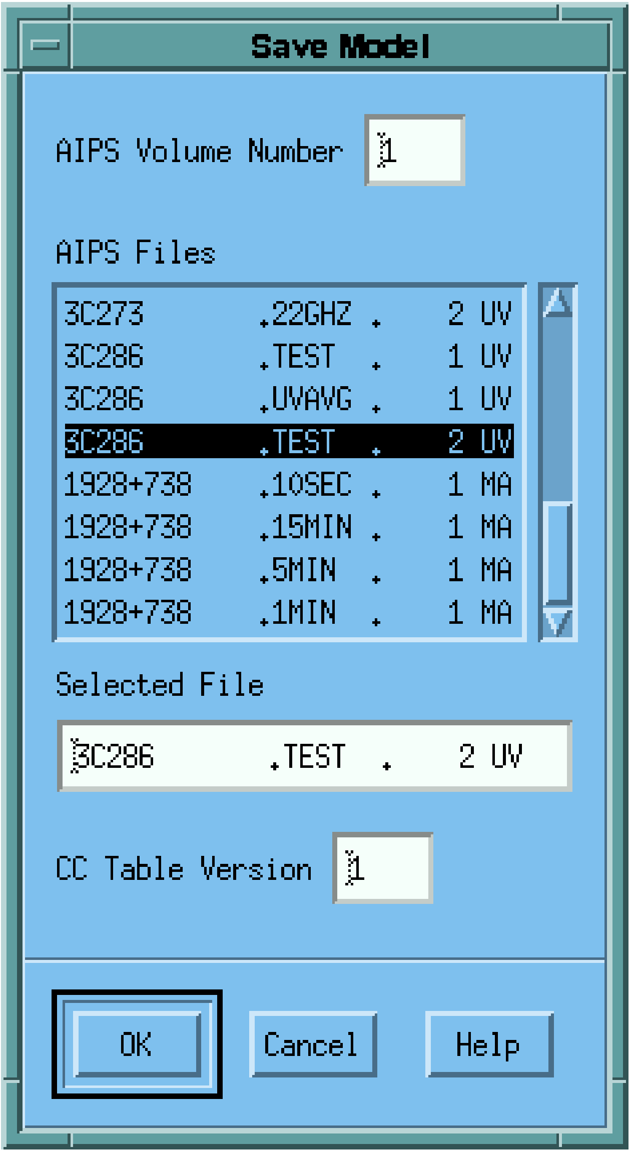

Figure 2.8: The Save Model dialogue.

The main part of the working area shows an AIPS catalogue listing, similar to that you would get from the **PCAT** verb, in a scrolling list. You can select the file you want to attach the model to by clicking on it in the list; your data file should be already selected. If you want to choose a file on another disk, type the disk number into the **Volume Field** and press the ⟨**Tab**⟩ key: the list now show the catalogue for the new disk.

When you have chosen the main file, type the version number for the clean-component file into the field at the bottom of the working area. This should already be set to a value one greater than the highest clean-component table version already attached to the file (watch it change as you click on different files in the list) so you can usually leave it as it is.

Finally, click on the **OK** button to save the new model.

2.7 Finishing Up

The final step is, of course to close **SLIME** down. To do this, go to the model editing tool, pull down the **Model** menu and select the **Exit** command. If you exit from **SLIME** without saving your model, you will be given one last chance to save it.

Part II

Reference Section

Chapter 3

Application Resources

SLIME has a number of application resources that can be used to set program options when **SLIME** is started. The class name of the program is **Slime**. The application resources are listed in Table 3.1 and their default values are given in Table 3.2.

Name	*Class*	*Description*	*Type*
aspmm	Aspmm	The scale used for the model editor in arc seconds per millimeter.	float
gridSpacing	GridSpacing	The spacing between lines in the reference grid in arc seconds.	float
showGrid	ShowGrid	Should the reference grid be shown?	boolean
psTrace	PsTrace	Echo Display PostScript commands? This is only useful for debugging and will slow the program to a crawl.	boolean
printCommand	PrintCommand	The command used to print a file with $printer standing for the name of the printer and $file for the name of the file to be printed.	string
useNetscape	UseNetscape	Use Netscape as the help viewer? The alternative is to use Mosaic.	boolean
helpPrefix	HelpPrefix	A prefix to be prepended onto help tags to form a full URL. This tells **SLIME** where the help files are located.	string

Table 3.1: Application Resources.

Resource	*Default Value*
aspmm	0.0001
gridSpacing	0.001
showGrid	True
psTrace	False
printCommand	lp -d $printer $file
useNetscape	True
helpPrefix	http://info.aoc.nrao.edu/c̃flatter/slime-manual/

Table 3.2: Default Values for the Application Resources.

Chapter 4

The On-Line Help System

SLIME uses **Netscape** or **Mosaic** to display on-line help. The help text is taken from a hypertext version of this manual. All **SLIME** installations are capable of using **Netscape** but, since **SLIME** needs to be linked against a special library from NCSA that is not included in the **SLIME** distribution (for copyright reasons) and that is not as portable as it should be, your version of **SLIME** may not support **Mosaic**.

I recommend that you use **Netscape** in any case.

- If you already have a **Netscape** viewer running, **SLIME** will use this to display on-line help rather than starting a new one. **Mosaic** is less flexible about being controlled by other programs and **SLIME** will always have to start its own instance of **Mosaic**.
- If **Netscape** has been iconized, it will open automatically when **SLIME** loads a new help page. **Mosaic** will stay iconized.

You may change your help viewer using the **Help Configuration** command from the **Options** menu belonging to the model-editing tool. You may also change the location from which the help-text will be read. Help text may be held in local disk files or on a remote http server.

Each **SLIME** tool has a **Help** menu with a number of commands.

Context-Sensitive Help This command initiates one of the two context-sensitive help systems available in **SLIME**. The cursor will change to a question pointer. Click on the component on which you want help. The cursor will then revert to its normal shape. You can abort this operation by clicking outside any of the **SLIME** windows. You can also invoke this command by pressing the ⟨**Help**⟩ key while holding down the ⟨**Shift**⟩ key. This command will sometimes provide more specific help than the alternative method for obtaining context-sensitive help described below.

Overview This command requests general information about the application window from which you invoked it. For example if you issue this command using the **Help** menu in a baseline tool, you will get information about baseline tools.

Index This command requests an index for all of the help information available for **SLIME**. It will actually cause the table of contents to be displayed rather than a full index.

