

# Difwrap: A Graphical User Interface for Error Analysis in Difmap

JIM LOVELL

*ATNF, PO Box 76, Epping NSW 1710, Australia*

## Abstract

Difwrap is a software package that provides a Graphical User Interface (GUI) to Difmap. The main purpose of the software is to provide a means to estimate uncertainties in source models generated by Difmap's *modelfit* task. Difwrap also allows for some limited configuration of Difmap parameters through the GUI.

## 1 Introduction

Difwrap is a program written in the Perl language to provide a Graphical User Interface (GUI) to Difmap (Shepherd et al. 1994). The main function of the software is to provide a means to estimate errors in source models generated by Difmap's *modelfit* task through a comparison of trial models with visibility data.

## 2 Model Error Analysis

The Model Error Analysis function in Difwrap is based on the process first described by Tzioumis et al. (1989). This process involves adjusting the model parameter of interest by a small amount and then fixing it. The fitting process is then run to allow the model to re-converge. This cycle of parameter adjustment and model fitting is repeated until an obvious visible difference between the model and the data is seen.

This visual inspection method to determine goodness of fit provides more realistic error estimates than a traditional chi-squared analysis because the number of degrees of freedom is typically not well known. This method also has the advantage that it allows for the inter-dependency of model components to be taken into account during model fitting. For example, if the  $(u, v)$  coverage is limited, there can be a strong inter-dependency between the size and flux density of the model component.

The main problem with this method is many trial models may be needed before a good understanding of the errors can be obtained. Carrying out this task by hand is tedious and time-consuming as it requires

the generation of many model files, followed by a visual comparison of each model with the data. The model error analysis function of Difwrap removes much of this drudgery. It works in the following way:

1. The model components are presented to the user who decides which parameter (flux density, position or component size/shape) requires an error estimate.
2. The user then decides what range of parameter values require trialing and how many points to sample within that range.
3. Difwrap will then create a test model for each grid point, carry out the model fitting and store the final model and goodness of fit values.
4. When this is complete, the user can select how the goodness of fit values are to be presented. For example, if a component flux density uncertainty is being investigated, the user can choose to plot trial flux density against chi-squared of the fit. When the user selects a point on this plot the corresponding model is shown with the data for comparison. The user then indicates if the fit is acceptable or not.
5. After this inspection, the estimated error values are presented.

### 3 An Example Error Analysis

As an example of using Difwrap to obtain error estimates, an error analysis of a model for the VSOP Survey source J1316–3338 is shown.

In this example the objective is to estimate the core brightness temperature uncertainties. This requires an error analysis of the flux density and size of the core component. Firstly, the limits on the size of the component are requested. A range of Major Axis, Axial Ratio and Major Axis Position Angles are chosen with a sampling grid of 5 points in each dimension. The user then chooses to run the Difmap task *modelfit* with 10 iterations for every trial model. Difwrap is then instructed to construct the models for each of the grid points, run *modelfit* and measure the goodness of fit in each case.

On completion, Difwrap displays a “Plotting and Analysis” window which allows the user to choose how to display the results. In this case the results will be plotted as “slices” of a cube with X and Y axes of

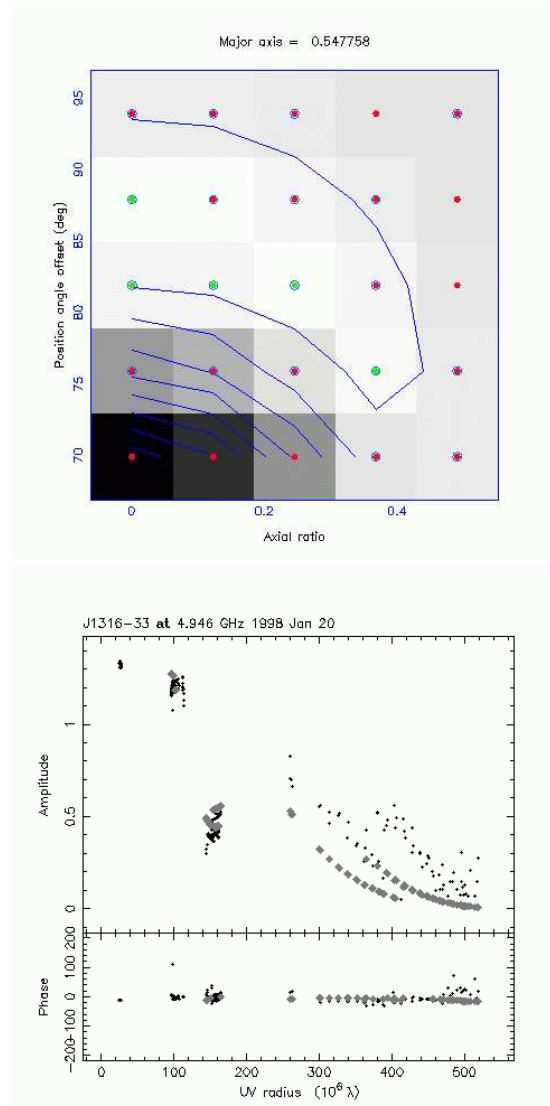


Figure 1: **Top:** RMS of the *modelfit* (logarithmic contours and greyscale) as a function of Position Angle and Axial Ratio for the best fit Major Axis. Darker pixels represent a larger rms. **Bottom:** The visibility data (black) with a model (grey) corresponding to a grid point sampled by Difwrap and plotted at top. In this case the user has plotted a model corresponding to a sampled grid point with an unacceptably high rms.

Position Angle and Axial Ratio respectively. The user steps sequentially through the gridded Major Axis values. Figure 1 shows the rms of the fit (greyscale) plotted as a function of Position Angle and Axial Ratio for the best fit Major Axis. Each pixel may be selected and the corresponding model fit is then plotted. The user may then decide if the fit is acceptable or not by changing the colour of the point plotted over each pixel. For this source, an Axial Ratio of 0 makes an acceptable fit for some position angles (implying an infinite brightness temperature) so only a lower limit on brightness temperature can be obtained. A similar error analysis to obtain limits on the core flux density results in an uncertainty in flux density of  $\pm 0.12$  Jy. The lower-limit on flux density combined with the upper-limit on component area (i.e when Major Axis and Axial Ratio are at their largest) thus provides a lower limit on brightness temperature of  $4.8 \times 10^{11}$  K in the source frame.

#### 4 Obtaining Difwrap

Difwrap is still under development. The most recent version, together with documentation for installation and use, can be obtained from <http://www.vsop.isas.ac.jp/survey/difwrap/>.

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#### References

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Tzioumis, A.K., Jauncey, D.L., Preston, R.A. et al. 1989, *AJ* **98**, 36