Tools for data analyses in Cosmology

- Aula 3 -

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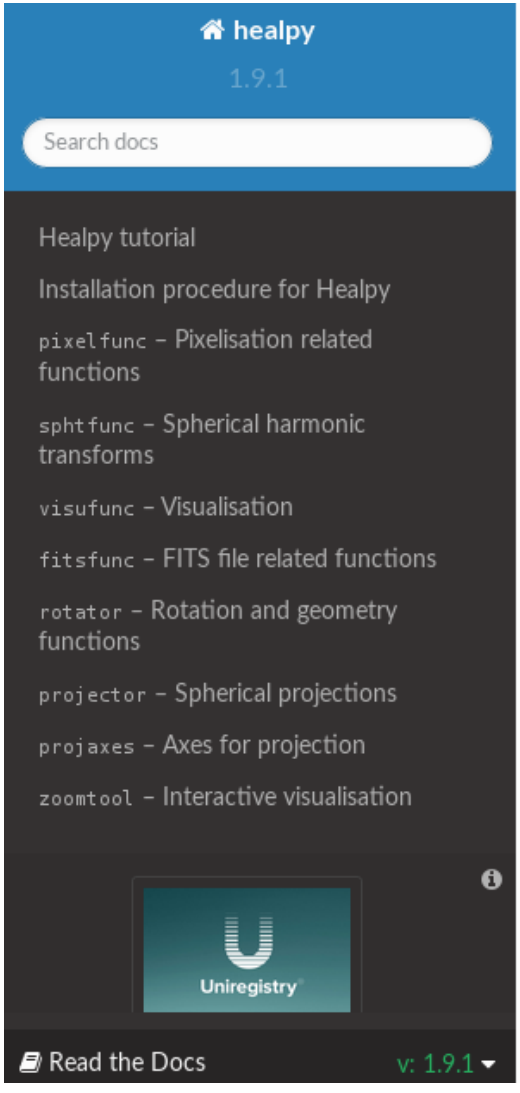
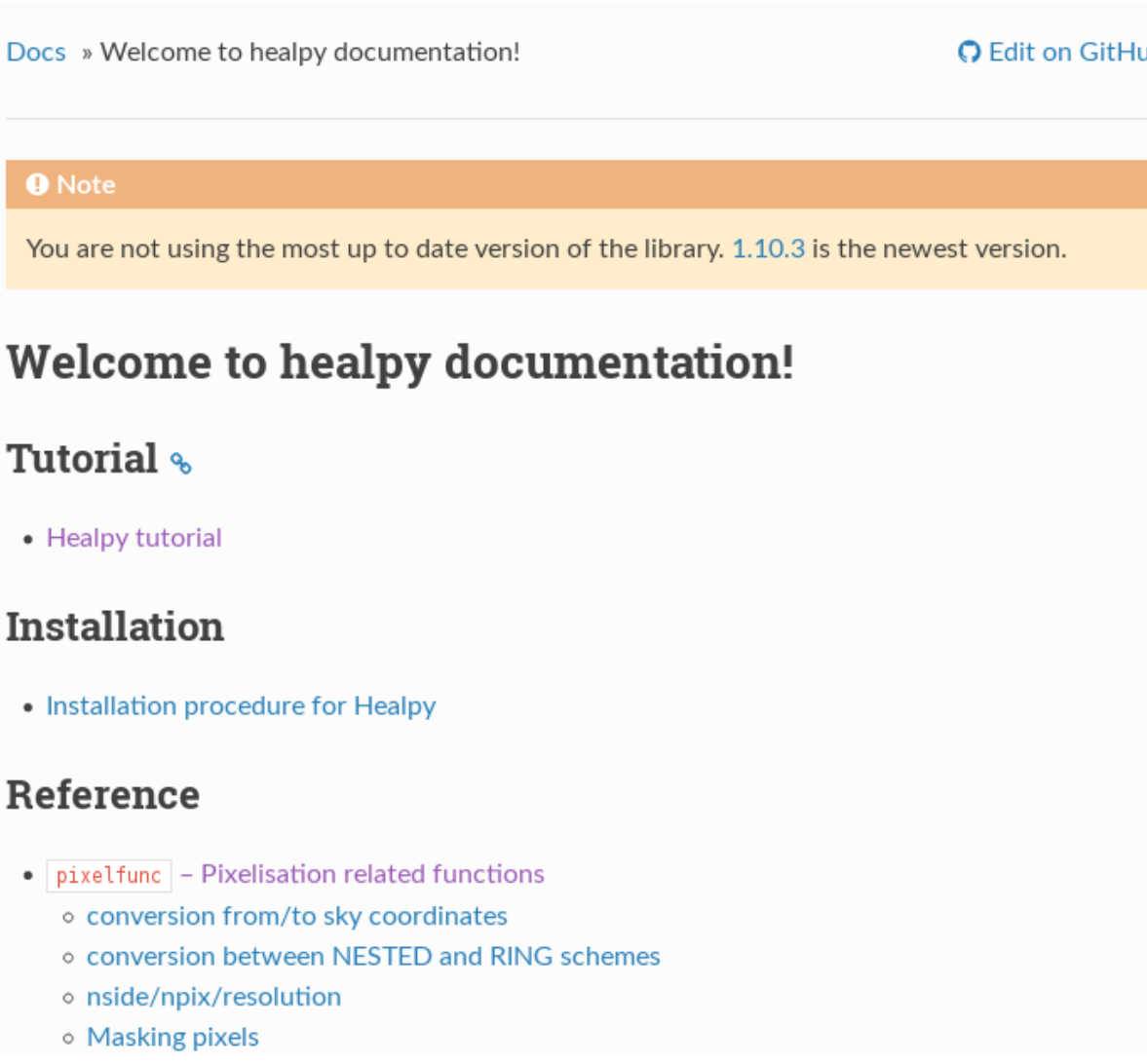
Installation