Keyboard This command requests help on special keys used by **SLIME**.

Tutorial This command requests a hypertext version of the tutorial given in Chapter 2.

Using Help This command requests help on using help (this chapter).

Product Information This command is used to display the version number and copyright information for the version of **SLIME** that you are using. This information will be displayed in an information dialogue rather than the hypertext viewer.

You may also obtain context-sensitive help by clicking on the **Help** button in a dialogue or by pressing the ⟨**Help**⟩ key. If you press the ⟨**Help**⟩ key over a user-interface component that does not respond to the keyboard you will get help for the first component that contains the one for which you requested help and that responds to keyboard events. The much clumsier method for obtaining context sensitive help from the menu does not have this problem but you may still find it less complicated to press the ⟨**Help**⟩ key and use the hypertext links to navigate to the help page that you want.

Chapter 5

Special Keys

It is not possible to use **SLIME** using only the keyboard. It is, however, possible to navigate menus and dialogues without using the mouse.

If a window containg a menu bar has the keyboard focus (the window manager will usually highlight a window with keyboad focus in some way), you can activate the menu bar by pressing the ⟨**Menu**⟩ key. If your keyboard does not have a menu key you should be able to use ⟨**F10**⟩ instead. The first item in the menu bar will then be highlighted: the CDE version of Motif highlights menu items by making them appear recessed while other versions of Motif highlight items by making them appear raised. You can use the left and right arrow keys to choose a menu item and pull down the corresponding menu by pressing ⟨**Return**⟩, ⟨**Space**⟩ or the down-arrow key. You can also pull down a menu without highlighting its title by pressing its **mnemonic** which is underlined in the menu. Once you have pulled down a menu you can navigate between the items in it using the up and down arrow keys. You can activate a selected item by pressing ⟨**Return**⟩ or ⟨**Space**⟩ or activate an item without first selecting it by pressing its mnemonic.

Some menu commands can be invoked without taking the trouble to navigate through the menu structure using special combinations of keys called **keyboard accelerators**. The only keyboard accelerator used by **SLIME** is the ⟨**Shift**⟩⟨**Help**⟩ combination used to invoke context-sensitive help (see Chapter 4).

Controls are grouped into control groups. You may switch between control groups by pressing ⟨**Tab**⟩, which will move the focus from left to right and top to bottom, or by pressing ⟨**Shift**⟩⟨**Tab**⟩, which will traverse the control groups in the reverse order. You can navigate within a group using the arrow keys and activate a selected component using the ⟨**Space**⟩ key. The ⟨**Return**⟩ key will activate the selected default button in a dialogue (usually **OK**) regardless of which control has been selected.

Chapter 6

The Model Editing Tool

The model editing tool is the central point of control for the **SLIME** program. You will use menu commands from this tool to create new tools and to shut down the program.

The main part of the model editing tool is an editing area that provides a graphical representation of the current model. Model components are displayed as coloured glyphs against a black background.

A message area is located beneath the editing area. This is used to display informational messages and prompts.

6.1 Model Editing Tool Menus

The model editing tool has a number of menus, each of which contains a number of functionally related commands and toggle switches. The menus are as follows.

Model Commands for saving, loading and printing models and for shutting down the **SLIME** program.

Edit Commands for editing the source model.

View Controls governing the way in which the model is shown in the editing area.

Tools Commands for creating new tools.

Options Commands for changing option settings.

Help Commands for obtaining on-line help on various subjects.

These menus are described in greater detail in the following sections.

6.1.1 The Model Menu

The **Model** menu holds commands for saving, loading and printing models and for shutting down the **SLIME** program. The menu items are as follows.

New Removes all model components and starts a new model.

Open Reads a model from a clean-component table.

Save Saves the model to a clean-component table.

Save As Saves the model to a designated clean component table.

Print Prints the model.

Exit Terminates the program.

The items are described in greater detail in the following sections.

The New Command

Use the **New** command to remove all of the components from the current model and start a new one. This command can not be undone so you will be asked to confirm that you want to do this if you have made any unsaved changes to the model.

The Open Command

Use the **Open** command to load a model from a clean-component table. You will be presented with a dialogue that allows you to browse the AIPS catalogue and open the table that you wish to use.

The current model will be cleared before loading the model from the clean-component table. This is an irreversible action so you will be asked to confirm that you wish to load a new model if you have made changes to the model that have not yet been changed.

The Save Command

Use the **Save** command to save the model in the default clean-component table, overwriting its previous contents. The default table is the one that you specified in the last **Save As** or **Open** command. If you have not yet used the **Save As** or **Open** command then you will be presented with a dialogue that allows you to choose the clean-component table to save the model in.

The Save As Command

Use the **Save As** command to save the current model to a clean-component table. You will be presented with a dialogue that allows you to choose the destination clean-component table.

The Print Command

Use the **Print** command to print a summary of the current model or to store a summary of the current model in a text file. The **Print** command will produce a table listing the parameters of the components in the current model. You will be prompted to choose between printing the table directly and saving the table to a file.

The Exit Command

Use the **Exit** command to shut **SLIME** down. If you have made changes to your model that have not yet been saved, you will be given an opportunity to save them before **SLIME** shuts down completely.

You may also use the window manager to close **SLIME** down. This will have the same effect as the **Exit** command.

In either case, once you have requested the **SLIME** be shut down, there is no way you can countermand the request.

6.1.2 The Edit Menu

The **Edit** menu contains commands for editing the current model. These commands tend to be used frequently, so this menu is a tear-off menu. If you click on the perforations at the top of the menu, the menu will be torn away from the menu bar and will become a free-floating window so that its commands are immediately available at all times.

The **Edit** menu is also available as a pop-up menu within the editing area.

The following commands are available from the **edit** menu.

Undo Undoes the last editing command.

Add Component Adds new components to the model.

Modify Component Changes the parameters of the selected component.

Delete Component Deletes the selected component from the model.

These commands are described in more detail in the following sections.

The Undo Command

Use the **Undo** command to reverse the last change made to the model.

A few editing operations are irreversible: if the last editing operation was one of these or if no edits have been made then the **Undo** command will not be available. In such a case the **Undo** menu item will be insensitive (indicated by stippling).

The Add Component Command

Use the **Add Component** command to add one or more components to the model. This command will invoke a dialogue that you will use to enter the types and parameters of the components that you wish to create.

