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T. J. Harries

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POLMAP

An interactive data analysis package for linear spectropolarimetry

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Contents

1 Introduction

A linear polarization spectrum is a set of Stokes vectors $(I_\lambda, Q_\lambda, U_\lambda)$. Hence linear spectropolarimetric data is four-dimensional (six-dimensional if the variance arrays of the Stokes parameters are included) and cannot be manipulated using the standard spectral analysis packages (*e.g.*, DIPSO; Howarth & Murray 1991).

POLMAP owes much to DIPSO as far as the style of user interface is concerned, but no attempt was made to provide the wealth of spectral analysis routines available in DIPSO. The routines provided by POLMAP are specifically designed for the spectropolarimetrist. The manual includes a simple step-by-step guide to the program and some example data analysis recipes.

1.1 POLMAP and TSP

The TSP package (Bailey 1990) runs under the ADAM environment and provides many routines for handling time-series and polarimetric data. The TSP routines are biased towards data reduction, and facilities are provided to reduce data from several different instruments. POLMAP does not contain any data reduction routines, but was designed with data analysis in mind.

POLMAP also provides routines for displaying data that are not available in TSP. Command are provided to read and write TSP polarization spectrum format files from within POLMAP. Hence the packages should be seen as complimentary, in a similar manner to FIGARO and DIPSO.

1.2 The command interface

Commands may be entered at the prompt in either upper- or lower-case. Numerical parameters must follow the command in the order specified and must be separated by spaces. If any command parameters are omitted on the command line they are usually prompted for. Several commands may be entered on the same command line provided they are separated by commas; the only exception is the **COMFILE** command, which must appear on its own command line.

If a character string parameter (such as a filename) contains upper-case characters it must be placed in double quotes in order to protect it from the command parser. If a range of integers is required as a parameter to a command a greater-than sign may be employed. For example instead of `DELETE 4 5 6 7` the form `DELETE 4 > 7` may be used. **HELP COMMANDS** will give a list of the available commands and you can also obtain help on a specific command using **HELP** *command*.

1.3 Data storage

The data storage system is very similar to DIPSO. The polarization spectra are stored in a stack and spectra may be put onto the top (numerically largest) stack entry or pulled from the middle of the stack. Routines that alter or measure data generally work on the spectrum in the current arrays and results to any operation are generally stored in these arrays as well. The entire stack may be saved in NDF format using the **WRSTK** command.

1.4 Getting started

In order to run POLMAP you must source the `polmap.csh` script. On Starlink systems, the command alias `polmapsetup` will do this for you if you have initialised the Starlink Software for use.

The `polmap.csh` script sets the environment variable `POLMAP_DIR` to point to the location of the POLMAP files, and defines the command alias `polmap` to run the POLMAP exectuable.

Then copy the file `sn1987a.sdf` from the POLMAP directory into an empty working directory:

```
% cp $POLMAP _DIR/sn1987a.sdf .
```

Typing `polmap` at your normal shell prompt will start the program. A message-of-the-day will appear with any updates or changes to the program and the arrow prompt notifies you that the program is now ready for input.

Data may be read into the program from ascii files (**RDALAS**), *TSP* files (**RDTSP**) or from stack files that were created using POLMAP (**RDSTK**). Type `rdtsp sn1987a` to read in the file demonstration spectrum from your working directory. The case of the input string in unimportant and if parameters are omitted they are normally prompted for. Place character string parameters in quotes to protect them from the command parsing routine. The polarization spectrum is now in the current arrays. The current arrays are the arrays on which most of the POLMAP commands act and are the arrays to which results of commands are written. The polarization spectrum can be put onto a *stack* of spectra using the **PUT** command. Try it now. The program should respond with a short message naming the stack entry in which the spectrum has been copied. It is important to note that although the spectrum has been put onto the stack it is also still in the current arrays. Using **PUT** again will put another copy of the current spectrum onto the stack. The **LIST** command will list the stack contents along with some useful information such as the spectral range and the number of data points. Typing `LIST 0` will display the contents of the current arrays.