Healpy ✓

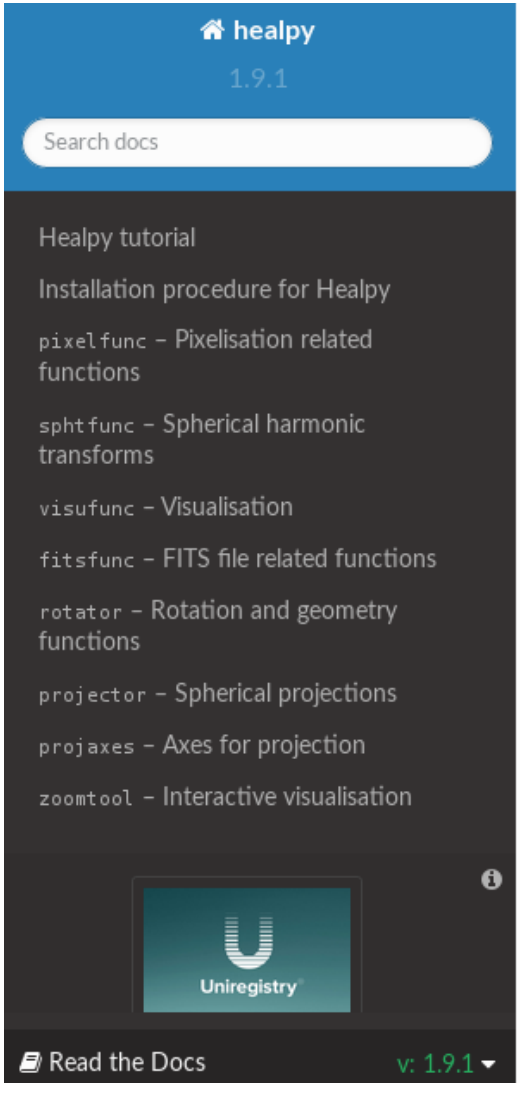
Healpy: Online Documentation *

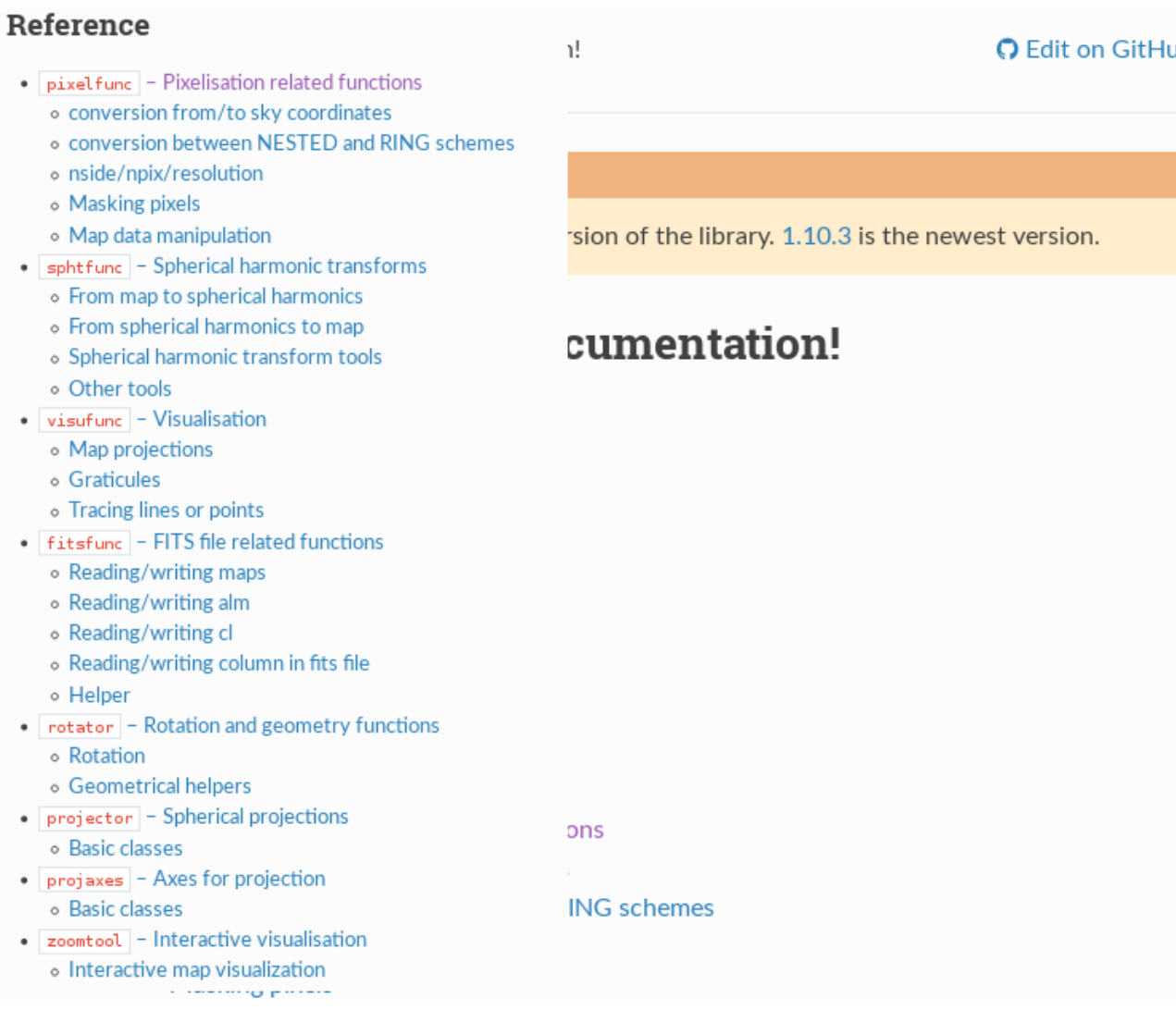