The Modify Component Command

Use the **Modify Component** command to modify the parameters of the selected component. This command will invoke a dialogue that you will use to enter the new parameter values. This dialogue can also be used to monitor the parameters of a selected component during direct manipulation or automatic model fitting.

This command will be made insensitive if there is no current selection.

The Delete Component Command

Use the **Delete Component** Command to delete the selected component.

This command will be made insensitive if there is no current selection.

6.1.3 The View Menu

The **View** menu contains controls governing the way in which the model is displayed in the editing area. It contains the following items.

Reference Grid Controls the display of the reference grid.

Grid Spacing Sets the spacing between lines in the reference grid.

Map Scale Sets the scale for the displayed model.

These items are described in greater detail in the following sections.

The Reference Grid Toggle

Switch the **Reference Grid** toggle on to display a reference grid in the background of the editing tool. Switch it off to remove the reference grid.

The Grid Spacing Command

Use the **Grid Spacing** command to set the spacing between lines in the reference grid. You will be prompted for the new spacing.

The Map Scale Command

Use the **Map Scale** command to change the scale used to plot the model in the editing area. You will be prompted for a new scale in milliarcseconds per cm.

6.1.4 The Tools Menu

The **Tools** menu contains commands for starting new tools to examine and analyze your data. It contains the following items.

Baseline Tool Starts a baseline tool to examine amplitude and phase data.

Least-Squares Tool Starts the least-squares tool which is used to optimize the fit between the model and the data.

These items are described in greater detail in the following sections.

The Baseline Tool Command

Use the **Baseline Tool** command to start a new baseline tool to examine real and model amplitude and phase data for a particular baseline. You will be prompted for the baseline to display.

You may create as many baseline tools as you like.

The Least-Squares Tool Command

Use the **Least-Squares Tool** command to open the least-squares tool, which is used to optimize the fit between the model and the data.

6.1.5 The Options Menu

The **Options** menu is used to set program options. It contains the following items.

Help Configuration Configures the on-line help system.

Printer Configuration Sets up the printer.

These items are described in greater detail in the following sections.

The Help Configuration Command

Use the **Help Configuration** command to choose the viewer that you will use to display on-line help and to set the location from which the help text will be obtained.

The Printer Configuration Command

Use the **Printer Configuration** command to specify the command that will be used to send files to the printer.

6.1.6 The Help Menu

The **Help** menu contains commands for obtaining on-line help on **SLIME**. It contains the following items.

Context-Sensitive Help Invokes context sensitive help.

Overview Provides general information about the model editing tool.

Index Provides a list of subjects on which help is available.

Keyboard Provides information about the programs use of special keys.

Tutorial Provides access to the tutorial.

Using Help Provides information about the on-line help system.

Product Information Displays the name and version of the application.

These items are described in more detail in the following sections.

The Context-Sensitive Help Command

Use the **Context-Sensitive Help** command to invoke context-sensitive help. The cursor will change to a 'query pointer'. Position this over the item on which you want help and press **BSelect**. Click **BSelect** outside the model editing tool to abort the operation.

Pressing the ⟨**Help**⟩ key while the pointer is over the item of interest provides a more direct means of accessing context-sensitive help.

The Overview Command

Use the **Overview** command to see general information on the model editing tool.

The Index Command

Use the **Index** command to see a list of help topics. Each entry in the list is a hyperlink to the corresponding help topic.

The Keyboard Command

Use the **Keyboard** command to call up information about special keys used by **SLIME**.

The Tutorial Command

Use the **Tutorial** command to call up the on-line tutorial.

The Using Help Command

Use the **Using Help** command to call up information about the on-line help system.

The Product Information Command

Use the **Product Information** command to display the name and version number of the program. These are displayed in an information dialogue rather than the hypertext viewer.

6.2 The Editing Area

The working area of the model editing tool is the editing area. This displays a scale diagram of the current model. The scale can be set using the **Map Scale** command from the **View** menu.

Point components (which have no angular extent) are represented as small red crosses which turn cyan when selected. You may drag point components by pressing **BSelect** when the pointer is inside the area containing the arms of the cross and moving the mouse while keeping the button down.

Optically thin spheres are represented by green circles with magenta borders with a diameter corresponding to the components diameter. The colours are interchanged when the component is selected. You may move a sphere by pressing **BSelect** with the pointer near the centre of the graphic and moving the mouse while keeping the button down. You can also change its diameter by pressing **BSelect** when the pointer is over the border of the graphic and moving the mouse while keeping the button down.

Elliptical, Gaussian components are represented by blue ellipses with yellow borders and crossed lines marking the axes of the ellipse. The lengths along the two axes correspond to the full-widths to half maxima of the component. The colours are interchanged when the component is selected. You may move a Gaussian component by pressing **BSelect** with the pointer near the centre of the component and moving the mouse while keeping the button down. You may also change the length and orientation of an axis of the ellipse by placing the pointer at one end of the axis, pressing **BSelect** and keeping it down while you move the mouse.

Any component may be selected by clicking on it. This marks the component for modification or deletion using commands from the **Edit** menu. No more than one component may be selected at any one time. Selecting a component deselects any component that was previously selected. Click on the background to deselect all components.

You may access a pop-up version of the **Edit** menu by pressing the **BMenu** button while the cursor is in the editing area.

A reference grid may be displayed in the background of the editing area to provide some guidance in positioning components. You can choose whether this grid is displayed using the **Reference Grid** toggle and set the spacing between the grid lines using the **Grid Spacing** command. Both the **Reference Grid** toggle and the **Grid Spacing** command are located on the **View** menu.

6.3 The Message Area

The message area located beneath the editing area is used to display low-priority messages. More important messages are displayed using dialogues which are more easily noticed than changes in the message area.

Typical messages appearing in this area are those that inform you of the completion of some action (such as loading data). This area will also display a prompt that reminds you of the actions to take when using the modal form of context-sensitive help from the **Help** menu.

6.4 Dialogues Associated with the Model Editing Tool

There are a number of dialogues associated with the model editing tool. In the main, they are used to enter information that **SLIME** needs in order to carry out your commands. These dialogues are described in the following sections.

6.4.1 The Confirm New Model Dialogue

The **Confirm New Model** dialogue will appear if you issue the **New** command from the **Model** menu after you have made some changes to the model since you last saved it. If you do not wish to keep these changes, click on **OK** to dispose of the current model and start a new one. This action can not be reversed with the **Undo** command.

