

Introduction to CASA

Common Astronomy Software Application

Dan Walker

What is CASA?

Common Astronomy Software Application



- Used for calibration, imaging and analysis of interferometric data
- Used via the command line using an iPython interface
- Available for Linux (RedHat) and Mac OS
- Current general version is CASA 6.5
- Current pipeline version is CASA 6.4 (this is what we will use)
- Latest and previous releases can always be found here: https://casa.nrao.edu/casa_obtaining.shtml

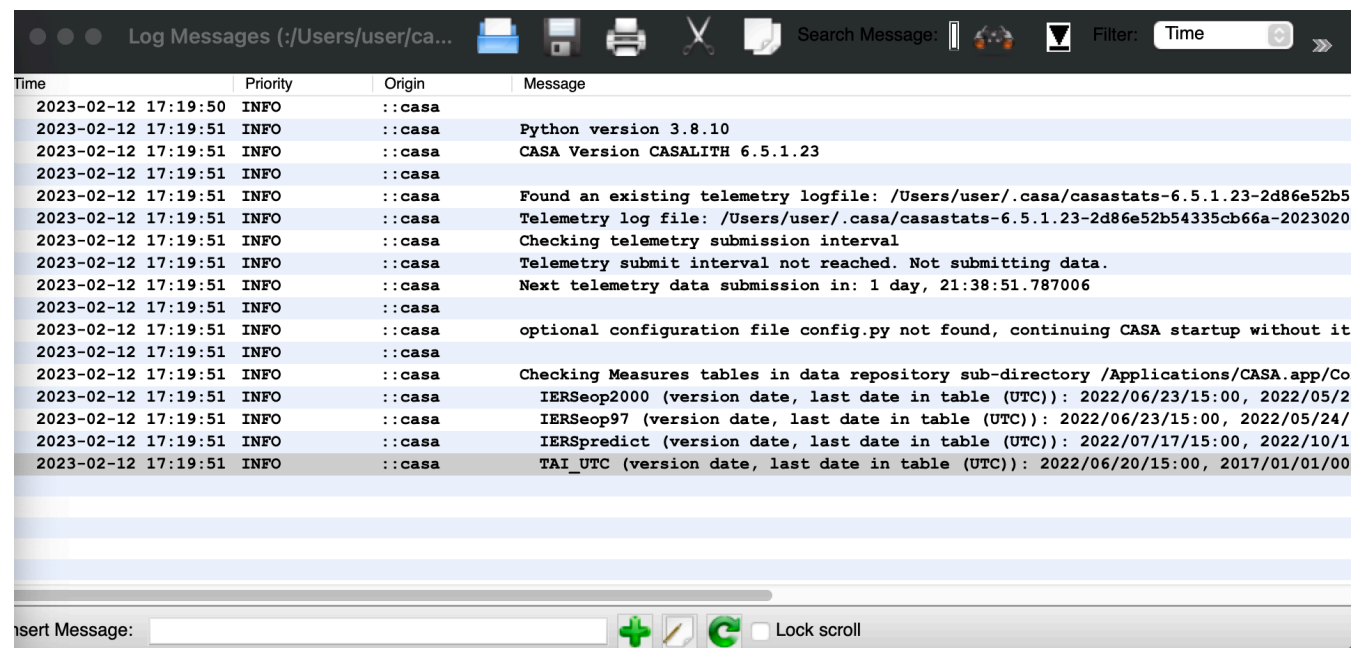
Launching CASA

- If you have set up an alias, simply type `casa` on the command line. Otherwise, enter the full path, e.g.:

```
/usr/path/casa-6.4.1-12-pipeline-2022.2.0.64/casa
```

- This will launch the IPython session in the terminal, along with the CASA logger GUI:

```
user — IPython: Users/user — casalogger < Python -m casashell — 7...
~ — IPython: Users/user — casalogger < Python -m casashell
(base) Dans-Macbook-Pro:~ g25238dw$ casa
optional configuration file config.py not found, continuing CASA startup without it
IPython 7.33.0 -- An enhanced Interactive Python.
Using matplotlib backend: MacOSX
Telemetry initialized. Telemetry will send anonymized usage statistics to NRAO.
You can disable telemetry by adding the following line to the config.py file in your rcdir (e.g. ~/.casa/config.py):
telemetry_enabled = False
--> CrashReporter initialized.
CASA 6.5.1.23 -- Common Astronomy Software Applications [6.5.1.23]
CASA <1>:
```