* Note: We will follow Healpy version 1.9.1

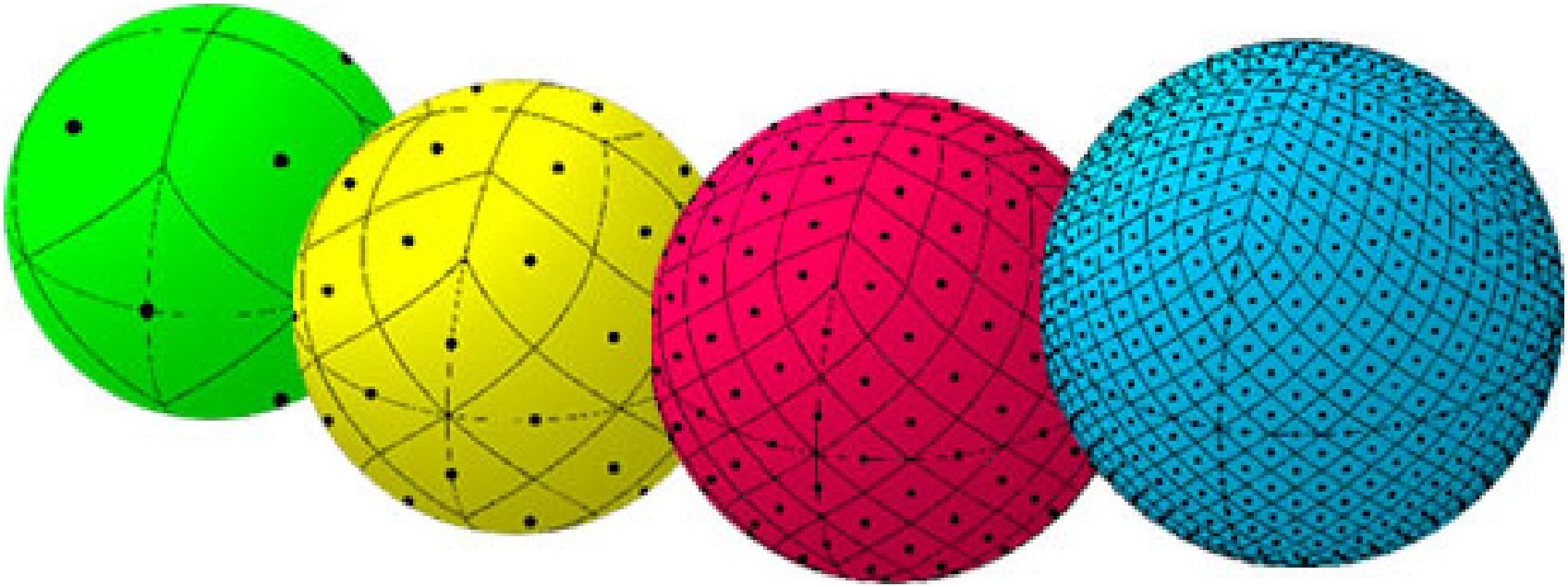
Healpy: Online Documentation *





