An Introduction to the ALMA Simulations

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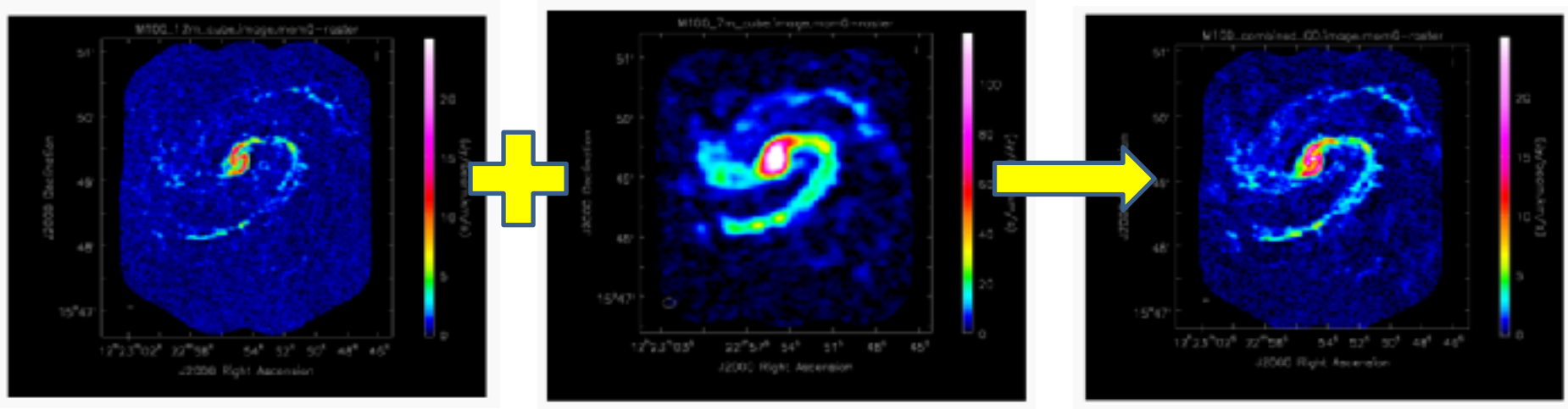
Atacama Large Millimeter/submillimeter Array
Expanded Very Large Array
Very Long Baseline Array

CASA Simulations

- CASA can take any input image, smooth it, change it's location/resolution, and make mock observations+images
- Helps demonstrate to the TAC that the observations are feasible, they will achieve desired results, and you have expertise in dealing with radio data
- We'll be (mostly) following a CASA guide on simulation data for a star-forming region

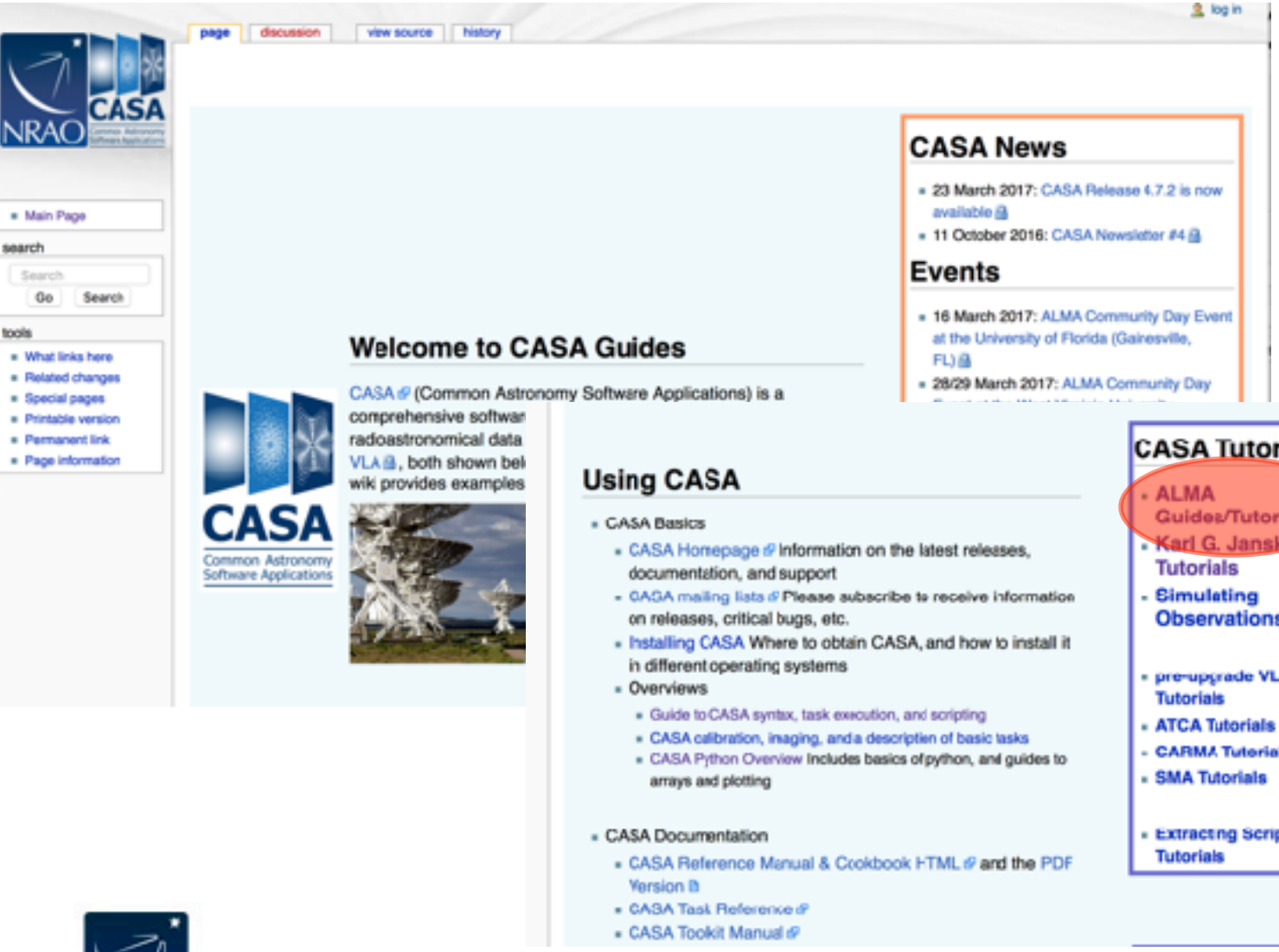
Why simulating?