The screenshot shows the CASA logger GUI window titled "Log Messages (/Users/user/ca...". It features a search bar, a filter dropdown set to "Time", and a scrollable log area. The log contains the following entries:

Time	Priority	Origin	Message
2023-02-12 17:19:50	INFO	::casa	
2023-02-12 17:19:51	INFO	::casa	Python version 3.8.10
2023-02-12 17:19:51	INFO	::casa	CASA Version CASALITH 6.5.1.23
2023-02-12 17:19:51	INFO	::casa	
2023-02-12 17:19:51	INFO	::casa	Found an existing telemetry logfile: /Users/user/.casa/casastats-6.5.1.23-2d86e52b5
2023-02-12 17:19:51	INFO	::casa	Telemetry log file: /Users/user/.casa/casastats-6.5.1.23-2d86e52b54335cb66a-2023020
2023-02-12 17:19:51	INFO	::casa	Checking telemetry submission interval
2023-02-12 17:19:51	INFO	::casa	Telemetry submit interval not reached. Not submitting data.
2023-02-12 17:19:51	INFO	::casa	Next telemetry data submission in: 1 day, 21:38:51.787006
2023-02-12 17:19:51	INFO	::casa	
2023-02-12 17:19:51	INFO	::casa	optional configuration file config.py not found, continuing CASA startup without it
2023-02-12 17:19:51	INFO	::casa	
2023-02-12 17:19:51	INFO	::casa	Checking Measures tables in data repository sub-directory /Applications/CASA.app/Co
2023-02-12 17:19:51	INFO	::casa	IERSseop2000 (version date, last date in table (UTC)): 2022/06/23/15:00, 2022/05/2
2023-02-12 17:19:51	INFO	::casa	IERSseop97 (version date, last date in table (UTC)): 2022/06/23/15:00, 2022/05/24/
2023-02-12 17:19:51	INFO	::casa	IERSpredict (version date, last date in table (UTC)): 2022/07/17/15:00, 2022/10/1
2023-02-12 17:19:51	INFO	::casa	TAI.UTC (version date, last date in table (UTC)): 2022/06/20/15:00, 2017/01/01/00

