A VLBI Image Model-Fitting Pipeline Programme

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1 Introduction

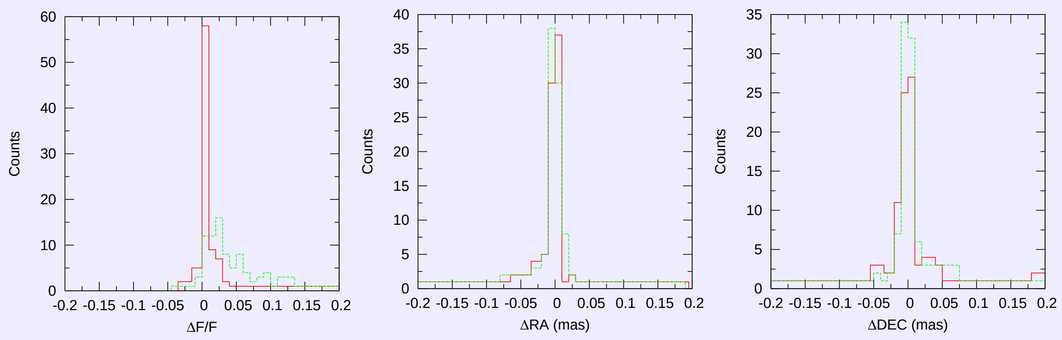
Since we need model-fitting to extract the physical information either from VLBI image or visibility data, we hope it can be done automatically for larger survey or monitor observations. This is not a trivial practice because machine-only processing will not have the prior knowledge from eye guidance and is parameter-sensitive. However, a qualified success can still be achieved with a certain source-finding algorithm. In this presentation, we will demonstrate our try in developing an image model-fitting pipeline programme to help digesting large VLBI image database. This work is an incorporation to the *Bordeaux VLBI Image Database* project.

2 Method lines

- *Search and Destroy* (SAD) source-finding algorithm.
- Image plane model-fitting and uv plane model-fitting.
- Image model reconstruction.
- Parameter-control programme frame.
- Simultaneous output parsing and summarising.
- ObitTalk Python interface to AIPS.

3 Testing over RDV observations

We applied our programme on RDV geodetic VLBI observations. This programme frame is able to include early stage calibration and self-calibration procedure, but in this test we started with self-calibrated data in our image database. Our interests were flux and positional parameters, so we supposed the source brightness model can be described by a handful discrete components (elliptical Gaussians). We used SAD to find out bright peaks in the image plane above a certain flux threshold. The brightness-ordered source suspects were then fed to image plane model-fitting and uv model-fitting programmes. The image models were then reconstructed from the fitted models. The inter-task/functions data transfer were partly done through formatted output parsing. Some statistics of batch-fitted parameters from this pipeline programme are shown below. The tested data was from RDV20 X-band global VLBI observation. The component number was fixed to one for both image plane fitting and uv plane fitting.