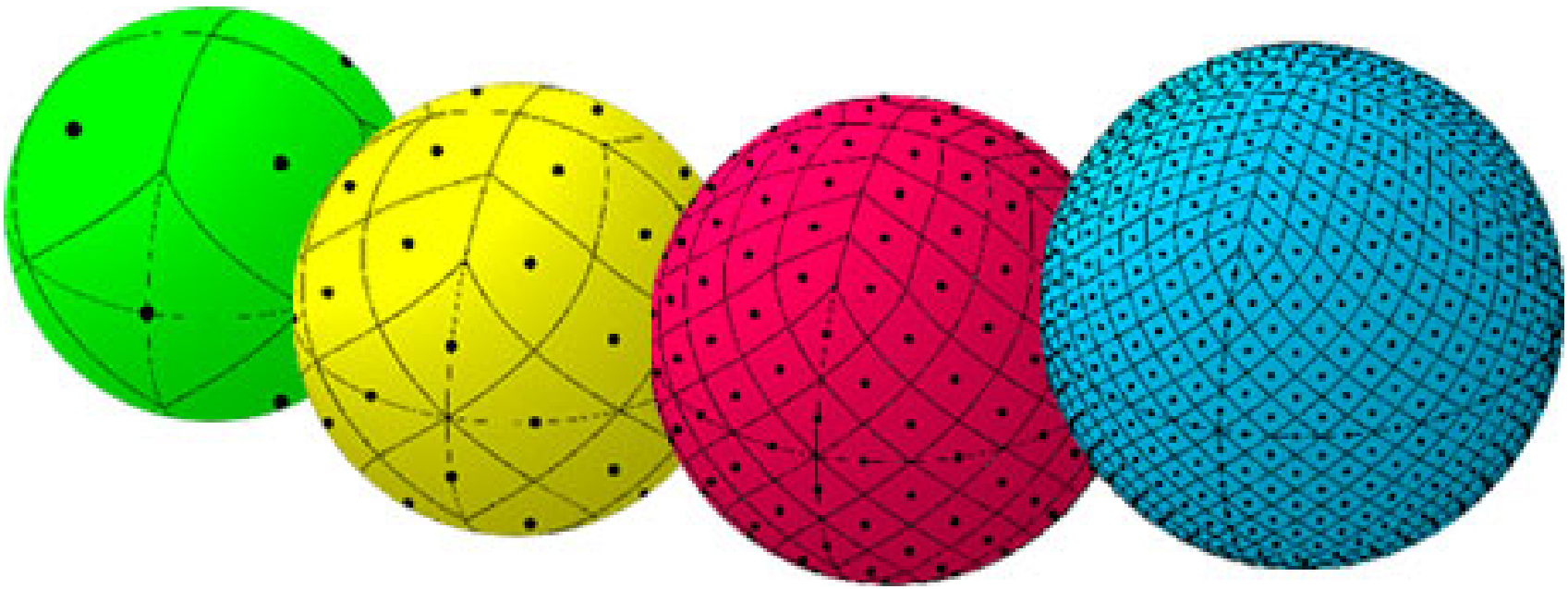
* Note: We will follow Healpy version 1.9.1

Ready to start ...