If you do not wish to lose your changes, click on **Cancel** to return to editing your existing model. You may then choose to save the model to a clean-component table.

6.4.2 The Confirm Open Model Dialogue

The **Confirm Open Model** dialogue will appear if you issue the **Open** command from the **Model** menu after you have made some changes to the model since you last saved it. If you do not wish to keep these changes, click on **OK** to continue opening a clean-component table: you changes will be lost when you load the the model

If you do not wish to lose your changes, click on **Cancel** to return to editing your existing model. You may then choose to save the model to a clean-component table.

Parameter	*Constraints*
Flux	$0.0 < flux$
Diameter	$0.0 < diameter$
Primary Axis	$0.0 < axis$
Secondary Axis	$0.0 < axis$
Position Angle	$-90.0 \leq pa \leq +90.0$

Table 6.1: Constraints on the Parameters for a New Component.

6.4.3 The Error Dialogue

The **Error** dialogue will appear whenever the program detects a non-fatal error condition. The most frequent errors are due to entering invalid values into a dialogue.

The message in the error dialogue will inform you of the nature of the error and, when appropriate, suggest a corrective action.

Click on **OK** or **Cancel** to dismiss the dialogue.

6.4.4 The Confirm Overwrite Dialogue

The **Confirm Overwrite** dialogue will appear if you elect to save your model in a clean-component table that already exists. If you do this, the original contents of the table will be lost. If this is acceptable you can click on **Yes** to erase the current contents of the table and replace them with your current model. If you wish to keep the original contents of the table click on **No** to return to editing the model without saving it.

6.4.5 The Add Component Dialogue

The **Add Component** dialogue is used to add new components to the model. It will appear when you select the **Add Component** command from the edit menu.

Select the component type (**Point**, **Sphere** or **Gaussian**) using the option menu at the top of the dialogue and fill in the component parameters in the fields in the middle part of the dialogue. The fields all take floating-point quantities and will reject any character that can not be part of a floating-point number; it is still possible to type invalid floating-point (eg. '1.0.0') into the fields, however.

The flux density is given in Jy, offsets and sizes are given in milliarcseconds and position angles are given in degrees.

Click on **OK** or **Apply** to create a component. The values in the fields will be checked to see that they are valid floating-point numbers and that they meet the constraints given in Table 6.1. A new component will only be created if no errors are detected. If an error is detected, an error dialogue will be posted. If you clicked on **OK**, the dialogue will be dismissed when the component is created. If you clicked on **Apply** the dialogue will remain in place allowing you to create more components.

Parameter	*Constraints*
Flux	$0.0 < flux$
Diameter	$0.0 < diameter$
Primary Axis	$0.0 < axis$
Secondary Axis	$0.0 < axis$
Position Angle	$-90.0 \leq pa \leq +90.0$

Table 6.2: Constraints on the Parameters for a Modified Component.

If you wish to dismiss the dialogue without creating a component, click on the **Cancel** button.

6.4.6 The Modify Component Dialogue

The **Modify Component** dialogue is used to change the parameters of the selected component. It will appear when you select the **Modify Component** command from the edit menu.

Type the new parameter values into the fields in the working area of the dialogue. The fields all take floating-point quantities and will reject any character that can not be part of a floating-point number; it is still possible to type invalid floating-point (eg. '1.0.0') into the fields, however.

The flux density is given in Jy, offsets and sizes are given in milliarcseconds and position angles are given in degrees.

Click on **OK** or **Apply** to apply the changes. The values in the fields will be checked to see that they are valid floating-point numbers and that they meet the constraints given in Table 6.2. The changes will only be applied if no errors are detected. If an error is detected, an error dialogue will be posted. If you clicked on **OK**, the dialogue will be dismissed when the changes are applied. If you clicked on **Apply** the dialogue will remain in place.

If you wish to dismiss the dialogue without modifying a component, click on the **Cancel** button.

As long as the dialogue is visible, it will reflect any changes in the selected component. If none of the components in the model are selected the dialogue will become insensitive, indicated by a stippling of the labels in the dialogue.

6.4.7 The Save Changes Dialogue

The **Save Changes** dialogue will appear if you try to exit from **SLIME** while you have unsaved changes. Click on **Yes** to save the current model (**SLIME** will behave as if you issued a **Save** command) or click on **No** to discard the changes. You can not return to editing the model at this point.

6.4.8 The Open Model Dialogue

The **Open Model** dialogue allows you to choose a clean-component model to load into the editor.

Use the **AIPS Volume Number** field at the top of the dialogue to specify the AIPS disk number of the disk from which you wish to load the table. This field will only take numeric inputs. The **AIPS Files** list will be updated to show your catalogue for the selected disk when you move the keyboard focus from this field by pressing the ⟨**Tab**⟩ key or by clicking over another part of the dialogue.

If you enter a number outside the range of allowable AIPS volume numbers (1 to 16) an error dialogue will appear. If you enter the number of an AIPS disk that does not exist or to which you have not been granted access, the file list will be blank.

Select a file from the list by clicking on it. The file name will be highlighted in the list and copied to the **Selected File** field. You can also type the file name directly into the **Selected File** field but if you do the name must match the file's entry in the list exactly, including spaces and the two-character type code.

The **CC Table Version** field will be set to the highest version number of a clean-component table attatched to the selected file as soon as you select it. If there are no clean-component tables attatched to the file, this field will show zero. If you do not require the latest clean-component table, you can change the version number to that of the table that you want.

Click on the **OK** button to load the model. If you have specified a clean-component table that does not exist, you will see an error dialogue otherwise the current model will be deleted and a new model loaded from the clean-component table.

If you change your mind about loading a model, click on **Cancel** to return to editing your original model.

6.4.9 The Save Model Dialogue

The **Save Model** dialogue allows you to choose a clean-component table in which to save your model.

Use the **AIPS Volume Number** field at the top of the dialogue to specify the AIPS disk number of the disk to which you wish to save your model. This field will only take numeric inputs. The **AIPS Files** list will be updated to show your catalogue for the selected disk when you move the keyboard focus from this field by pressing the ⟨**Tab**⟩ key or by clicking over another part of the dialogue.

If you enter a number outside the range of allowable AIPS volume numbers (1 to 16) an error dialogue will appear. If you enter the number of an AIPS disk that does not exist or to which you have not been granted access, the file list will be blank.

Select a file from the list by clicking on it. The file name will be highlighted in the list and copied to the **Selected File** field. You can also type the file name directly into the **Selected File** field but if you do the name must match the file's entry in the list exactly, including spaces and the two-character type code.