In order to plot the data we must first initialize a graphics device. This is done using the **DEV** command. The command requires as a parameter a standard GKS device name (eg. xwindows) along with the number of subdivisions in x and y into which the plotting surface must be divided. If x and y are not specified then the defaults ($x = 1$,$y = 1$) are employed. Once you have initialised your graphics device try typing `TRIPLOT 0.03 1`. This command will produce a triplot of the data in stack entry 1 (which should be the demonstration spectrum). The top section of the triplot shows the position angle of the polarization (in degrees), the middle sections shows the percentage polarization and the final section is the Stokes I component. Note that the top two sections appear to have a varying bin size. This is because the polarization spectrum is binned to a constant percentage polarization error (of 0.03 percent). This means that regions of the spectrum with smaller errors on Stokes Q and U have a higher spectral resolution. The range over which the spectrum is plotted can be adjusted using **TRANGE**,**PRANGE**,**IRANGE** and **WRANGE** to limit the position angle, percentage polarization,intensity and wavelength ranges respectively. **TAUTO**,**PAUTO**,**IAUTO** and **WAUTO** switch off the ranges and let the program autolimit them. The wavelength range can also be set interactively using the **CWRANGE** command, which uses the cursor.

1.5 A step-by-step analysis example

You should now have two copies of the demonstration data on the stack. Type `title demo2` to change the title of the current spectrum and then put it on the stack. Listing the stack you should now find three entries of the same spectrum, so let's delete some. Typing `DEL 1 2` will delete the first and second stack entries. Listing the stack again will show that there is now only one entry, entitled `demo2`. Triplot this entry and type `CONTDEF`. This command allows the user to define multiple regions of continuum. Start at the shortward end of the spectrum and define four line-free continuum bins. Define a bin with the end shortward of the start in order to quit the continuum definition. Typing `CONTFIT 1 2` will fit a second order polynomial to the three Stokes components of the first stack entry. The fit has been mapped onto the wavelength grid of the current array, so title the fit and put it onto the stack. You can plot the two spectra on the same axes using `TRIPLOT 0.03 1 2`. Note that the line styles are the same for both the spectra. The **LROT** command will make the line style change for each plot. In order to rectify the spectrum type `IDIV 1`. The Stokes *I* spectrum of the current arrays has been divided into the *I* array of stack entry number one. The results are now in the current arrays. `TRIPLOT 0.03` will plot the current polarization (hopefully rectified) spectrum. Put this onto the stack and then use `wrstk junk` to write out the entire stack onto disk. The file `junk.sdf` will be in our current directory. Typing `QUIT` will leave the program.

1.6 Command files

The **COMFILE** command may be used to read input from a text file rather than from the keyboard. The **COMFILE** must be given on its own command line. The text file is simply a list of commands as you would have typed them in. The default extension of a command file is `.cmd`. A command file may contain a **COMFILE** command but the nest must be no deeper than twenty files (more than enough hopefully). If you have a set of commands that you regularly issue after starting the program then these may be placed in the file `.polmap` in your home directory. If found, this command file is executed on start-up. It might contain a **DEV** command to initialize your specific device type, or a command to set your plotting styles.

1.7 The command history

The **COMMS** command lists the twenty previous commands. Any of these commands may be accessed using the pling (!) symbol. For example `!203` will execute the command number 203 from the command history, in a similar fashion to the UNIX operating system. It should be noted that if commas are used to separate commands then each will be given a separate command history number.

2 The TRIPLOT command

2.1 Introduction

The **TRIPLOT** command provides a flexible but straightfoward method for displaying polarization spectra. As mentioned in the previous section a triplot consists of three separate graphs.

The top panel displays the position angle of the polarization in degrees, the middle section shows the percentage polarization and the bottom section shows the intensity spectrum. The first command parameter is the percentage error in polarization with which to bin the spectrum. If no further parameters are given the polarization spectrum in the current arrays will be plotted. Additional parameters refer to stack entries. If only one stack entry is specified then that polarization spectrum is plotted. If more than one stack entry are specified then they are all plotted, but on the axis limits of the first polarization spectrum specified. If don't want the plotting surface erased before each triplot command is executed then use the **NOBOX** command. The **BOX** command negates this.

A polarized flux section may be included in the triplot using the **PFLUX** command. The **NOPFLUX** command negates this. The polarized flux section appears between the percentage flux and the position angle section.

In some cases, the polarization structure is more clearly seen in normalized Stokes Q and U. The **QUPANEL** will tell the triplot command to produce a plot showing Stokes I in the bottom panel and Stokes Q and Stokes U in place of the usual position angle and percentage polarization.

