Report from the last MKSP polarization imaging busy week, June 17-19

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on behalf of the LOFAR MKSP

LOFAR status meeting, July 22, 2015

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LOFAR MKSP polarization busy weeks

New MKSP management structure

Need for proper polarization calibration and imaging with LOFAR.
→ **Decision: restart dedicated polarization busy weeks.**

Polarization calibration busy weeks

LOFAR-specific polarization **calibration problems**. **Develop** a working calibration **guideline**.

Polarization imaging & RM-Synthesis busy weeks

Develop strategies for LOFAR-specific **polarization imaging: advanced RM-Synthesis techniques, source finding, image analysis**. Test and develop needed software.

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Develop strategies for LOFAR-specific **polarization imaging: advanced RM-Synthesis techniques, source finding, image analysis**. Test and develop needed software.

Overview: PYRMSYNTH *(Report bugs & issues on github or via mail to henrikju@astro.uni-bonn.de)*

A **python-based code** framework to perform **RM-Synthesis**, developed for the MKSP by M. Bell & H. Junklewitz. **Fast** using gridding and **FFTs**, and **C routines** where most needed. Enables **RMClean**. Many extra **features**.
Check out on **github** (https://github.com/mrbell/pyrmsynth):

`pyrmsynth` - Python based RM Synthesis code including RMCLEAN

Current version: 1.3.0 *Updated on:* 2015-06-22

`pyrmsynth` performs RM-synthesis, either simply by Fourier transformation (to produce a dirty image) or using the RMCLEAN method as described by Heald, et al. (2009). It uses FFTs for the Fourier inversion and, as far as
known to the authors, this is the only RM synthesis software around that does this. The Numpy FFTs

BW results I: Small new features & bugfixes in PYRMSYNTH

For details see the description of release 1.3 on github.

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- A new simulation tool has been devised (part of the release).
- Several bugfixes.
- Probing 3D RM-cube visualization

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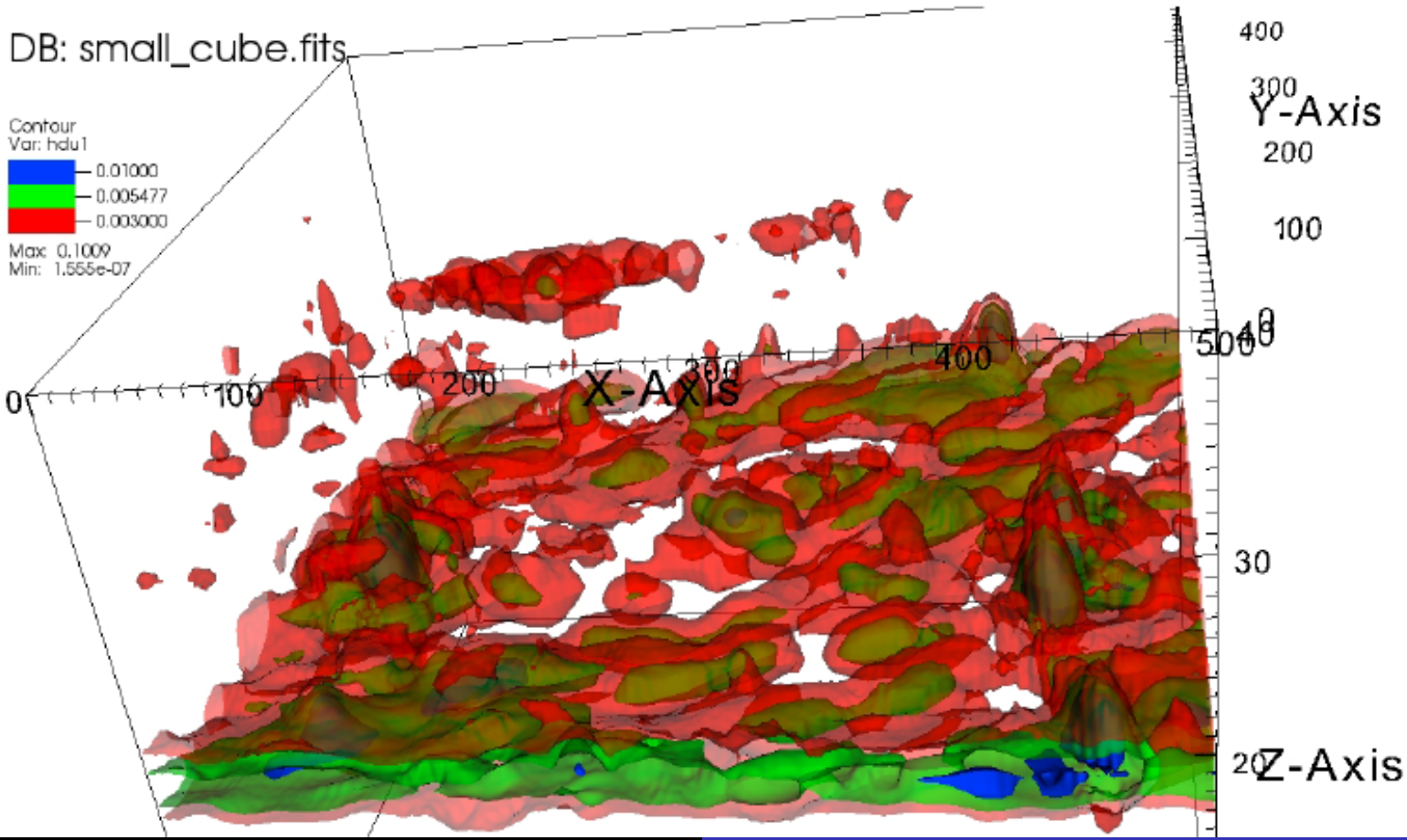