The **CC Table Version** field will be set one higher than the highest version number of a clean-component table attatched to the selected file as soon as you select it. If there are no clean-component tables for the selected files, this field will be set to 1. If you wish to use a different table version number you can enter it here.

Click on the **OK** button to save the model. You will be asked to confirm the operation if it will overwrite an existing table.

If you change your mind about saving the model, click on **Cancel** to dismiss the dialogue.

6.4.10 The Grid Spacing Dialogue

Use the **Grid Spacing** dialogue to specify the interval between the line in the reference grid in the model editing area in milliarcseconds. Type the new value into the field and click on **OK** to have it take effect or click on **Cancel** to dismiss the dialogue without changing the grid spacing.

6.4.11 The Map Scale Dialogue

Use the **Map Scale** dialogue to specify the scale used in the model editing area in milliarcseconds per cm. Type the new value into the field and click on **OK** to have it take effect or click on **Cancel** to dismiss the dialogue without changing the scale.

Note that the scale will only be approximate since **SLIME** does not necessarily have access to the true size of your monitor.

6.4.12 The Loading Data Dialogue

The **Loading Data** dialogue appears automatically when the program is started and shows the amount of data loaded so far. The dialogue is updated every 100 data points.

Click on the **OK** button to dismiss the dialogue or the **Abort** button to stop loading data at the earliest possible opportunity. Any data read so far will be retained if the loading process is aborted.

6.4.13 The New Baseline Tool Dialogue

Use the **New Baseline Tool** dialogue to choose a baseline for which data will be displayed in a new baseline tool. Choose a baseline from the list and click on **OK** or **Apply** to create a baseline tool for the selected baseline. Baselines in the list are not guaranteed to have and data. If you choose a baseline with no data you will see an error dialogue informing you of the fact rather than a new tool. The dialogue will be dismissed if you click on **OK** but will be retained if you click on **Apply**.

You may also double-click on a baseline in the list which is equivalent to first selecting that item and then clicking on **OK**.

If you decide to dismiss the dialogue without creating a new baseline tool, click on the **Cancel** button.

6.4.14 The Print Model Dialogue

Use the **Print Model** dialogue to route a listing of the model components to a particular printer or to a text file.

Type the name of the destination printer into the **Printer** field or, if you want to store the listing in a file rather than printing it directly, make sure that the **Print to File Only** toggle is set and type the full pathname of the file to which it will be written in the **File** field.

Click on **OK** to print the listing or store it in the designated file or **Cancel** to dismiss the dialogue without producing a model listing. If there are no components in the model, no listing will be produced and you will be presented with an error dialogue.

6.4.15 The Help Settings Dialogue

Use the **Help Settings** dialogue to configure the viewer you are using for on-line help.

The radio buttons at the top of the dialogue allow you to choose either **Netscape** or **Mosaic** as your viewer. **Mosaic** may not be available as an on-line help viewer, in which case the **Mosaic** button will be insensitive.

Use the **URL Prefix** field to specify the area from which the help pages will be taken. This should include the '**file:**' specifier if they are installed locally or the '**http:**' specifier if they will be read remotely and should also include a trailing slash. The URL prefix will normally have been set correctly by the AIPS manager when he installed **SLIME** and there should rarely be any need to change this value.

Click on the **OK** button to make any changes take effect or click on **Cancel** to dismiss the dialogue.

6.4.16 The Printer Settings Dialogue

Use the **Printer Settings** dialogue to specify the command used to send a file to the printer. This command should be entered in the **Print Command** field with the string '**$file**' standing for the name of the file to be printed and '**$printer**' standing for the name of the printer.

Click on the **OK** button to make any changes take effect or click on **Cancel** to dismiss the dialogue.

6.4.17 The Product Information Dialogue

The **Product Information** shell displays the version number and copyright information for **SLIME**. Click on **OK** or **Cancel** to dismiss the dialogue.

Chapter 7

Baseline Tools

A baseline tool displays amplitude and, optionally, phase data for a single baseline. Actual data are plotted in green while model data are plotted in red. Model data are automatically updated whenever the model is changed in the model editing tool.

The real data may be plotted with error bars which represent the standard error of each measurement as indicated by the data weights assuming that $weight = 1/error^2$.

You may create as many baseline tools as you wish and each may be iconfied separately.

7.1 Baseline Tool Menus

Baseline tools have a number of menus.

Baseline Commands to change the displayed baseline and close the display.

View Options governing the way the data is displayed.

Help Access to on-line help.

These menus are discussed in greater detail in the following sections.

7.1.1 The Baseline Menu

The baseline menu hold two commands.

New Baseline Changes the baseline displayed in the baseline tool.

Close Closes the baseline tool.

These commands are described in greater detail below.

The New Baseline Command

Use the **New Baseline** command to change the baseline displayed in the baseline tool. You will be prompted for the new baseline.

The Close Command

Use the **Close** command to close the baseline tool. This removes it completely rather than iconifying it.

7.1.2 The View Menu

The **View** menu controls the appearence of the data plots in the baseline tool. It has the following items.

Display Phase Determines whether phases are plotted.

Display Errors Determines whether error bars are plotted.

Autoscale Plots Determines whether autoscaling is used.

Amplitude Range Sets the maximum and minimum amplitudes to plot.

Phase Range Sets the maximum and minimum phases to plot.

These items are described in more detail in the following sections.

The Display Phase Toggle

Switch on the **Display Phase** toggle to plot phase in the baseline tool. Switch it off to plot amplitude only.

The Display Errors Toggle

Switch on the **Display Errors** toggle to plot data with error bars in the baseline tool. Switch it off to plot the data as points.

The Autoscale Plots Toggle

Switch on the **Autoscale Plots** toggle to scale the amplitude and phase plots so that the maxima and minima correspond to the maxima and minima in the data. Switch it off to allow the maxima and minima to be set explicitly.

The Amplitude Range Command

Use the **Amplitude Range** command to set the maximum and minimum amplitudes to plot. You will be prompted for the new maximum and minimum amplitudes.

The Phase Range Command

Use the **Phase Range** command to set the maximum and minimum phases to plot. You will be prompted for the new maximum and minimum phases.

7.1.3 The Help Menu

The **Help** menu contains commands for obtaining on-line help on **SLIME**. It contains the following items.

Context-Sensitive Help Invokes context sensitive help.