2.2 The plotting ranges

The plotting limits may be altered by the user. For example, the wavelength range to be plotted is by default the first and last wavelength points of the polarization spectrum. The **WRANGE** command allows the user to specify a range and the **CWRANGE** allows the user to select a range from a previous triplot using the cursor. **WAUTO** switches back to the default wavelength range. **IRANGE** and **IAUTO** can be used to set the plotting range for the intensity section and **TRANGE** and **TAUTO** refer to the position angle plot. **PRANGE** and **PAUTO** change the percentage polarization plotting ranges. **PFRANGE** and **PFAUTO** perform similar functions on the polarized flux panel.

It is an truism of spectropolarimetry that the most interesting objects have a polarization with a position angle close to 0° or 180°, resulting in a position angle plot that oscillates madly between the extremes of the plot because of wrap-around. In order to prevent this the triplot can be forced to plot position angles either higher than 180° (**THI**) or lower than 0° (**TLOW**). Simply set the range to (0°,200°) for example using **TRANGE** and invoke **THI**. The effects of **THI** or **TLOW** can be lifted using **TFREE**.

2.3 Plotting styles

The type of line used to plot the spectrum can be changed for each plot using **LROT** and the colour of the line (for those of you lucky enough to have a colour terminal) can be rotated using **CROT**. You can select a specific line style or colour using the **SETLINE** or **SETCOLOUR** commands. If you wish to plot a join-the-dots spectrum then use the **POLY** command. The **HIST** command returns to histogram style plots. The data may be plotted as points with error bars using the **MARK** command.

The axis labels on the plot can be changed. **XLABEL** alters the (guess) label on the x-axis and **ILABEL** changes the label on the intensity spectrum. The font used to annotate the axes may be changed using the **FONT** command.

3 The QUPLOT command

A polarization spectrum may also be plotted in the QU plane. The **QUPLOT** commmand requires the bin error a parameter. This plots the current polarization spectrum in the QU plane. The axis limits may be alted using **QRANGE** and **URANGE** or autoscaled using **QAUTO** and **UAUTO**. The **BOX** and **NOBOX** commands work as described above. The entire current polarization spectrum is plotted unless a wavelength range is specified using **WRANGE**. The plotting symbol style my be change with the **SETSYMB** command. For a list of the various plotting symbols available see the PGPLOT manual.

If you want the QU points to be joined up in wavelength order (to emphasize a QU loop for example) then use the commannd **QUJOIN** before the **QUPLOT** call. **NOQUJOIN** switches off the point drawing. Arrowheads may be employed using the **QUARROW** command. The arrowhead style can be altered using the **ARROWSTYLE** command.

4 Interstellar polarization

A raw polarization spectrum is a vector sum of the interstellar polarization spectrum (introduced by interstellar dust grains aligned in the galactic magnetic field) and the intrinsic polarization spectrum. In order to analyse the intrinsic polarization spectrum it is therefore necessary to subtract the interstellar polarization vector. Obtaining a reliable estimate of the interstellar polarization is difficult, but it is crucial to the subsequent analysis since the magnitude of this vector is often significantly larger than that of the intrinsic vector. The wavelength dependence of the interstellar polarization can be described empirically using the Serkowski law (Serkowski 1973):

$$p(\lambda) = p_{max} \exp[-k \ln^2(\lambda_{max}/\lambda)] \tag{1}$$

where $p(\lambda)$ is the percentage polarization at wavelength λ, p_{max} is the maximum polarization which occurs at wavelength λ_{max} and k is a curve width parameter. Originally $k = 1.15$ but it has been suggested that allowing k to vary may improve the fit (Condina-Landaberry & Magalhães 1976 and Whittet *et al* 1992).

The command **ISFIT** uses a non-linear least-squares method to fit a Serkowski law (equation 1) to the data in the current arrays. The four parameters to this command are q, the maximum Stokes Q polarization, u, the maximum Stokes U polarization, w, the wavelength of the maximum polarization and k the curve width parameter. A free parameter is initialised with the : symbol and a parameter to be held fixed is defined using the = symbol. A typical command line may look like:

```
> isfit q:1.5 u:0.1 w:5500 k=1.15
```

This command holds k at 1.15 but q, u and w are free parameters. These parameters are used to create a polarization spectrum at the wavelength bins defined by the spectrum in the current

arrays. This means that the spectrum in the current arrays is lost. Errors are reported if the number of free parameters exceeds the number of available polarization datum.