- Realistic beam (elongation)
- Realistic phase noise
- Most important: spatial filtering => need for multiple configurations



12m array | 7m array | Combination

CASA Guides



NRAO

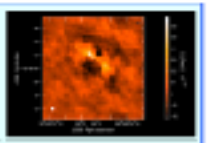
https://casaguides.nrao.edu

Simulations in the CASA Guides

- Scroll down to “A Tutorial for Simulating ALMA Data”
- Click “Simulation Examples in CASA 4.3”
- Scroll down to “Tutorials”

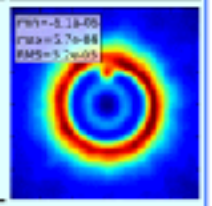
Simulation Guide for New Users (CASA 4.3)

A fully annotated tutorial that uses a Spitzer SAGE 8 micron continuum image of 30 Doradus and scales it to greater distance. A good place for new users to start.



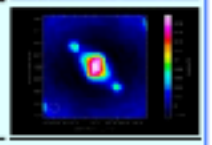
Protoplanetary Disk Simulation (CASA 4.3)

A sky model with a lightly annotated script that simulates a protoplanetary disk. Uses a theoretical model of dust continuum from Sebastian Wolff, scaled to the distance of a nearby star. This is another fairly generic simulation - if you're short on time, you probably don't need to go through this one and the New Users guide, but it can be useful to go through multiple examples.



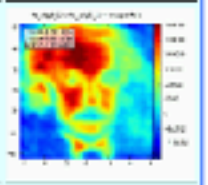
Simulation Guide Component Lists (CASA 4.3)

Tutorial for simulating data based on multiple sources (using both a FITS image and a component list). If you are interested in simulating from a list of simple sources (point, Gaussian, disk), rather than or in addition to a sky model image, then read the considerations here.



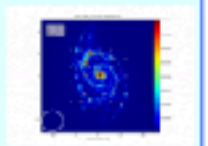
Einstein-Face (CASA 4.3)

A sky model and lightly annotated script that simulates the face of Einstein as seen by ALMA. This simulation is particularly useful for those who wish to better understand spatial filtering by an interferometer, but doesn't demonstrate new capabilities of the simulation tasks beyond those described above.



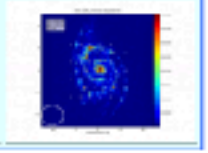
ACA Simulation (CASA 4.3)

A tutorial for simulating ALMA observations that use multiple configurations or use the 12-meter array in combination with the ALMA Compact Array. This tutorial demonstrates combining data from each ALMA component "by hand". This guide is of particular interest to those wishing to explore using the 12-m array in combination with the ACA, and those interested in combining data from multiple 12-m array configurations.



Simalma (CASA 4.3)

This tutorial demonstrates how to use simalma, a task that simplifies simulations that include the main 12-m array plus the ACA. Like the previous guide, this one is of particular interest to those wishing to explore multi-component ALMA observations.



Quick Check!

- Do you have CASA installed?
  - https://casa.nrao.edu/casa_obtaining.shtml
- Can you run it?
  - Within working directory, command line: casapy
- Do you have a model image to use?
  - Fits is preferable, but can convert jpeg etc. (https://casaguides.nrao.edu/index.php/Convert_jpg_to_fits)
  - Tutorial has link to file in "Getting Started"
- Do you have the ALMA configuration files?
  - If you have newest CASA or ran !update-data these may already exist within your CASA installation

(https://almascience.nrao.edu/tools/casa-simulator)

Start CASA!

```
CASA <2>: tasklist
--------> tasklist()
Available tasks, organized by category (experimental tasks in parenthesis ()
  deprecated tasks in curly brackets {}).

Import/export      Information        Editing
-----------------  -----------------  ---------------
exportasdm         imhead             fixplanets
exportfits         imreframe          fixvis
exportuvfits       imstat             flagcmd
importasdm         imval              flagdata
importatca         listcal            flagmanager
importfits         listfits           msview
importfitsidi      listhistory        plotms
importmiriad       listobs
importuvfits       listpartition
importvla          listvis
```

```
Simulation
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simanalyze
simobserve
(simalma)
```

- simobserve: creates mock uv data for input image
- simanalyze: images that data and creates useful diagnostic plots
- simalma: combines the two, particularly useful for combining 12m+7m+TP array data, but still in progress

Online simulator frontend!

- Online: http://almaost.jb.man.ac.uk/
- Put in your input image (or model image), set your settings and simulate!
- No need to install CASA or learn all the parameters
- Simulation may take awhile: enter your e-mail address and you get an e-mail when it is done
- Output: image in png/fits format, beam, uv-coverage, etc.
- Limitation: cannot combine multiple configurations

CASA Simulating is useful...

- Not only to demonstrate to the TAC that the observations are feasible, they will achieve desired results, and you have experience in dealing with radio data.
- But also to test whether the mosaic setup is what you want,
- and see if you really need those ACA/TP observations.