BW results II: Include spectral information in PYRMSYNTH

Take account spectral evolution in RM-Synthesis.
$\rightarrow$ Divide spectral function from Faraday spectrum.

Reminder

$$F(\phi, \lambda^2) = f(\phi)s(\lambda^2)$$

$$\frac{P(\lambda^2)}{s(\lambda^2)} = W(\lambda^2) \int_{-\infty}^{\infty} f(\phi) \exp 2i\phi\lambda^2 d\phi$$

Now implemented and tested in PYRMSYNTH.

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Simulations: much better shape of the RM spread function improves tails of peaks in Faraday spectrum. Important to distinguish sources, and especially to divide out instrumental polarization.

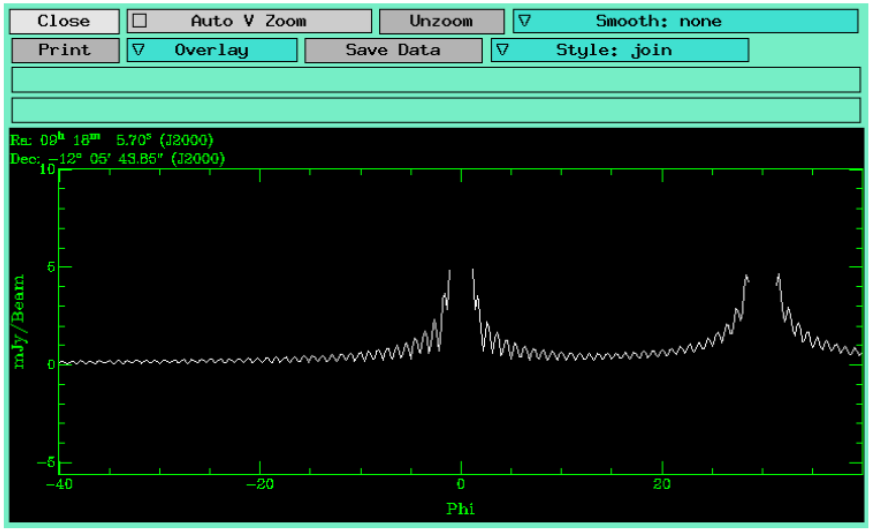

Figure: Without spectral index.