Overview Provides general information about the baseline tool.

Index Provides a list of subjects on which help is available.

Keyboard Provides information about the programs use of special keys.

Tutorial Provides access to the tutorial.

Using Help Provides information about the on-line help system.

Product Information Displays the name and version of the application.

These items are described in more detail in the following sections.

The Context-Sensitive Help Command

Use the **Context-Sensitive Help** command to invoke context-sensitive help. The cursor will change to a 'query pointer'. Position this over the item on which you want help and press **BSelect**. Click **BSelect** outside the baseline tool to abort the operation.

Pressing the ⟨**Help**⟩ key while the pointer is over the item of interest provides a more direct means of accessing context-sensitive help.

The Overview Command

Use the **Overview** command to see general information on the baseline tool.

The Index Command

Use the **Index** command to see a list of help topics. Each entry in the list is a hyperlink to the corresponding help topic.

The Keyboard Command

Use the **Keyboard** command to call up information about special keys used by **SLIME**.

The Tutorial Command

Use the **Tutorial** command to call up the on-line tutorial.

The Using Help Command

Use the **Using Help** command to call up information about the on-line help system.

The Product Information Command

Use the **Product Information** command to display the name and version number of the program. These are displayed in an information dialogue rather than the hypertext viewer.

7.2 Dialogues Associated with the Baseline Tool

There are a number of dialogues associated with baseline tools. Each of these dialogues is described below.

7.2.1 The Change Baseline Dialogue

Use the **Change Baseline** dialogue to choose a new baseline to be displayed in the baseline tool. Choose a baseline from the list and click on **OK** or **Apply** to display data for the selected baseline. Baselines in the list are not guaranteed to have and data. If you choose a baseline with no data you will see an error dialogue informing you of the fact and the display will not be changed. The dialogue will be dismissed if you click on **OK** but will be retained if you click on **Apply**.

You may also double-click on a baseline in the list which is equivalent to first selecting that item and then clicking on **OK**.

If you decide to dismiss the dialogue without changing the displayed baseline, click on the **Cancel** button.

7.2.2 The Amplitude Range Dialogue

Use the **Amplitude Range** dialogue to change the maximum and minimum amplitudes plotted in the baseline tool. Enter the maximum and minimum values (in Janskys) in the appropriate fields and click on **OK** or **Apply** to make the new values take effect. The dialogue will be dismissed if you click on **OK** and will remain in place if you click on **Cancel**. If you entered a negative flux or a maximum that was less than or equal to the minimum then you will be informed of the error and given the change to correct it.

Click on **Cancel** to dismiss the dialogue without making any change.

7.2.3 The Phase Range Dialogue

Use the **Phase Range** dialogue to change the maximum and minimum phases plotted in the baseline tool. Enter the maximum and minimum values (in degrees) in the appropriate fields and click on **OK** or **Apply** to make the new values take effect. The dialogue will be dismissed if you click on **OK** and will remain in place if you click on **Cancel**. If you entered an angle outside of the range -180 to 180 degrees or a maximum that was less than or equal to the minimum then you will be informed of the error and given the change to correct it.

Click on **Cancel** to dismiss the dialogue without making any change.

Chapter 8

The Least-Squares Fitting Tool

The least-squares fitting tool provides an automatic method for adjusting the parameters of your model so that it fits the data better. It does this by using a non-linear optimization package to minimize χ^2 for the model and data.

Use the radio buttons at the top left to choose between fitting amplitudes and phases and amplitudes only. The fields at the top are updated during the fitting process and show the number of iterations carried out so far, the number of times that χ^2 has been evaluated (function evaluations) and the current value of χ^2 divided by the number of data points. If the model fits the data within the errors, the last number should be about 1.0.

The large text area at the bottom of the tool is used to report the results of the fit. This shows the conditions under which the fitting process ended and, if successful, the final parameter values and their standard errors (assuming that the data errors have a Gaussian distribution). As is the usual case, these errors represent the standard error in each parameter if only that parameter were in error: in reality, the parameters are not independent of each other and these error estimates will tend to underestimate the actual standard error for any given model parameter.

Start the fitting process by selecting the **Fit Data** command from the **Fitter** menu. A dialogue will appear to remind you that the model can not be changed while the fitting tool is working. This dialogue may not appear until the first iteration is complete which make take several minutes. You can use the **Cancel** button on this dialogue to stop the fitting tool at the earliest possible opportunity.

SLIME is unable to respond to any X events during an iteration of the model-fitting process so it will appear not to be working while an iteraction is being carried out. This may take anywhere from a few seconds to several minutes depending on the complexity of the model and the amout of data you are using. Don't attempt to kill **SLIME** if it appears to be hang during model fitting: it is still working.

The fitting procedure will report one of several reasons for ending when it has finished.

X-convergence Achieved The fitting procedure has determined that the parameters lie within the x-convergence tolerance of the parameters which give the minimum value of χ^2 in a scaled parameter space. This is a good result.

Relative function convergence achieved The fitting procedure has determined that the fractional decrease in χ^2 has dropped below a threshold value and that further significant decreases in χ^2 are unlikely. This is a good result.

Both x-convergence and relative function convergence achieved Both of the previous conditions ahve been met. This is a good result.

Perfect fit achieved The fitting tool has found a set of parameter values that fit the data exactly. This is impossible for real data in the absence of a miracle or cheating.

Singular convergence The data do not constrain one or more parameters of your model. The most frequent problem is that the position angle of a Gaussian component is not constrained by the data (you may see the component rotating in the model editor before this happens). This is a bad result and indicates that you should simplify your model.

False convergence The fit appears to have converged on a solution that is not a true minimum. In principal these means that the tolerances may be too tight but usually results from using a poor starting model in practice.

Reached an iteration limit The fitting process either reached the maximum number of iterations or of function evaluations. This usually indicates a poor starting model.

Fitting aborted by user Self-explanatory.

You can change the convergence tolerances and iteration limits but this is rarely effective and is not recommended.

Irrespective of whether the fit was successful or not, the final parameters will become the current model parameters. If you don't like them for any reason, you can use the **Undo** function of the model editor to restore the parameters to their pre-fit state.

8.1 The Least-Squares Tool Menus

The least-squares tool has a number of menus.

Fitter Commands to perform a least-squares fit and to close the tool.

Options Options governing the fitting procedure.

Help Access to on-line help.

These menus are discussed in greater detail in the following sections.

8.1.1 The Fitter Menu

The **Fitter** menu contains the following commands.