Overview

- Read and write special[1] FITS files,
- Visualise the data in diverse projection types, and more ...



[1] Data maps

First of all ...

- In the editor, import the packages you will need:

```
import heapy as hp
import numpy as np
...
```

- Syntax:

```
...  hp.routine_name ...
```

Reading a map

healpy.fitsfunc.read_map

healpy.fitsfunc.read_map(*filename, field=0, dtype=<type 'numpy.float64'>, nest=False, partial=False, hdu=1, h=False, verbose=True, memmap=False*)

Read an healpix map from a fits file. Partial-sky files, if properly identified, are expanded to full size and filled with UNSEEN.

Parameters:

- filename : fits file name
- field : column to read (Default: 0.)
- dtype : data type, optional (Default: np.float64)
- nest : bool (True or False)
- partial : bool (True or False)
- hdu : int, header number (start at 0)
- h : bool, if True, return also the header. (Default: False.)
- verbose : bool, if True, print a number of diagnostic messages.
- memmap : bool, if True, the map is not read into memory, the required pixels are read when needed. (Default: False).

Reading a map

How to use:

```
In [1]: import healpy as hp

In [2]: mapa = hp.read_map('COM_CMB_IQU-commander_0256_R2.00.fits',
field={0,1,2}, h=True, nest=True)
NSIDE = 256
ORDERING = NESTED in fits file
INDXSCHM = IMPLICIT

In [3]:
```

What is a map in python?

```
mapa_ex = list(range(192))
hp.mollview(mapa_ex)                # it DOES NOT work
hp.mollview(np.array(mapa_ex))      # it DOES work
```

Visualizing a map in a Mollweide projection

healpy.visufunc.mollview

healpy.visufunc.mollview(*map=None, fig=None, rot=None, coord=None, unit='', xsize=800, title='Mollweide view', nest=False, min=None, max=None, flip='astro', remove_dip=False, remove_mono=False, gal_cut=0, format='%g', format2='%g', cbar=True, cmap=None, notext=False, norm=None, hold=False, margins=None, sub=None, return_projected_map=False*)

Plot an healpix map (given as an array) in Mollweide projection.

`Main parameters:`

- map : float, array-like or None
- rot : scalar or sequence. In the form (lon, lat, psi) (unit: degrees)
- coord : sequence of character, 'G', 'E' or 'C' .
- unit : str, Default: ' '
- xsize : int, size of the image. Default: 800
- title : str, title of the plot. Default: 'Mollweide view'
- nest : bool. Default: False (RING)
- + min, max, remove_dip, remove_mono, ...

Visualizing a map in a Mollweide projection

How to use:

```
In [6]: from matplotlib import pyplot

In [7]: mollview_fig = hp.mollview(mapa[0], nest=True,
norm='hist', coord=['G','E'])
   ...: pyplot.savefig('mollweide_view.png')
```

