# POLPACK—An Imaging Polarimetry Reduction Package

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**Abstract.** We present an overview of the facilities provided by POLPACK— an imaging polarimetry reduction package written by the UK Starlink project.

## 1. Introduction to POLPACK

POLPACK is a package of applications for mapping the linear or circular polarization of extended astronomical objects, either in a single waveband, or in multiple wavebands (spectro-polarimetry). Data from both single and dual beam polarimeters can be processed. It is part of the Starlink Software Collection (SSC) which is currently available for Linux, Solaris and Tru64 Unix (more systems will be added to this list in the near future). Facilities include:

- alignment of images on the sky.

- extraction of O and E images from individual frames of dual-beam data.

- sky subtraction.

- calculation of Stokes parameters with errors.

- binning of Stokes parameters.

- creation of catalogues of polarization vectors with errors.

- graphical display of vector maps.

- creation of simulated intensity images from a Stokes cube.

## 2. Single and Dual Beam Facilities

Data can be processed from single-beam polarimeters or spectro-polarimeters containing either a fixed analyser and a rotating half-wave plate, or multiple fixed analysers, or a single rotating analyser (only linear polarization is supported). The transmission and efficiency of non-perfect analysers can be taken

into account, if known values for these quantities are available. Estimates of the variance in the observed intensity images can be made if necessary. This is useful if your data does not have usable variance information associated with it.

In dual-beam mode, it is assumed that the polarimeter or spectro-polarimeter contains a fixed analyser and a rotating half or quarter wave-plate which is stepped in units of 45°. Both linear and circular polarization can be measured. Variances can be calculated for the reduced quantities (Stokes vectors, polarization vectors, etc.) if the observed intensity images have usable variances associates with them (i.e. these input variances cannot be estimated for dual-beam data).

Corrections can be applied when calculating the Stokes vectors which take account of any differences in the exposure times between raw frames, or any difference in the sensitivity of the two channels of the dual-beam polarimeter (such as may be produced by an imperfect analyser). The level of correction required is found automatically and relies on redundancy in the supplied data, requiring a specific set of analyser positions to be used when obtaining the data.

## 3.   Integration with GAIA

GAIA[1] is a popular graphical image browser and analysis tool produced and distributed by Starlink. It includes a toolbox for displaying and analysing polarization maps. Facilities include:

- Overlaying of vector maps on top of images and/or contour maps with complete control over the appearance of vectors (colour, width, scale, etc.)

- Simultaneous display of a table showing all parameters for all displayed vectors. Statistics for each column in the table can be displayed.

- Selection of vectors either by clicking and dragging on the vector map, clicking and dragging on the vector table, or by giving a Boolean expression based on algebraic functions of the vector parameters (e.g.
  "`dp < 5 && dang < 20`"). Selected vectors are highlighted in both the vector map and the vector table, and the selected vectors can be binned, erased, copied, saved to a new file, etc.

- FITS binary tables can be read which use arbitrary (e.g. non-POLPACK) column names.

## 4.   Further Information

For further information, including download instructions, see the POLPACK web page[2], or contact David Berry (`dsb@ast.man.ac.uk`).

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[1]http://www.starlink.ac.uk/gaia/

[2]http://www.starlink.ac.uk/polpack