Fit Data Perform a least-squares fit.

Close Close the least-squares tool.

These commands will be described in greater detail below.

The Fit Data Command

The **Fit Data** command starts the least-squares fitting process. The program will begin the iterative process of adjusting the model parameters to improve the fit to the data. You will not be able to change the model until this process is finished.

The Close Command

The **Close** command closes the least-squares fitting tool. This removes it completely from the display.

8.1.2 The Options Menu

The options menu contains the following item.

Convergence Parameters Change convergence parameters and iteration limits.

This command is described in greater detail below.

The Convergence Parameters Command

Use the **Convergence Parameters** command to alter the convergence thresholds and iteration limits that determine when the least-squares process reaches convergence and govern how long it will run before giving up. A dialogue will prompt you for new values.

Changing the convergence parameters rarely has any significant effect and is not generally recommended.

8.1.3 The Help Menu

The **Help** menu contains commands for obtaining on-line help on **SLIME**. It contains the following items.

Context-Sensitive Help Invokes context sensitive help.

Overview Provides general information about the least-squares tool.

Index Provides a list of subjects on which help is available.

Keyboard Provides information about the programs use of special keys.

Tutorial Provides access to the tutorial.

Using Help Provides information about the on-line help system.

Product Information Displays the name and version of the application.

These items are described in more detail in the following sections.

The Context-Sensitive Help Command

Use the **Context-Sensitive Help** command to invoke context-sensitive help. The cursor will change to a 'query pointer'. Position this over the item on which you want help and press **BSelect**. Click **BSelect** outside the least-squares tool to abort the operation.

Pressing the ⟨**Help**⟩ key while the pointer is over the item of interest provides a more direct means of accessing context-sensitive help.

The Overview Command

Use the **Overview** command to see general information on the least-squares tool.

The Index Command

Use the **Index** command to see a list of help topics. Each entry in the list is a hyperlink to the corresponding help topic.

The Keyboard Command

Use the **Keyboard** command to call up information about special keys used by **SLIME**.

The Tutorial Command

Use the **Tutorial** command to call up the on-line tutorial.

The Using Help Command

Use the **Using Help** command to call up information about the on-line help system.

The Product Information Command

Use the **Product Information** command to display the name and version number of the program. These are displayed in an information dialogue rather than the hypertext viewer.

8.2 Dialogues Associated with the Least-Squares Tool

There are a number of dialogues associated with the least-squares tool. These dialogues are described in the following sections.

8.3 The Working Dialogue

The **Working** dialogue indicates that a least-squares fit is in progress and reminds you that you can not change the model while the fit is in progress. The dialogue will be dismissed automatically when the fit is complete.

Click on **OK** to dismiss the dialogue or click on **Cancel** to stop the fit at the earliest possible opportunity.

Note that the fitting process is computationally intensive and the **SLIME** will not be able to respond to input immediately while it is going on: this includes providing the usual feedback that shows that a button has been pressed.

8.4 The Convergence Parameters Dialogue

Use the **Convergence Parameters** dialogue to set the conditions under which the fit will terminate. It is rarely useful to change these settings from their default values and doing so is not recommended. You may set the following values.

Function Evaluation Limit The maximum number of times that χ^2 may be evaluated, ignoring evaluations for determining gradients and the curvature matrix.

Iteration Limit The maximum number of iterations to be performed. Note that convergence will usually only take 10 to 20 iterations if the starting model is reasonable.

Relative Function Convergence Tolerance The largest relative change in χ^2 that will be accepted as showing that the process has converged. Other criteria must also be met so that the program is sure that a true minimum has been reached. Larger values (less than unity) are less stringent but raising this value is rarely effective.

X-Convergence Tolerance The distance in scaled parameter space that is used to test whether the parameters are close enough to their optimum values for the process to have converged. The scaling factors vary dynamically during the fit so this value can not be set from a set of accuracy requirements. Large numbers are less stringent.

False Convergence Tolerance A parameter used in the false convergence test. Smaller numbers make false convergence less likely but the default value is only 100 times the machine precision, giving little scope for significant reductions.

Click on **OK** or **Apply** to make any changes take effect. The dialogue will be dismissed if you click on **OK** but will remain in place if you click on **Apply**.

Click on **Cancel** to dismiss the dialogue without changing the convergence parameters.

Part III

Appendices

Appendix A

Obtaining and Installing SLIME

SLIME is not a part of the normal AIPS distribution because the AIPS compilation tools are not designed to handle large C programs and because **SLIME** will not run on all systems that can run AIPS.

In order to run **SLIME**, your system must meet the following requirements.

- The operating system must conform to the X/Open Portability Guide, Issue 3.
- You must have an implementation of the X Window System that conforms to X11R5 or later.
- You must have the OSF/Motif toolkit version 1.2 or later.
- You must have the Display PostScript extension to X (DPS/X), its client-side libraries and programming tools.
- You must have the 15JAN96 release of AIPS or a later release.

Note that these conditions are not true for Linux nor for Solaris 2.2 and earlier versions of Sun OS. In addition, **SLIME** will not run under AIX 3.2.5 on an RS/6000 although this system meets the general requirements listed above (the reasons for this are not yet known). The **SLIME** installation procedures currently support Solaris 2.3 and later running on SPARC-based CPUs and OSF1 T3.2 running on ALPHA/AXP-based CPUs. If your system has not been named here and meets the requirements listed above, contact me by electronic mail at `cflatter@nrao.edu` to arrange for **SLIME** to be ported to your system (this should normally require nothing more than adding a new configuration section to the installation files.

If your system is supported by the installation procedures then you can follow the step-by-step instructions given below. You do not need to have root privilege to do this but you should perform the installation from the AIPS manager's account.

1. Get the sources for **SLIME** by anonymous **ftp** from ftp://ftp.aoc.nrao.edu/pub/cflatter/slime.tar.g Make sure that you use binary transfer mode. This file has been compressed using **gzip** and is about 160k in size. Unpack the sources as follows.

   ```
   gunzip < slime.tar.gz | tar xvf -
   ```

   This will create a subdirectory named **SLIME** that contains the sources.