The interstellar polarization vector can be removed from the target spectrum using the **SUBTRACT** command. The polarization spectrum in the current arrays is subtracted from the specified entry. The subtraction is performed over the overlapping wavelength region. The Stokes *I* spectrum is obtained from the stack polarization spectrum and linear interpolation is used to regrid the stack polarization spectrum onto the current wavelength array. The resulting polarization spectrum is placed in the current arrays.

Other useful commands for adding and subtracting polarization vectors include **STATADD** and **STATSUB**, which add/subtract a constant vector found using the **PTHETA** command. The **ICADD** command adds a constant value to the *I* Stokes spectrum only, thereby diluting the polarization.

5 Merging spectra

The simplest way to merge two spectra is the **CONTADD** command, which is described above. The **MERGE** command merges two stack polarization spectra (that may or may not overlap) and uses a weighted mean on data with x-values common to both spectra. The **WMERGE** command works on spectra that have the same x-array (spectra can be remapped using the **GRID** and **CONTADD** commands) and produces a weighted mean of the two spectra.

6 PA calibration

Raw polarization spectra often have a PA that is a slow function of wavelength due to the slight chromicity of the waveplate. Two commands are provided in order to calibrate this effect (**FITPA** and **PACALIB**). The **FITPA** command fits a polynomial to the difference spectrum of the observed PA spectrum (usually a spectrum taken through a 100% polarizing filter) and the actual PA. Care must be taken that the observed PA spectrum does not wrap-around (i.e. flip from $\approx 0^\circ$ to $\approx 180^\circ$) as this will spoil the PA fit. This is *not* checked for by POLMAP, but may be fixed with a call to **ROTPA** prior to the fit. The **PACALIB** command applies this fit to the current arrays.

7 References

Bailey J. A., 1990, SERC Starlink User Note, No. 66.2

Codina-Landaberry S., Magalhães A. M., 1976, AA, 49 407

Howarth I. D., Murray J., 1991, SERC Starlink User Note, No. 50.13

Serkowski K., 1973, in Greenburg J. M., Hayes D. S., eds, IAU Symp. 52, Interstellar Dust and Related Topics. Reidel, p. 145

Whittet D. C. B., Martin P. G., Hough J. H., Rouse M. F., Bailey J. A., Axon D. J., 1992, ApJ, 386, 562

A At-a-glance guide

The following table summarizes the most frequently used POLMAP commands. More detailed information is given by the online help command **HELP**.

Command	Arguments	Description
		Plotting
DEV	*device [nx] [ny]*	Initializes GKS graphics device
TRIPLOT	*error [entry] ...*	Plots pol. spectrum in triplot form
QUPLOT	*error*	Plots pol. spectrum in *QU* space
LROT		Changes the line style for each plot
FONT	*type*	Changes the font style
		Reading and writing
RDALAS,WRALAS	*filename*	Reads/writes current pol. spectrum (ascii format)
RDTSP,WRTSP	*filename*	Reads/writes current pol. spectrum (TSP format)
RDSTK,WRSTK	*filename*	Reads/writes stack in NDF format
		Stack
PUT		Puts current pol. spectrum onto stack
GET	*entry*	Gets stack number *entry*
LIST		List stack entries
DEL	*entry [entry] ...*	Deletes stack entry
		Rectification
CONTDEF	*[wstart] [wend]*	Defines continuum bins
CONTFIT	*order entry*	Fits a polynomial to a pol. spectrum
IDIV	*entry*	Divides current Stokes *I* array into *entry*
		PA calibration
ROTPA	*angle*	Rotates PA of polarization spectrum
FITPA	*pa ncoeff*	Fits polynomial to PA
PACALIB		Applies polynomial fit
		Miscellaneous
MERGE	*entry*	Merges current pol. spectrum with stack entry.
HELP	*command*	Gives online help for *command*
PTHETA		Measures polarization in continuum bins
TOV	*wavelength*	Converts to velocity space
TOW	*wavelength*	Converts to wavelength space

B List of Commands

! *n*
Runs command number n from the command history. See help on COMMS command.

ADD *entry*
Adds the current polarization spectrum to the specified stack entry. See notes on the SUBTRACT command for more details.