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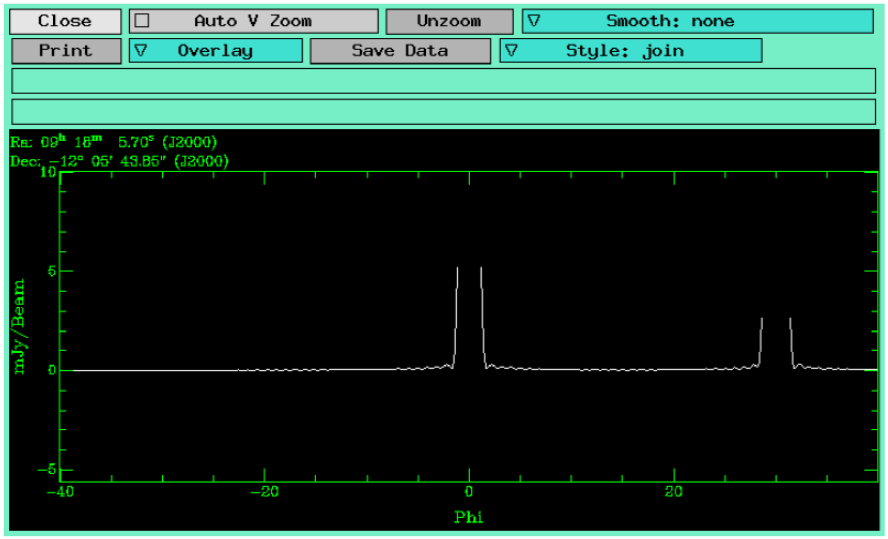


Figure: With (correct) spectral index.

Overview: polarization source finding

Only relatively experimental methods for polarization source finding. **No simple transfer** from Stokes I source finding: possibly **non-Gaussian noise** statistics in P maps, or **negative fluxes** in Q/U maps. Both is strictly breaking standard assumptions. **3D source finding** in RM cubes very complex.