Tip: use `casa -- nologger` if you don't need the logger GUI

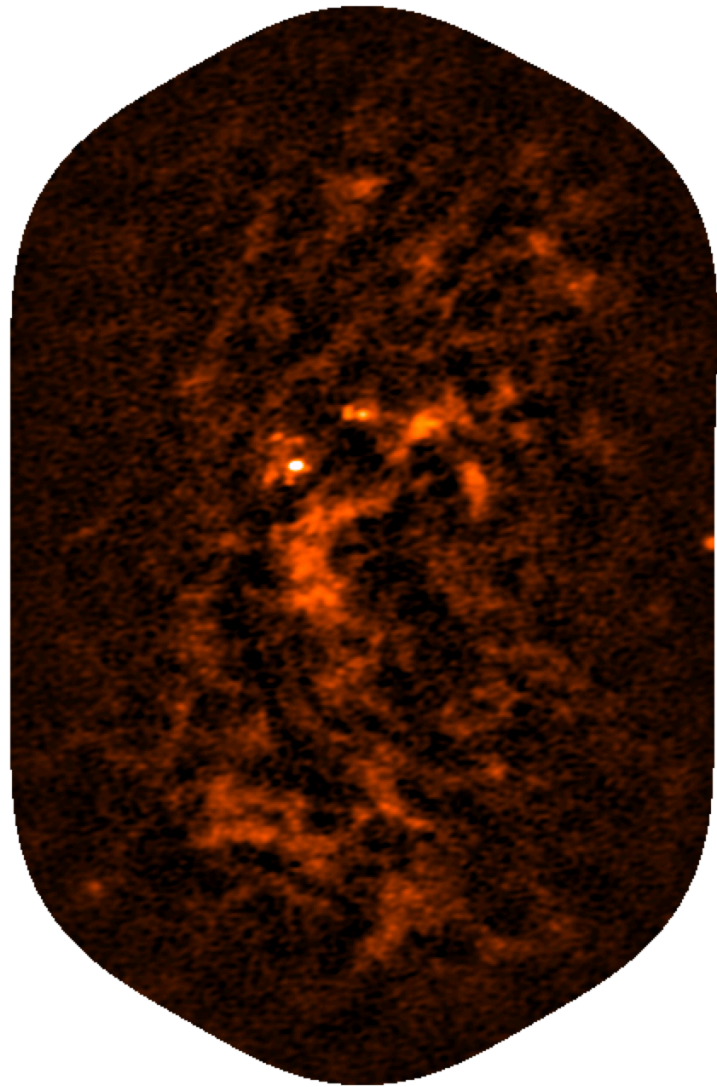
CASA tasks

- CASA tasks are an interface to the underlying toolkit
- Tasks perform a single job such as loading or plotting data
- Each task contains a set of user-defined parameters
- A complete list of available tasks can be found here: <https://casadocs.readthedocs.io/en/stable/api/casatasks.html>
- Example: change the coordinate system of an image using `imregrid`

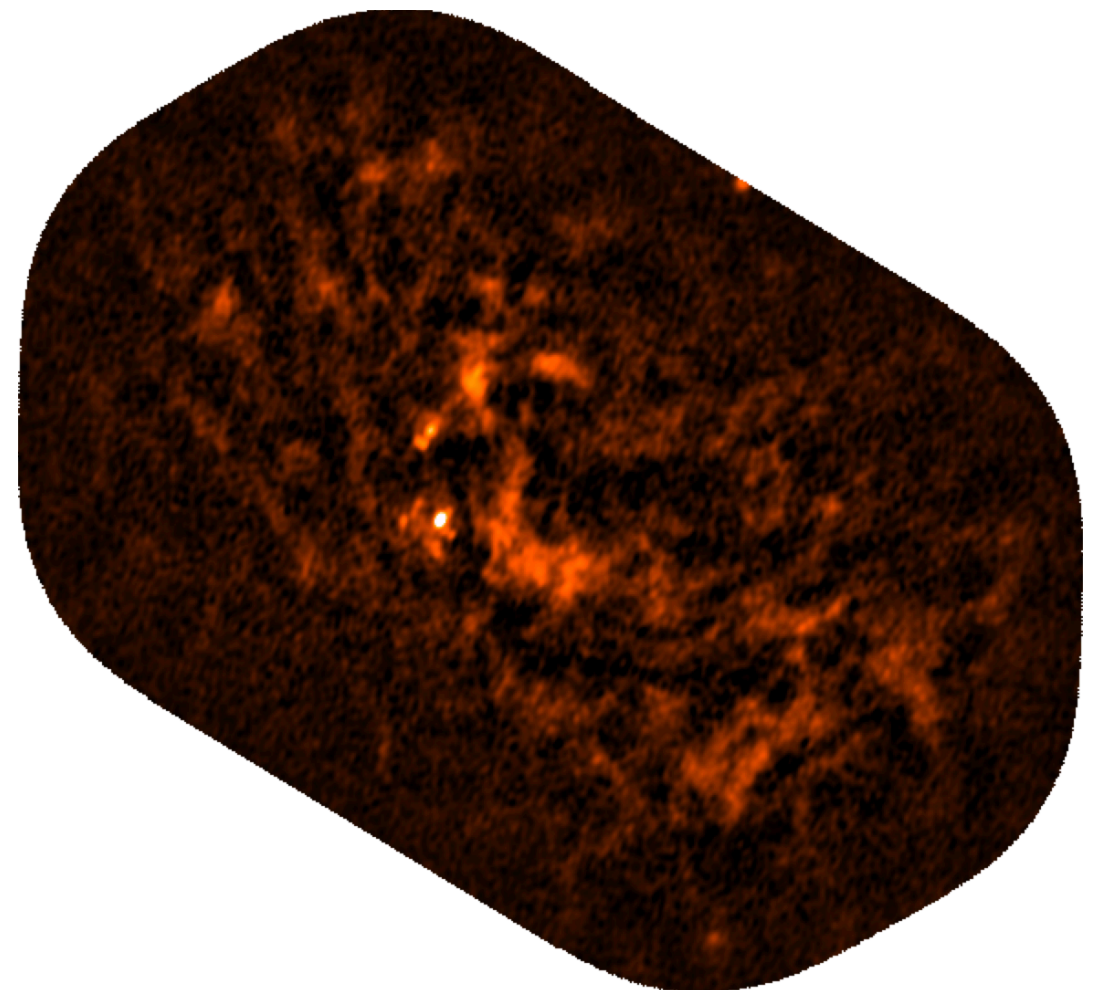
```
imregrid(imagename = 'input_image.fits',  
         template   = 'GALACTIC',  
         output     = 'output_image.galactic')
```