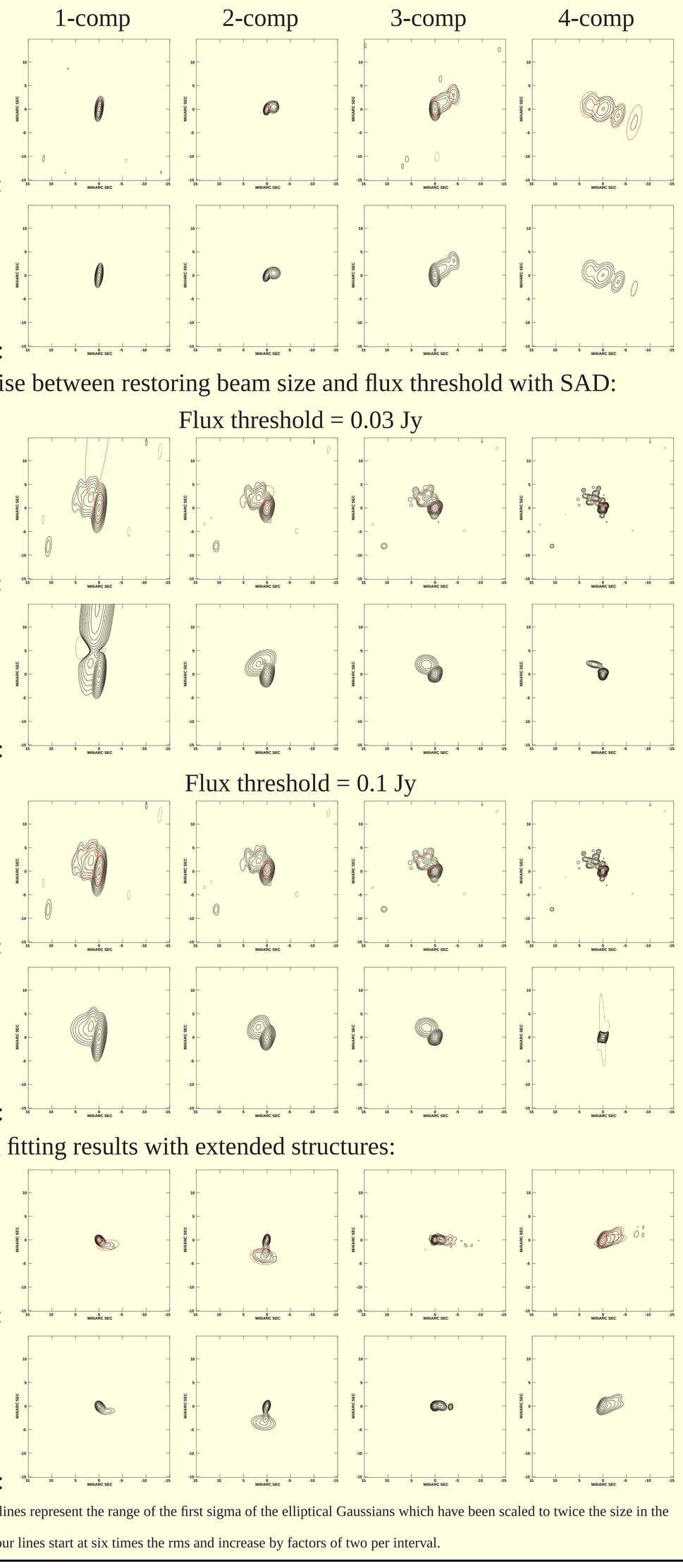
Distributions of the fitted parameter differences between image plane and uv plane approaches. The references are taken from SAD fitted parameters. The image plane fitting is done with JMFIT and the uv plane fitting is done with OMFIT. The red (solid) lines are for image plane fitting, and the green (dashed) lines are for uv plane fitting.

We can see the position difference distribution peaks from image plane fitting and uv plane fitting are nearly coincident while the flux difference distribution from uv plane fitting shows excessive flux. This is true since the deconvolution cannot fully recover the source flux [1].

For compact sources, the programme worked out fairly well, despite some limits from AIPS tasks like the fitting windows size, the number of simultaneously-fittable components number, the precision loss in formatted output. However, for extended or complicated structures the fitted models could be degenerated or erroneous. Some adjustments can be done by manually selecting appropriate parameters. For image plane model fitting, there is a compromise between the restoring beam size and the flux threshold with SAD. Larger beam will collect more flux as well as noise spikes, smaller beam may mottle the extended structure. Both beam size and flux threshold selection may confuse SAD or make modelling difficult. Some extended structures may be well represented by multi-component model, but not necessarily physical. A gallery of some typical fitting results from the pipeline programme is shown in Section 4.

4 Results gallery

Some successful automatic model-fittings of multi-component sources:



Compromise between restoring beam size and flux threshold with SAD:

Confusing fitting results with extended structures:

The red elliptical lines represent the range of the first sigma of the elliptical Gaussians which have been scaled to twice the size in the figures. The contour lines start at six times the rms and increase by factors of two per interval.

5 Conclusions

- Pros:
  - Simple-structured source models can be obtained automatically.
  - Erratic fittings may indicate structure complexity or low image quality.
  - AIPS tasks are utilised and easy for manual check.
- Cons:
  - Complex-structured source models still need manual care.
  - Limits inherited from AIPS tasks.

[1] M. Zhang, N. Jackson, R. W. Porcas and I. W. A. Browne. A search for the third lensed image in JVAS B1030+074. In *Monthly Notices of the Royal Astronomical Society*, pages 377–1623, 2007