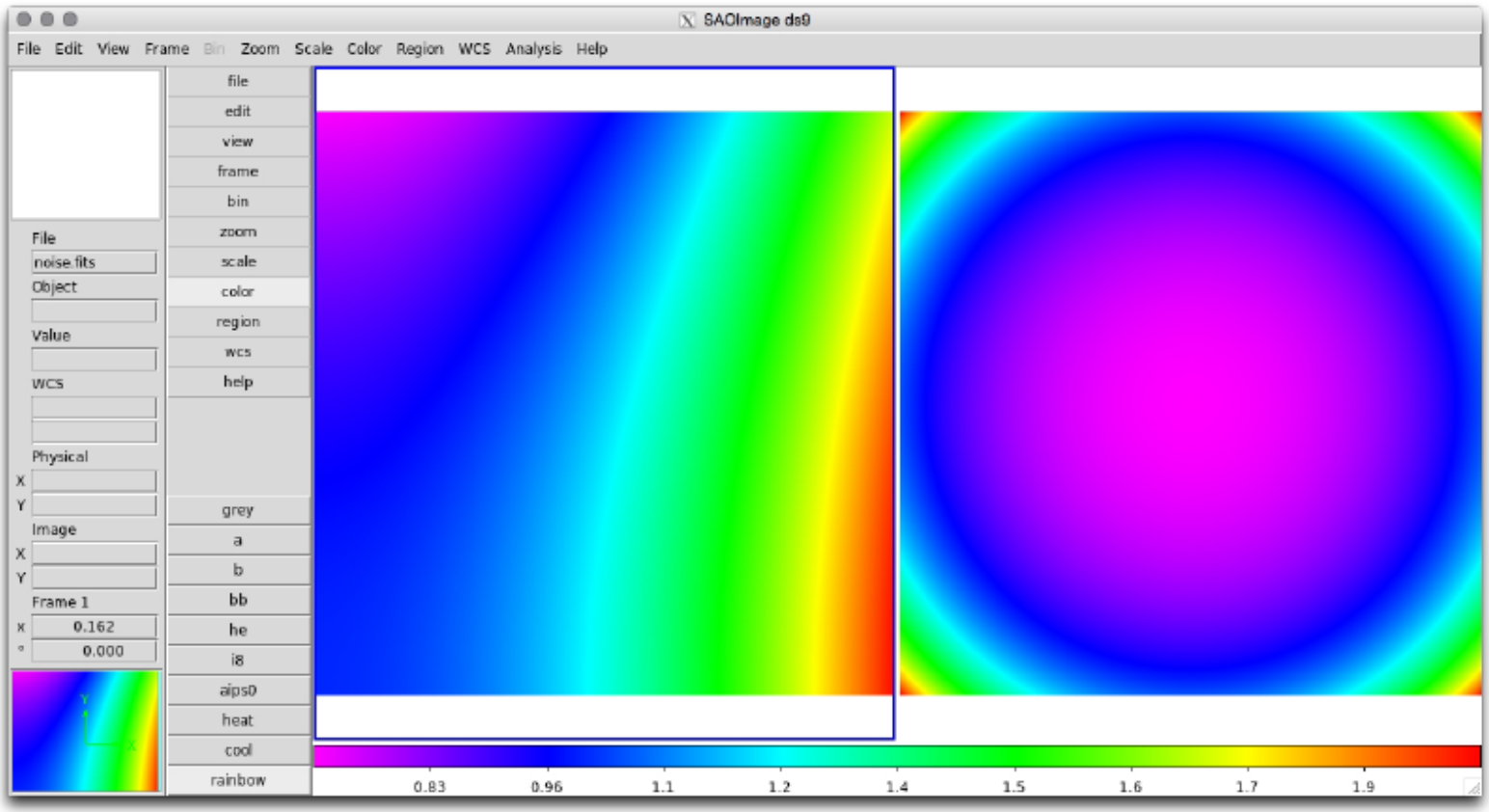
Overview: polarization source finding

Starting strategy:

Restrict testing to 2D-P source finding, test available software (in our case PyBDSM, Blobcat (http://adsabs.harvard.edu/abs/2012MNRAS.425..979H), sfind from miriad).

BW results III: Intermediate results on source finding

Tests of PyBDSM, Blobcat, and sfind on simulated data with different noise & background characteristics:



BW results III: Intermediate results on source finding

Tests of PyBDSM, Blobcat, and SFIND on simulated data with different noise & background characteristics:

- so far, all codes (including recent developments for polarization like Blobcat), have problems with high- and structured noise scenarios.
- but, PyBDSM, Blobcat are both much better than the old SFIND and produce comparable results.
- currently some problems with PyBDSM: crashed on real data, non-working polarization option. Still being investigated.
- in general, problems with close sources (like in Stokes-I source finding)

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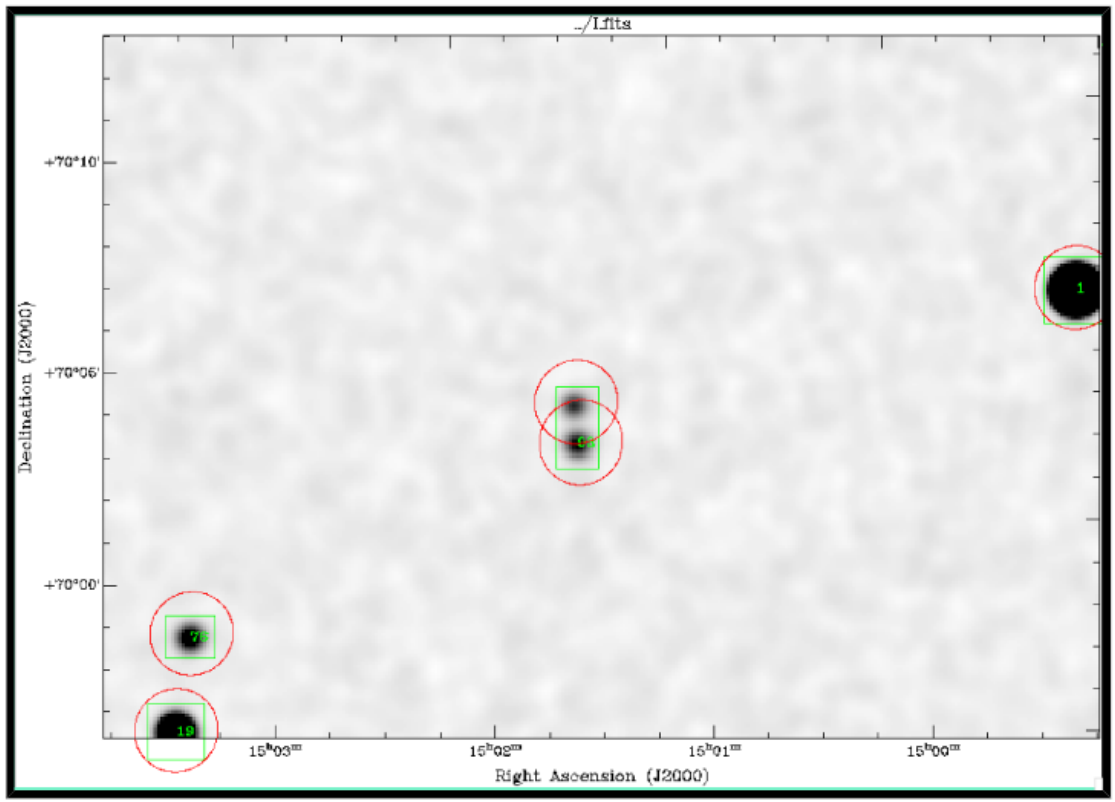