ARROWSTYLE *fs angle vent*
Sets the style of the arrowheads to be drawn by QUPLOT when QUARROW is set. fs=1 (filled arrowhead). fs=2 (outline). The angle denoted the acute angle of the arrow point in degrees. Vent is the fraction of the triangular arrowhead that is cut away from the back.

BIN *entry error*
Bins the specified stack entry so that each wavelength bin has a constant error in percentage polarization.

BOX
Flags the graphics screen to clear before each triplot.

CADD *q u*
Adds the constant polarization vector (q,u) to the currect arrays. q and u should be in % polarization.

CHOPW *min max*
Reduces the wavelength range of the current polarization spectrum to run from min to max.

CIRANGE
Sets the intensity plotting range interactively.

COMFILE *filename*
This command tells polmap to use a command file as input instead of the terminal.

CPFRANGE
Sets the polarized flux plotting range interactively.

CPRANGE
Sets the percentage polarization plotting range interactively.

COMMS
List the twenty previous commands issued.

CONTADD *entry*
Adds the current (I,Q,U) spectrum to the specified stack entry.

CONTDEF *[min max] [min max]*
Defines continuum regions of the polarization spectrum. Multiple continuum bins may be defined on one command line. If no parameters are given then the continuum bins are defined using the cursor. A triplot must have previously been plotted in order to interactively define windows. In order to quit contdef define a bin with max less than min.

CONTFIT *entry order*
Make a polynomial fit to the continuum of a polarization spectrum. The continuum is defined

using bins set up by CONTDEF. A polynomial fit is made to the Stokes vector (I,Q,U). The resulting fit is stored in the current arrays.

CONTSUB *entry*
Subtracts the current (I,Q,U) spectrum from the specified stack entry. This command can be used to remove polarized continuum counts from a polarization spectrum.

COUNTS
Finds the mean value of the I stokes parameter using all the bins in the current polarization spectrum.

CREMOVE
Uses the cursor to set two (wavelength,intensity) points. The parts of the current spectrum with wavelengths outside the range defined are lost. An intensity i (found by linear interpolation between the two points) is subtracted from each of the remaining intensities. This command is useful for removing the effects of a depolaring continuum from an emission line, for example.

CROT
Sets the plotting colour for the line to change after each plot

CSUB *q u*
Subtracts the constant polarization vector (q,u) from the currect arrays. q and u should be % polarization.

CTRANGE
Sets the PA plotting range interactively.

CURSOR
Use the graphics cursor to measure points on the current plot.

CWRANGE
Define the plotting wavelength range using the cursor. A triplot must have previously been made.

DEL *entry [entry]*
Deletes the specified entries from the stack.

DEV *device [nx] [ny]*
Initialize the plotting device. The device name must be a GKS standard. Use a question mark as the parameter in order to list the possible devices. The plotting surface is divided into nx subdivisions in x and ny subdivisions in y. If nx and ny are not specified then the default values are used (nx=1 and ny=1).

DRAWLINE *x1 y1 x2 y2*
This command draws a line in the current line style from point (x1,y1) to (x2,y2), where the distances are given in world coordinates.

EDIT *[wmin] [wmax]*
Removes the data points from the current spectrum that lie between wmin and wmax.If wmin and wmax are not specified the cursor is used to specify the wavelength range.

FITPA *pa ncoeffs*
Given the actual pa of the current spectrum a polynomial fit of ncoeff coefficients is made to the difference between the actual and observed position angles as a function of wavelength. This fit can then be applied to another observation using PACALIB.

FONT *type*
Sets the character font for plotting. There are four fonts: 1. Simple single-stroke (default) 2. Roman font 3. Italic font 4. Script font

GET *entry*
Takes the polarization spectrum from the stack and places it in the current arrays.

HELP *command*
Gives online help to polmap commands. HELP COMMANDS will give a list of all the possible commands. HELP <command> will provide detailed online help for the selected command. Parameters shown in brackets are optional.

HIST
Flags triplot to produce histogram style output.

IAUTO
Automatically set the Stokes I range.

ICADD *constant*
Adds a constant to the Stokes I array of the current polarization spectrum.

ILABEL
Sets the label for the intensity on a triplot.

INTEG
Integrates the Stokes I parameter of the current array using trapezoidal integration.

IPLOT
Plots the Stokes I parameter of the current spectrum.

IQUADD *i q u*
Adds the constant polarization vector (i,q,u) to the current arrays.

IRANGE *min max*
Limits the Stokes I plotting range.