imregrid task example

Input: J2000



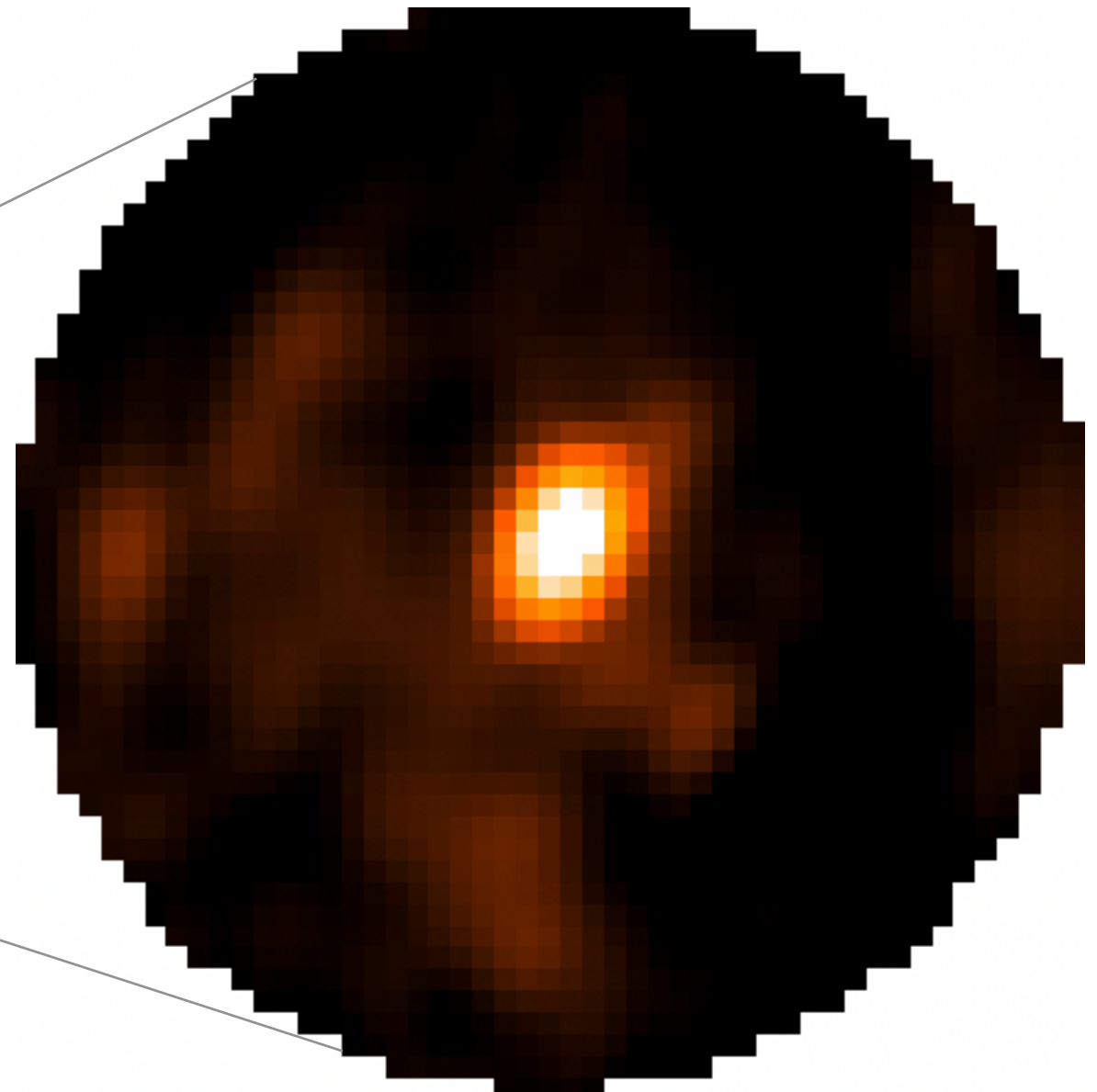
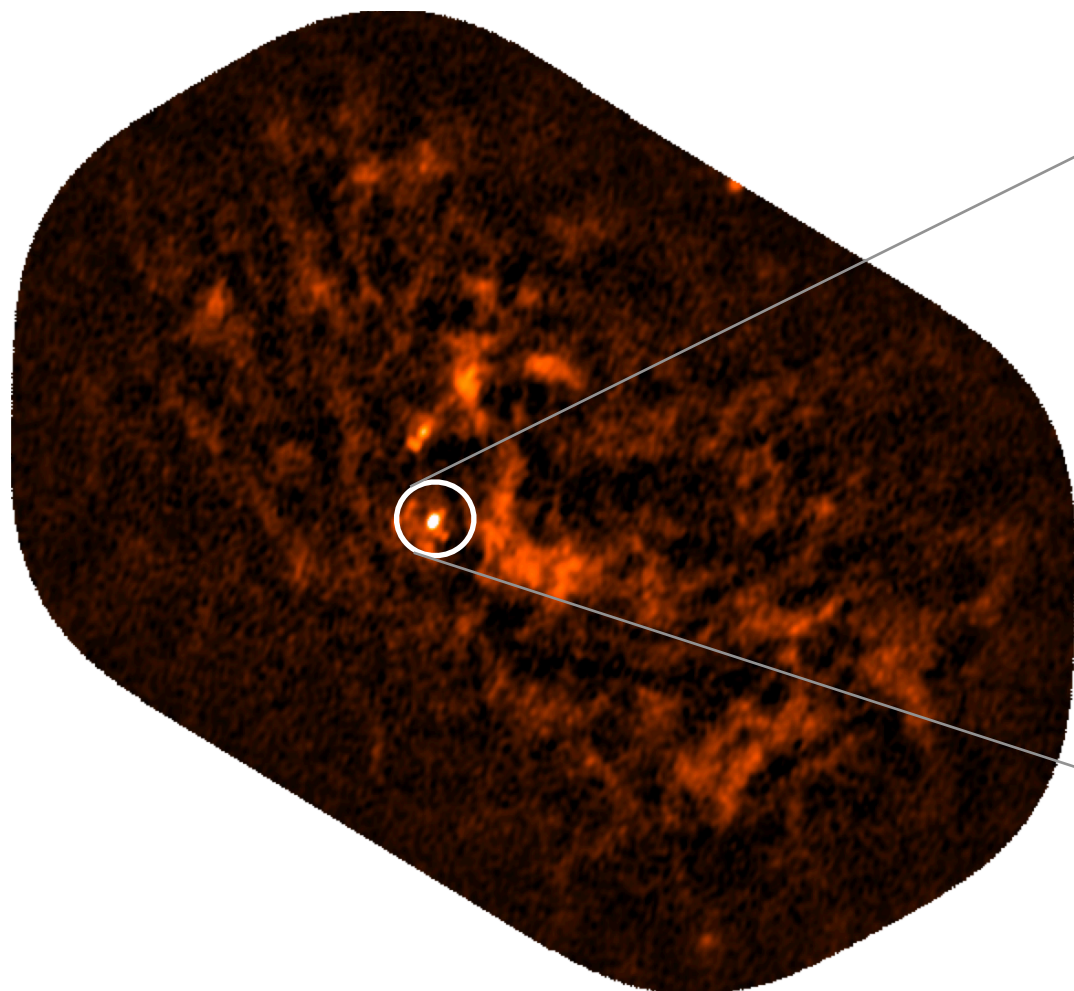
Output: Galactic



imsubimage task example

```
imsubimage(  
  imagename = 'input_image.fits',  
  region    = 'crop_region.crtf',  
  output    = 'output_image')
```

Note: .crtf extension means 'casa region text format' (see [here](#))



CASA tasks

- You can also specify the parameters in turn, and run the task later:

```
default(imregrid)

imagenname = 'input_image.fits'

template   = 'GALACTIC'

output     = 'output_image.galactic'

imregrid()
```

Beware! This method defines parameters globally, so be sure to run `default(task)` for other tasks to avoid potential issues.