Figure: BLOBCAT on simulated data: problems with nearby sources.

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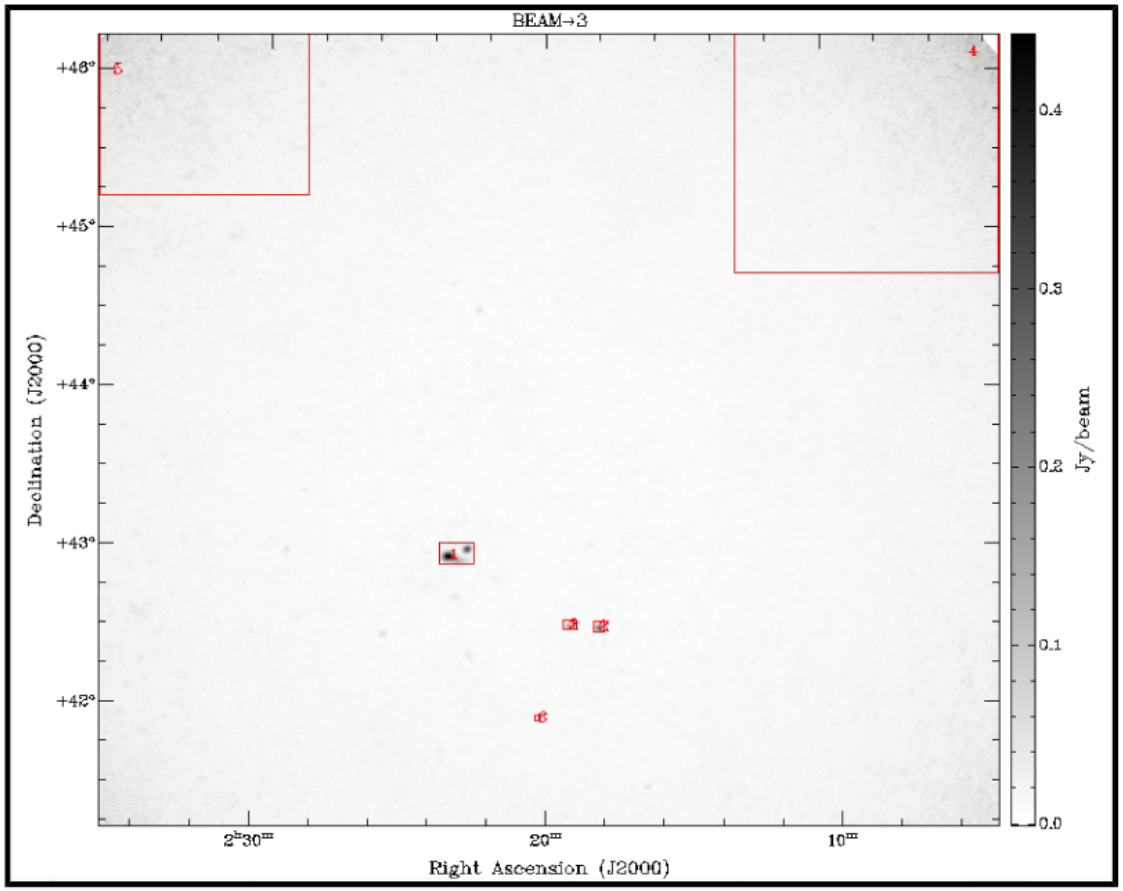

Figure: BLOBCAT on MSSS data: problems high noise regions due to

Summary & outlook

- PYRMSYNTH is being mantained and developed. Feel free to use it.
- newest feature in PYRMSYNTH: option to include a spectral index.
- ongoing effort: test and develop polarization source finding. Main topic for next busy week. Be welcome to join.