ISFIT
Fits a Serkowski law to the data held in the current arrays. Non-linear least-squares minimization is used. The resulting IS law is mapped onto the X array of the current polarization spectrum.

LIST *[mode]*
List the stack contents. If mode is 0 then the contents of the current arrays are listed.

LROT
Flags the line style to change after every plot with nobox set.

LS
List the polarization spectra titles that are on the current stack in 'page' format, useful for large stacks.

MARK
Flags triplot to mark bins with points and error bars rather than in histogram style (HIST) or join-the-dots style (POLY).

MAXPOL
This command finds the maximum polarization datum within each of the continuum bins.

MERGE *entry*
Merges the current polarization spectrum with the spectrum in the specified stack entry. The

resulting spectrum is sorted into wavelength order. Weighted means for the polarization vector are calculated for bins of identical X value.

MOTD
Displays the message of the day

NOBOX
Stops automatic clearing of the plotting surface before a triplot.

NOCROT
Sets the line ploot colour to the forground colour.

NOLROT
Stops the line style changing.

NOPFLUX
Don't include polarized flux box in triplot.

NOQUARROW
Stops the QUPLOT command joining the dots with arrows.

NOQUJOIN
Data are plotted as points in the QU plane.

NOQUPANEL
Switches TRIPLOT back to its default mode of plotting.

PACALIB
Applies a position angle fit (previously made using FITPA) to the current spectrum. This command is usually used to remove the rotation of pa with wavelength associated with achromatic half-wave plates.

PAGE
Clears the graphics screen and moves on to a new page.

PAPER *width height*
Sets the physical size of the plotting windows. Width and height must be in cms and a call to DEV must have been made immediately before.

PFLUX
Incude polarized flux box in triplot.

PFRANGE *min max*
Limits the polarized flux plotting range.

POLY
Forces join-the-dots plotting rather than histogram plotting.

POP *entry*
Same as GET (qv).

PPLOT
Plots the polarization spectrum of the current arrays.

PRANGE *min max*
Limits the percentage polarization plotting range.

PTHETA
Sums the Stokes parameters over each of the pre-defined continuum bins and display the results.

PUSH
Same as PUT (qv).

PUT
Places the current polarization spectrum on to the top of the stack. If the stack is too large a warning message is given.

PVAL *number value*
Sets the value of a specified IS parameter to the value

QAUTO
Automatically set the Stokes Q range.

QRANGE *min max*
Limits the Stokes Q plotting range.

QSM *width*
Convolves the current spectrum with a Gaussian profile of the given width. Intensities beyond the ends of the arrays are assumed to be zero.

QUARROW
Forces QUPLOT to join-the-dots using arrows. The style of the arrowhead may be altered using ARROWSTYLE.

QUIT
Quits the polmap program.

QUJOIN
Forces points to be joined by a dotted line in the QU plane.

QUPANEL
Flag the TRIPLOT command to plot Stokes I, Q and U rather than the usual I, P and PA.

QUPLOT *error*
Plots the data in the current arrays in the QU plane. The data is binned to the constant error given. The wavelength range of the data to be plotted can set using WRANGE. The axes of the plot can be adjusted using QRANGE and URANGE. The data are plotted with error bars and consecutive points can be joined by setting the QUJOIN flag.

RDALAS *filename*
Reads in a polarization spectrum from the file filename. The file must be in ascii format. The first column must be the wavelength followed by the Stokes Q parameter and its variance and the Stokes U parameter and its variance. The polarization spectrum is placed in the current arrays.

RDSTK *filename*
Reads a stack into polmap.

RDTSP *filename*
Reads in a polarization spectrum from a TSP (Bailey 1992) format file. Details of the N-dimensional data format files can be found in the TSP user guide. The polarization spectrum is placed in the current arrays.

REGRID *binsize*
Rebins the current polarization spectrum. Each bin in the results spectrum corresponds to binsize bins in the old spectrum.

RETITLE *entry*
Retitle the specified stack entry. The retitle command will prompt for the new title.

ROTPA *angle*
Rotates the position angle of the current polarization spectrum through angle where the angle is given in degrees.

RVEL *vel*
Applies the given radial velocity correction to the wavelength arrays of the current polarization spectrum. The standard sign convention is used in which a positive velocity indicates the source is moving away from the observer.