CASA tasks

- You can also write tasks in a Python script, which can be executed with CASA. This is good practice for keeping track of your analyses, and making your work repeatable/reproducible.
- **Within CASA:** `execfile(script_name.py)`
- **In terminal:** `casa -c script_name.py`
- **Script example:**

```
import glob

fns = [x for x in glob.glob('*.fits')]

for fn in fns:

    imregrid(imagename = fn, template='GALACTIC',
             output=fn.replace('.fits', '.galactic'))
```


CASA data formats

- Raw visibility (uv) data from ALMA comes in *ALMA Science Data Model (ASDM)* format
- Once imported into CASA this is stored as a Measurement Set (*MS*)
- These are structured as directories containing many (sub-)tables, *not* individual files, e.g.:
- Any image files produced by a CASA task will also be stored in this format
- Use task `exportfits` to convert CASA image files to FITS format

```
dwalker2@iris3 /raid/dwalker2/UK_workshop/uid__A002_Xf396d6_X45bb.ms > ls
ANTENNA                POINTING                table.f17              table.f23_TSM1
ASDM_ANNOTATION        POLARIZATION           table.f17_TSM1        table.f23_TSM2
ASDM_ANTENNA           PROCESSOR              table.f17_TSM2        table.f24
ASDM_CALATMOSPHERE     SOURCE                 table.f17_TSM3        table.f24_TSM1
ASDM_CALPOINTING      Source.xml             table.f17_TSM4        table.f24_TSM2
ASDM_CALWVR            SPECTRAL_WINDOW       table.f18              table.f24_TSM3
ASDM_EXECBLOCK         SpectralWindow.xml    table.f19              table.f24_TSM4
ASDM_RECEIVER          STATE                 table.f2              table.f3
ASDM_SBSUMMARY         SYSCAL                table.f20              table.f4
ASDM_SOURCE            SYSPower              table.f20_TSM0         table.f5
ASDM_STATION           table.dat             table.f21              table.f6
CALDEVICE              table.f1              table.f21_TSM1         table.f7
DATA_DESCRIPTION       table.f10             table.f21_TSM2         table.f8
DataDescription.xml    table.f11             table.f21_TSM3         table.f9
FEED                   table.f12             table.f21_TSM4         table.info
FIELD                  table.f13             table.f22              table.lock
FLAG_CMD               table.f14             table.f22_TSM1         WEATHER
HISTORY               table.f15             table.f22_TSM2
OBSERVATION            table.f16             table.f23
```

Getting help with CASA

- Type `inp taskname` to get an overview of a given task and its input parameters