2. Get the manual by anonymousftp from ftp://ftp.aoc.nrao.edu/pub/cflatter/slime-man.tar.gz if you wish to install the manual locally. This is recommended but not necessary, since **SLIME** will access an on-line manual across the network if you can not afford the disk space for a local copy of the manual (about 7 MB). Unpack this in the same way that you unpacked the source archive. This will create a subdirectory containing the LaTeXsource for the manual, a set of encapulated PostScript figures and a PostScript version of the manual. This subdirectory will also contain a further subdirectory (**slime**) containing a number of HTML documents and GIF images: these are the on-line documentation for **SLIME**. Create a directory that can be read by any machine that will run **SLIME** and copy the HTML files and GIF images to this directory.

3. Make the directory that contains the **SLIME** sources your current directory and make sure that you have defined a full AIPS environment (you should have run **LOGIN.SH** or **LOGIN.CSH** and typed **$CDTST** or **$CDNEW**).

4. If you installed a local copy of the on-line manual, edit **Slime.ad**. Find the line

   ```
   ; Slime.helpPrefix:     file:/home/laphroaig/cflatter/working/slime-manual/slime/
   ```

   and remove the semicolon from the beginning of the line and replace

   ```
   /home/laphroaig/cflatter/working/slime-manual/slime/
   ```

   with the full pathname of the directory into which you installed the on-line documentation. Note that the entire string should begin with **:file** and end with a slash.

5. If you use the Common Desktop Environment (CDE) edit **Slime.ad** and remove the lines that specify colours in the section headed **Appearance**. This step is optional but will improve the appearance of **SLIME** under the CDE.

6. If you have the 15JAN96 release of AIPS, edit **Imakefile** and uncomment the line

   ```
   /* AIPSVERFLAGS = -DAIPS_15JAN96 */
   ```

   by deleting the asterisks and slashes. Do not change anything else in **Imakefile**. In particular you should not enable CCI support since there are serious bugs related to the use of Mosaic as a help viewer that have not been resolved yet.

7. Type **xmkmf** to generate a makefile.

8. Type **make depend** to generate dependency lists. If you see an error message about **ModelEditorWraps.h** type **make ModelEditorWraps.c** and then type **make depend** again.

9. Type **make** to compile and link the program. You should expect to see a number of warning messages, particularly from **ModelEditorWraps.c** but there should be no fatal errors (contact me if there are).

10. Type **make install**. This will copy **SLIME.EXE** to the load area, copy **SLIME.HLP** to the help area and create directories containg bitmaps and application defaults under **$AIPS_ROOT**.

11. If you are running the 15JAN96 release of AIPS, add the following lines to **$AIPS_ROOT/START_AIPS** before the comment that says, 'Finally, start AIPS'.

    ```
    #                                        Environment variables for X11
    #                                        programs started within AIPS
    if [ -z "$XBMLANGPATH" ]
    then XBMLANGPATH=$AIPS_ROOT/bitmaps/%B
    else XMBLANGPATH=$AIPS_ROOT/bitmaps/%B:$XBMLANGPATH
    fi
    if [ -z "$XFILESEARCHPATH" ]
    then XFILESEARCHPATH=$AIPS_ROOT/%T/%N
    else XFILESEARCHPATH=$XFILESEARCHPATH:$AIPS_ROOT/%T/%N
    fi
    export XBMLANGPATH
    export XFILESEARCHPATH
    ```

    This ensures that **SLIME** will be able to find the bitmaps and defaults installed in the previous step. These lines have already been added to the 15OCT96 version of **START_AIPS**. This completes the installation.

Appendix B

Common Problems and their Solutions

In this appendix, I list the most common problems likely to be encountered while running **SLIME** and suggest some solutions.

B.1 Text for SLIME is Unavailable

If you get the message

```
AIPS 1: TEXT FOR SLIME UNAVAILABLE
```

while trying to start **SLIME** or examine its inputs, **SLIME** has not been installed on your system. **SLIME** is not a part of the normal AIPS distribution and must be installed separately. If your system can run **SLIME** (see Appendix A), ask your local AIPS manager to install it for you.

B.2 Inability to Create a Rendering Context

SLIME uses the Display PostScript extension to the X Window System for the model editor display. If the main window does not appear or appears and immediately disappears and you see the message

```
SLIME1: CAN NOT CREATE RENDERING CONTEXT FOR EDITOR --- QUITTING
SLIME1: This may indicate that your display is not capable of
SLIME1: handling Display PostScript.  Check that you are running
SLIME1: the correct X server.
```

then it is likely you are not running an X server that is capable of handling Display PostScript requests (this message can also appear if the server has run out of a certain class of resources but this is extremely unlikely). You should shut down the X Window System and restart it with a server that supports

Display PostScript. Servers from the X Consortium sample distribution do not support the Display PostScript extension, which is a commercial product, but most vendor-supplied servers do. For example the OpenWindows server and the AIXwindows server both support Display PostScript.

There are a few systems for which Display PostScript is not available (eg. Linux). You can not run **SLIME** on these systems.

If you are not sure how to change your X server or which server you should use on your system, you should consult a local expert.

B.3 The Model Editor Appears in Black and White

If the model editor appears in black and white rather than colour (this will not be apparent until you create a new component) then some other application has used up the default colour table so that **SLIME** can not allocate enough colours to operate properly. The usual culprits are World Wide Web viewers and the AIPS TV. Shut down any programs that use large blocks of the colour table and then shut down and restart **SLIME**. After you have restarted **SLIME**, you can restart the other programs.

There are two useful tricks that can stop this happening. The first is to run a program that uses the Display PostScript extension before starting any program that uses a large colormap. Display PostScript allocates a colour cube when the first Display PostScript program is started so this technique reserves a block of the default colormap for use by Dispaly PostScript programs (including **SLIME**).

The second technique is to force programs that use large colormaps to allocate their own private colormaps rather than taking up large parts of the default colormap. For example, you can run **netscape** with the **-install** flag or you can configure the AIPS TV to use a large number of colours. This will mean that the rest of the screen will "go technicolor" when you are looking at these applications but they will not interfere with other programs that require only a few colour slots from the default colormap.

B.4 Can Not Perform Malloc

If **SLIME** dies and reports that it can not perform malloc, this indicates that you have exhausted the virtual memory available on your workstation. This is most likely to happen when you start the least-squares tool.

Your only recourse is to start again with a smaller data set (try averaging) or a simpler model.

Appendix C

Reporting Problems

If you encounter a problem running **SLIME** or installing it, report it directly to me at `cflatter@nrao.edu` rather than using the `aipsmail` address. You can also use the `bananas` mailing list or the `alt.sci.astro.aips` newsgroup for issues that may be of interest to other users.