SERKTHRU *q u lambda k lammax*
This command maps a Serkowski law onto the current arrays. The vector (q,u) at wavelength lambda is given along with the values ok k and lammax. The Serkowski law that passes through this point is mapped on the current arrays.

SETCOLOUR *colour*
Sets the line colour for a triplot.

SETHEIGHT *height*
Sets the height of the characters that are plotted. Standard size is height=1.

SETLINE *linestyle*
Sets the line style of a triplot. The parameter sould be in the range 1-5.

SETSYMB *style*
Sets the symbol style for a QU plot. The style parameter should be in the range 0 to 31.

SMOOTH *n*
Applies a box smooth to the current polarization spectrum (Bevington routine). The smooth is repeated n times.

STATADD
Adds the mean polarization vector obtained from the results of the most recent PTHETA to the currect arrays.

STATSUB
Subtracts the mean polarization vector obtained from the results of the most recent PTHETA to the currect arrays.

SUBTRACT *entry*
Subtract the current polarization from a specified stack entry. The Stokes Q and U parameters of both spectra are normalised and the current polarization vector is subtracted from the specified stack entry. The Stokes I parameter is obtained from the stack polarization spectrum. Linear interpolation is used to regrid the stack polarization spectrum onto the current wavelength grid.

SWAP *entry*
Swaps the current polarization spectrum with that of a stack entry.

TAPPEND *string*
Appends the character string string to the end to the current polarization spectrum title.

TAUTO
Switchs the position angle plotting range to (0,180).

TEXT *[x] [y]*
This command can be used to annotate diagrams. The x and y axis positions for the lefthand end of the text may be given. The angle at which the text is to be written is then prompted for. Finally the text string is prompted for. The text is written in the current font style. If x and y are not given on the command line the cursor is used to locate the position of the text.

TFREE
Releases PA plotting restrictions set using THI and TLOW.

THI
PA data in the range 0 to (Tmax-180) is plotted above 180. This avoids messy plots that can be obtained if the PA of the polarization spectrum is close to 0 or 180. eg. >TRANGE 0 190,THI will plot all PAs between 0 and 10 between 180 and 190.

TITLE *title*
Titles the current polarization spectrum with the character string title. Quotes are usually required to protect the case and numerics.

TLOW
PA data in the range (180+Tmin) to 180is plotted below 0. This avoids messy plots that can be obtained if the PA of the polarization spectrum is close to 0 or 180. eg TRANGE -10 180,TLOW will plot all PAs between 170 and 180 between -10 and 0.

TOV *wavelength*
Transforms the x-axis of the current polarization spectrum to velocity space. The wavelength given is the rest wavelength for the transformation and the velocity is in kilometers per second.

TOW *wavelength*
Transforms the x-axis of the current polarization spectrum to wavelength space. The parameter is the wavelength of the rest velocity for the transformation and should be given in Angstroms.

TRANGE *min max*
Limits the position angle plotting range.

TRIPLOT *error [entry] [entry] ...*
Plot the specified polarization spectra in triplot format. This format has the position angle in the top section, the percentage polarization in the middle section and the bottom section displays the I Stokes parameter. The polarization is binned to a constant error. The DEV command must have been called to initialize the plotting device. If no entry is specified the contents of the current arrays are plotted.

UAUTO
Automatically set the Stokes U range.

URANGE *min max*
Limits the Stokes U plotting range.

WAUTO
Automatically set the wavelength range.

WMERGE *spec1 spec2 weight1 weight2*
Merges two polarization spectra with identical x-grids. The spectra are merged according to the given weights and the result is placed in the current arrays.

WRALAS *filename*
Writes out the polarization spectrum from the current arrays into the file filename. The file is

written in ascii format with wavelength as the first column followed by the Q Stokes parameter and its variance and the U Stokes parameter and its variance.

WRANGE *min max*
Limits the wavelength plotting range.

WRTSP *filename*
Writes out the polarization spectrum from the current arrays into a TSP format file. Details of the N-dimensional data format files can be found in the TSP user guide.

WRSTK *filename*
Writes out the stack into a save file.

XADD *constant*
Adds a constant value to the x array.

XGRID *xstart xend npts*
Creates an evenly spaced wavelength grid on the current arrays. The Stokes parameters are zeroed and the current spectrum is lost. The grid has npts and runs from xstart to xend.

XLABEL *label*
Sets the x-axis label for the triplot.