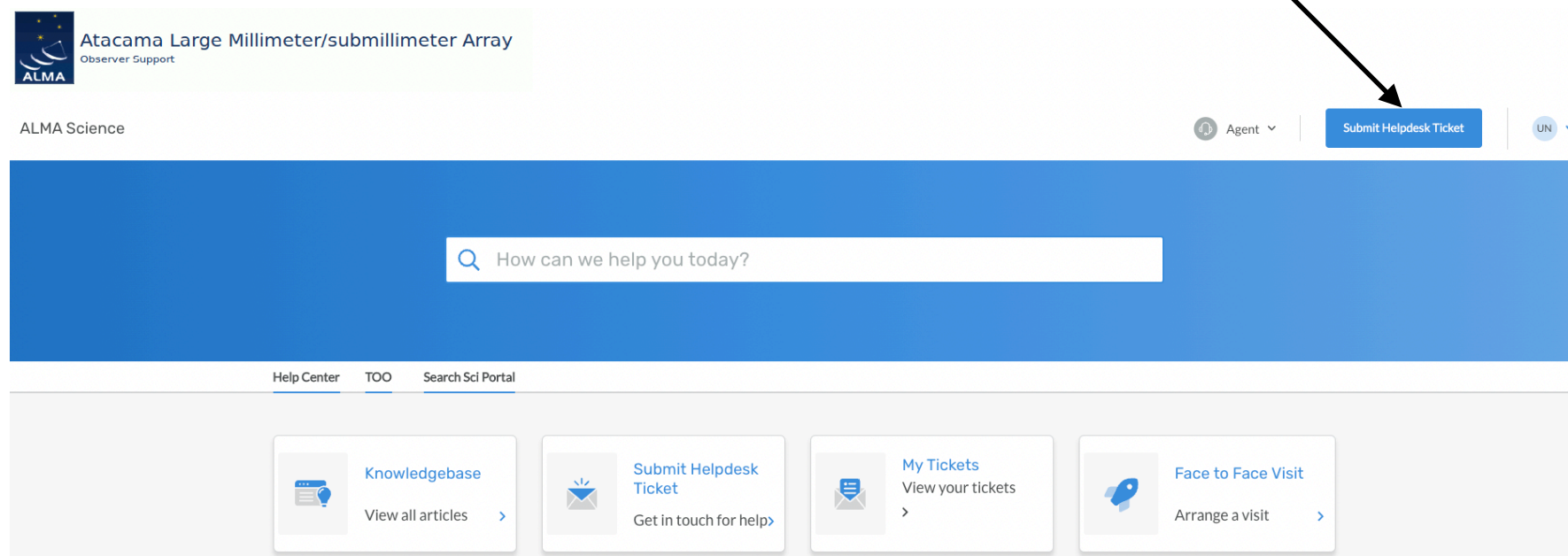
```
CASA <4>: inp imregrid
# imregrid -- regrid an image onto a template image
imagenam     = ''                # Name of the source image
              'get'              # A dictionary, refcode, or name of an image that provides the output
                                # shape and coordinate system
output       = ''                # Name for the regridded image
asvelocity   = True              # Regrid spectral axis in velocity space rather than frequency space?
axes         = [-1]              # The pixel axes to regrid. -1 => all.
interpolation = 'linear'         # The interpolation method. One of "nearest", "linear", "cubic".
decimate     = 10                # Decimation factor for coordinate grid computation
replicate    = False             # Replicate image rather than regrid?
overwrite    = False             # Overwrite (unprompted) pre-existing output file?
```

- Type `help taskname` to get a detailed description of a given task and its input parameters (use arrow keys to continue, press q to exit)

```
Help on _imregrid in module casashell.private.imregrid object:
class _imregrid(builtins.object)
|   imregrid ---- regrid an image onto a template image
|
|   Imregrid will regrid an input image onto a new coordinate system from a template image
|   or to a new directional reference frame. If a template image is used, then the input and
|   template images must have the same coordinate structure.
|
|   ----- parameter descriptions -----
|
|   imagenam     Name of the source image
|   template     A dictionary, refcode, or name of an image that provides the output shape and coordinate system
|   output       Name for the regridded image
|   asvelocity   Regrid spectral axis in velocity space rather than frequency space?
```

Getting help with CASA

- For the most detailed information, refer to the latest CASA documentation: <https://casa.nrao.edu/casadocs/latest>
- If you are still having issues, you can submit a Helpdesk ticket, and someone will happily assist you!
- Visit <https://help.almascience.org/>
- Submit to the Data Reduction department
- State CASA version and OS



CASA Guides

- Go to https://casaguides.nrao.edu/index.php?title=Main_Page for a suite of examples to guide you through using some CASA tasks (mostly imaging related).

The screenshot shows the main page of the CASA Guides website. At the top, there are navigation links: [main page](#), [discussion](#), [view source](#), and [history](#). The left sidebar contains the NRAO logo, a search box with the text "Search CASA Guide" and "Go" and "Search" buttons, and a "tools" section with links: [What links here](#), [Related changes](#), [Special pages](#), [Printable version](#), [Permanent link](#), and [Page information](#). The main content area features a "Welcome to CASA Guides" section with a description of CASA as a software package for calibrating, imaging, and analyzing radio astronomical data. Below this is a "CASA Tutorials" section with five thumbnail images: ALMA (highlighted with a red border), VLA, VLBI, ATCA, and Simulations. The Simulations thumbnail includes technical data: min=-6.1e-06, max=5.7e-04, and RMS=5.2e-05. At the bottom, there is a link: [Extracting Scripts from Tutorials](#).