Exercise

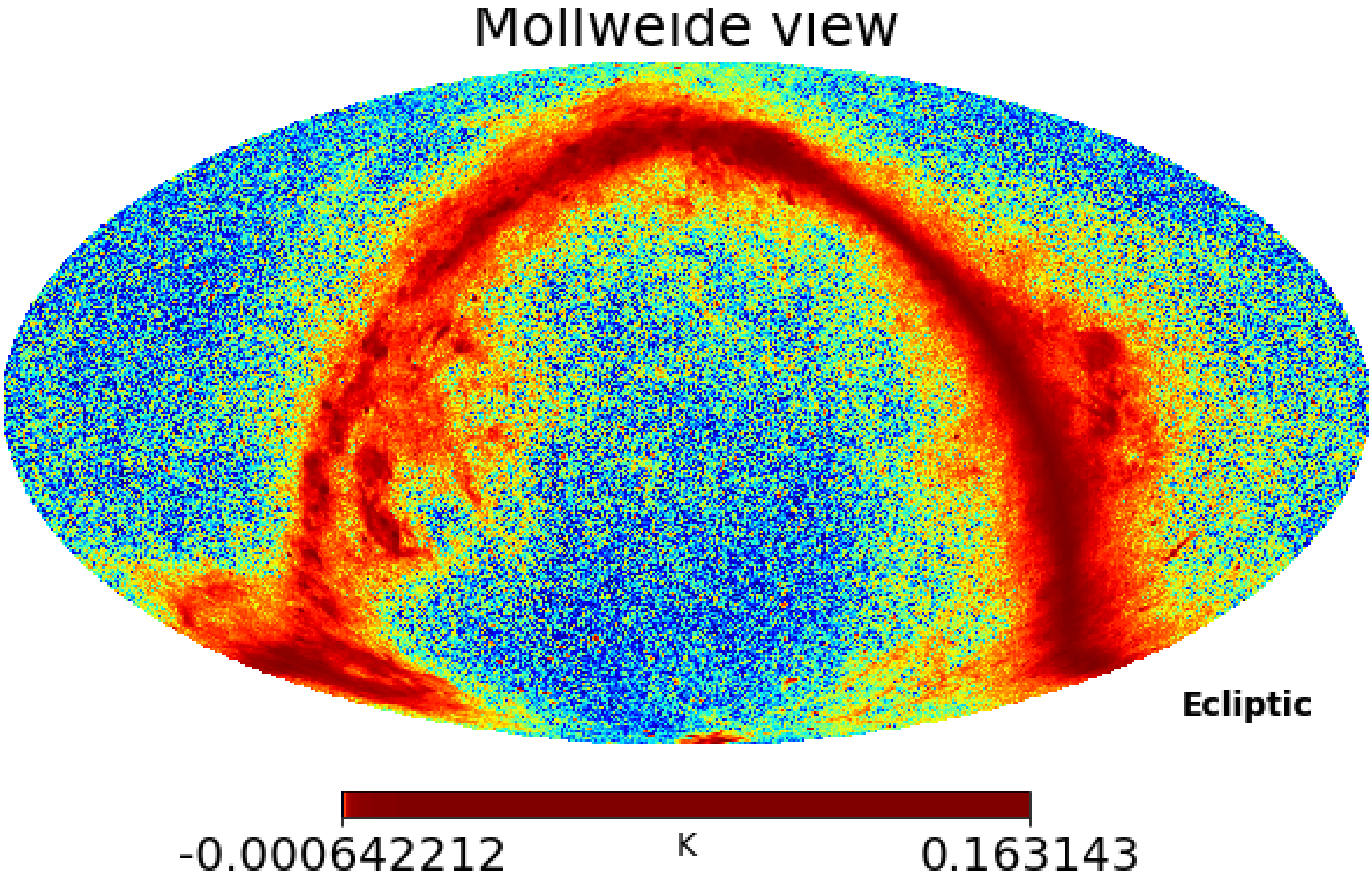
- Download one of the Planck maps. [`http://pla.esac.esa.int/pla/`]
- Read it using `healpy`.
- Visualize the `header` information. (use list() command)
- Plot the map in `Mollweide` projection (each column).
  - Try: rotation of [0,210,70], include unit, change the title, change the scale, histogram equalized color mapping (norm = 'hist'), change coordinates (coord=['G','E']), ...
- If you want to save the figure, remind:
  - `from matplotlib import pyplot`
  - hp.mollview(...)
  - pyplot.savefig('path/name_file.png')

Results

Header:

```
[('XTENSION', 'BINTABLE'),
...
('NAXIS2', 12582912),
...  ('COMMENT', ' *** Column names ***'),
('TTYPE1', 'C030'),
('TTYPE2', 'C044'),
('TTYPE3', 'C070'),
...
('COMMENT', ' *** Column units ***'),
('TUNIT1', 'K_CMB'),
('TUNIT2', 'K_CMB'),
('TUNIT3', 'K_CMB'),
('COMMENT', ' *** Planck params ***'),
('EXTNAME', 'LFI-RESID'),
('AST-COMP', 'FOREGDS'),
('PIXTYPE', 'HEALPIX'),
('COORDSYS', 'GALACTIC'),
('ORDERING', 'NESTED'),
 ('NSIDE', 1024),
('FIRSTPIX', 0),
('LASTPIX', 12582911),
```

Result



Results

Rotating the map and including the units / changing the scale: