healpy Documentation

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Contents

CHAPTER 1

Tutorial

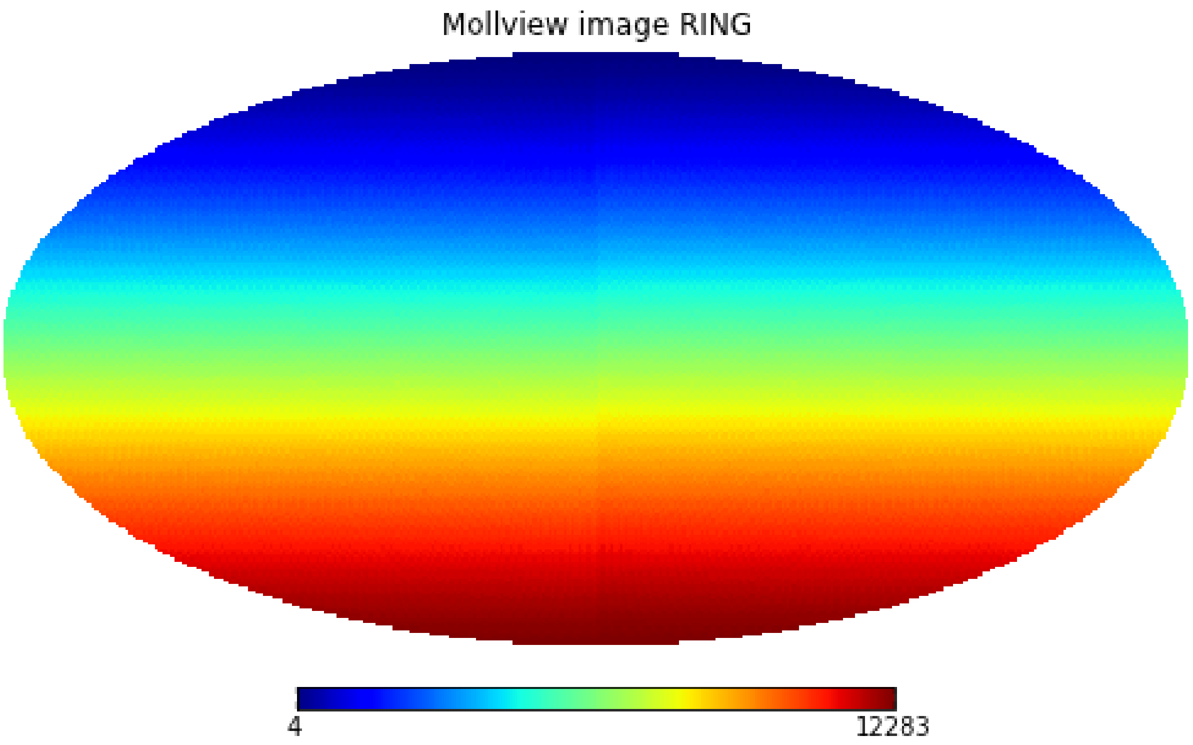
1.1 Healpy tutorial

1.1.1 Creating and manipulating maps

Maps are simply numpy arrays, each array element refers to a location in the sky as defined by the Healpix pixelization schemes, see the healpix website.

The resolution of the map is defined by the *NSIDE* parameter, the `nside2npix()` function gives the number of pixel *NPIX* of the map:

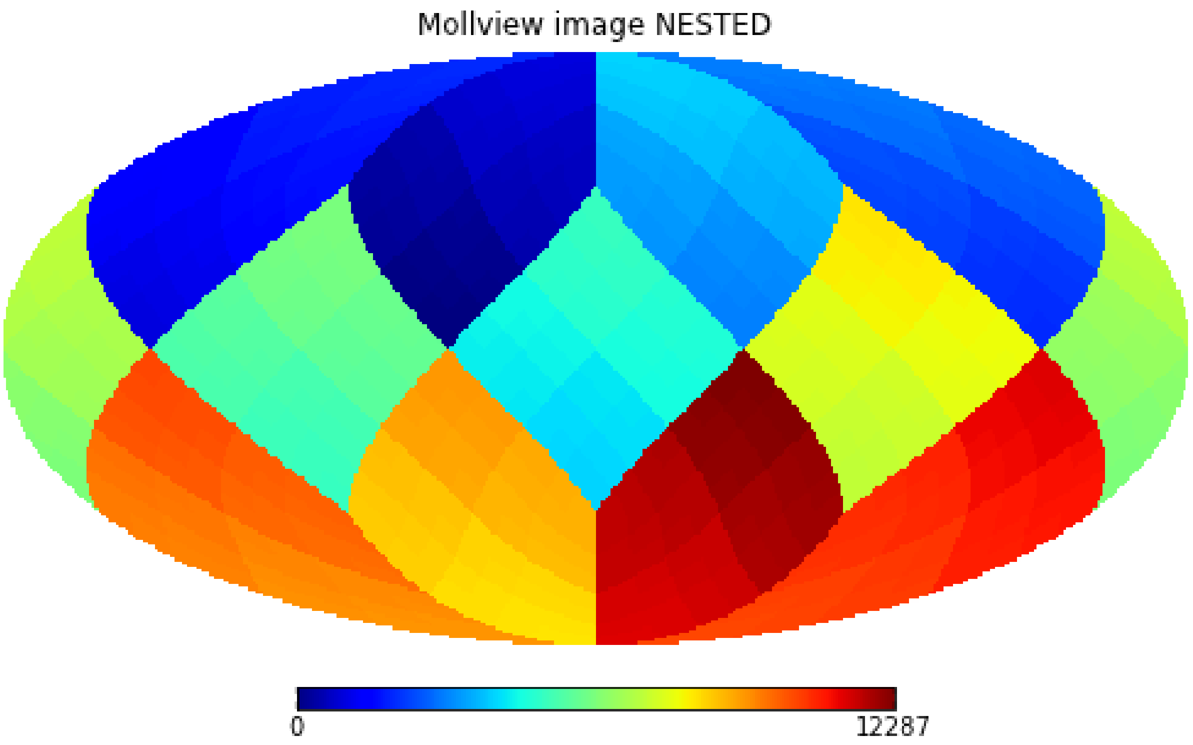
```
>>> import numpy as np
>>> import healpy as hp
>>> NSIDE = 32
>>> m = np.arange(hp.nside2npix(NSIDE))
>>> hp.mollview(m, title="Mollview image RING")
```



Healpix supports two different ordering schemes, *RING* or *NESTED*, **by default healpy maps are in *RING* ordering**.

In order to work with *NESTED* ordering, all map related functions support the *nest* keyword, for example:

```
>>> hp.mollview(m, nest=True, title="Mollview image NESTED")
```



1.1.2 Reading and writing maps to file

Maps are read with the `read_map()` function:

```
>>> wmap_map_I = hp.read_map(’../healpy/test/data/wmap_band_imap_r9_7yr_W_v4.fits’)
```

by default input maps are **converted to *RING* ordering**, if they are in *NESTED* ordering. You can otherwise specify *nest=True* to retrieve a map is NESTED ordering, or *nest=None* to keep the ordering unchanged.

By default `read_map()` loads the first column, for reading other columns you can specify the *field* keyword.

`write_map()` writes a map to disk in FITS format, if the input map is a list of 3 maps, they are written to a single file as I,Q,U polarization components:

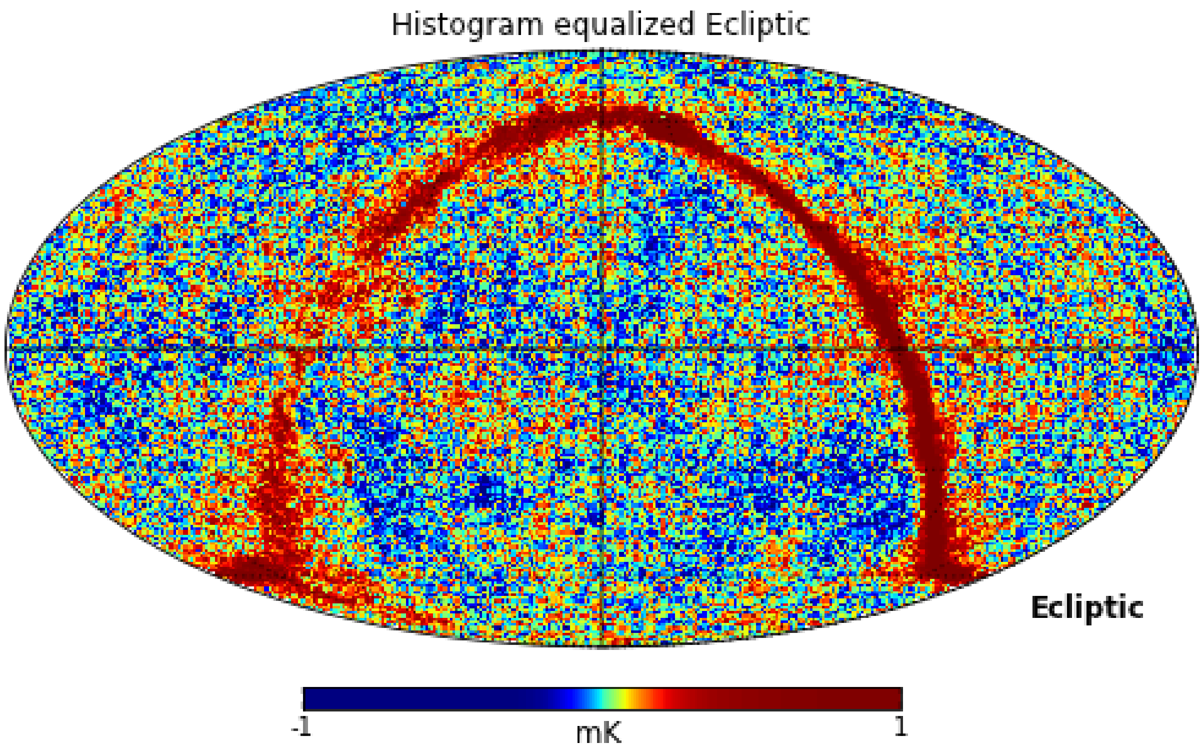
```
>>> hp.write_map("my_map.fits", wmap_map_I)
```

1.1.3 Visualization

Mollweide projection with `mollview()` is the most common visualization tool for HEALPIX maps, it supports also coordinate transformation:

```
>>> hp.mollview(wmap_map_I, coord=[’G’,’E’], title=’Histogram equalized Ecliptic’, unit=’mK’, norm=’
>>> hp.graticule()
```

coord does galactic to ecliptic coordinate transformation, *norm='hist'* sets a histogram equalized color scale and *xsize* increases the size of the image. `graticule()` adds meridians and parallels.



gnomview() instead provides gnomonic projection around a position specified by *rot*:

```
>>> hp.gnomview(wmap_map_I, rot=[0,0.3], title='GnomView', unit='mK', format='%.2g')
```

shows a projection of the galactic center, *xsize* and *ysize* change the dimension of the sky patch.

mollzoom() is a powerful tool for interactive inspection of a map, it provides a mollweide projection where you can click to set the center of the adjacent gnomview panel.

1.1.4 Masked map, partial maps

By convention HEALPIX uses -1.6375e+30 to mark invalid or unseen pixels, this is stored in healpy as the constant UNSEEN().

All healpy functions automatically deal with maps with UNSEEN pixels, for example mollview() marks in grey that sections of a map.

There is an alternative way of dealing with UNSEEN pixel based on the numpy MaskedArray class, ma() loads a map as a masked array:

```
>>> mask = hp.read_map('../healpy/test/data/wmap_temperature_analysis_mask_r9_7yr_v4.fits').astype(np
>>> wmap_map_I_masked = hp.ma(wmap_map_I)
>>> wmap_map_I_masked.mask = np.logical_not(mask)
```

by convention the mask is 0 where the data are masked, while numpy defines data masked when the mask is True, so it is necessary to flip the mask.

```
>>> hp.mollview(wmap_map_I_masked.filled())
```

filling a masked array fills the *UNSEEN* value in and return a standard array that can be used by *mollview*. *compressed()* instead removes all the masked pixels and returns a standard array that can be used for examples by the matplotlib *hist()* function:

```
>>> import matplotlib.pyplot as plt
>>> plt.hist(wmap_map_I_masked.compressed(), bins = 1000)
```

1.1.5 Spherical harmonic transforms

healpy provides bindings to the C++ HEALPIX library for performing spherical harmonic transforms. `anafast()` computes the angular power spectrum of a map:

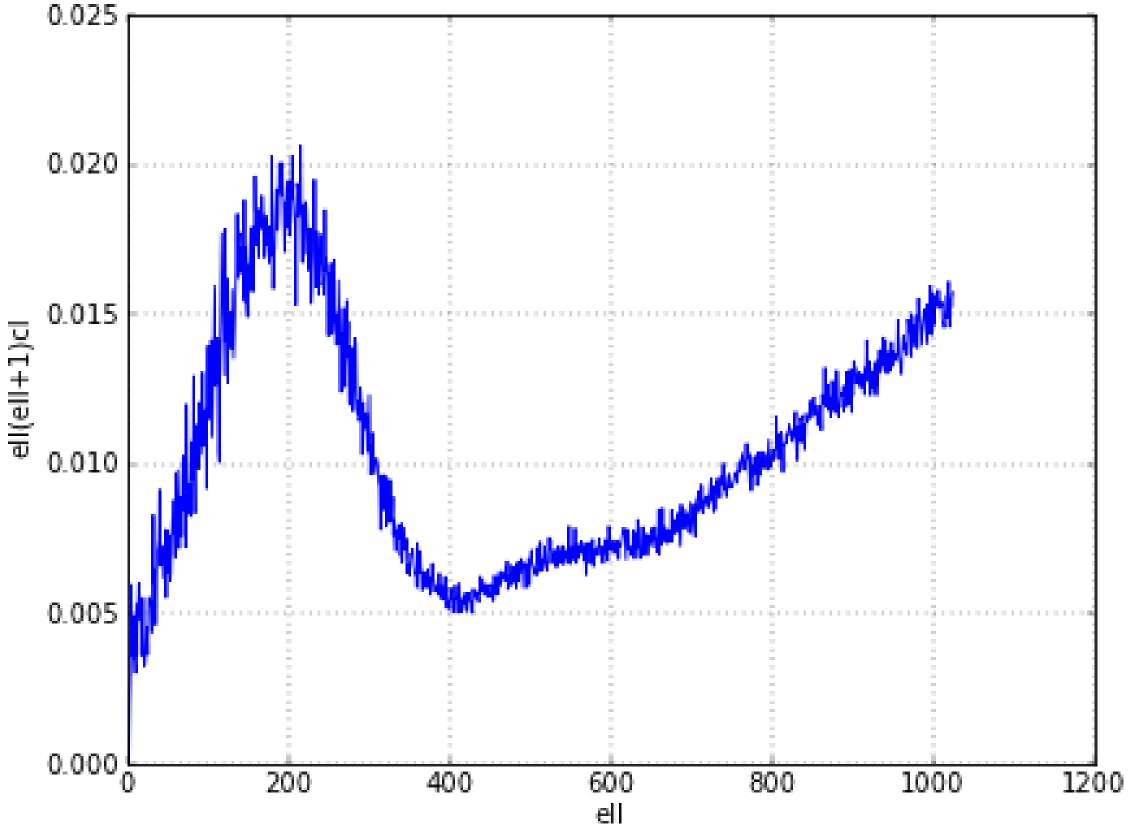
```
>>> LMAX = 1024
>>> cl = hp.anafast(wmap_map_I_masked.filled(), lmax=LMAX)
```

the relative *ell* array is just:

```
>>> ell = np.arange(len(cl))
```

therefore we can plot a normalized CMB spectrum and write it to disk:

```
>>> plt.figure()
>>> plt.plot(ell, ell * (ell+1) * cl)
>>> plt.xlabel('ell'); plt.ylabel('ell(ell+1)cl'); plt.grid()
>>> hp.write_cl('cl.fits', cl)
```



Gaussian beam map smoothing is provided by `smoothing()`:

```
>>> wmap_map_I_smoothed = hp.smoothing(wmap_map_I, fwhm=60, arcmin=True)
>>> hp.mollview(wmap_map_I_smoothed, min=-1, max=1, title='Map smoothed 1 deg')
```

CHAPTER 2

Installation

2.1 Installation procedure for Healpy

2.1.1 Requirements

Healpy depends on the Healpix C++ and cfitsio C libraries. Source code is include with Healpy and you do not have to install them separately.

2.1.2 Building against external Healpix and cfitsio

Healpy uses pkg-config to detect the presence of the Healpix and cfitsio libraries. pkg-config is available on most systems. If you do not have pkg-config installed, then Healpy will download and use (but not install) a Python clone called pykg-config.

If you want to provide your own external builds of Healpix and cfitsio, then download the following packages:

- pkg-config
- HEALPix
- cfitsio

If you are going to install the packages in a nonstandard location (say, –prefix=/path/to/local), then you should set the environment variable PKG_CONFIG_PATH=/path/to/local/lib/pkgconfig when building. No other environment variable settings are necessary, and you do not need to set PKG_CONFIG_PATH to use Healpy after you have built it.

Then, unpack each of the above packages and build them with the usual 'configure; make; make install' recipe.

2.1.3 Installation

healpy is available on pipy, you can install it with:

```
pip install healpy
```

otherwise, you can download a source tarball from:

https://pypi.python.org/pypi/healpy

DO NOT DOWNLOAD from github, github does not include the dependencies.

and build it with:

```
cd healpy
python setup.py build
sudo python setup.py install
```

If everything goes fine, you can test it:

```
cd build/lib*
python
```

```
>>> import matplotlib.pyplot as plt
>>> import numpy as np
>>> import healpy as H
>>> H.mollview(np.arange(12))
>>> plt.show()
```

or run the test suite with nose:

```
nosetests -v
```

If the plot looks good, you can install:

```
sudo python setup.py install  # install in default location, need root rights
```

or:

```
python setup.py install --install-lib=~/Softs/Python # will install healpy in directory ~/Softs/Pytho
```

or:

```
python setup.py install --user # will install it in your User python directory (python >= 2.6)
```

2.1.4 Known issues

- Incompatibility with `cfitisio` from `HEASOFT`: due to a conflict of header file names it is currently not possible to use the cfitsio library provided with the HEASOFT package for compilation of Healpix C++. HEASOFT's include directory contains a file called "rotmatrix.h" which clashes with Healpix's own rotmatrix.h.
- Compilation problems in the C++ package: some gcc versions (we have reports for 4.4.5 and 4.4.6) crash with an internal compiler error during compilation of libsharp. Unfortunately we have not found a workaround for this compiler problem. To our knowledge, it has been fixed in gcc 4.4.7 and in the 4.5.x and newer versions.

2.1.5 Development install

Developers building from a snapshot of the github repository need:

- *autoconf* (in Ubuntu: sudo apt-get install autoconf automake libtool pkg-config)
- *cython* > 0.14
- run `git submodule init` and `git submodule update` to get the healpix sources

the best way to install healpy if you plan to develop is to build the C++ extensions in place with:

```
python setup.py build_ext --inplace
```

the add the healpy/healpy folder to your PYTHONPATH

2.1.6 Clean

When you run “python setup.py”, temporary build products are placed in the “build” directory. If you want to clean out and remove the “build” directory, then run:

```
python setup.py clean --all
```

CHAPTER 3

Reference

3.1 pixelfunc – Pixelisation related functions

3.1.1 conversion from/to sky coordinates

pix2ang(nside, ipix[, nest])	pix2ang : nside,ipix,nest=False -> theta[rad],phi[rad] (default RING)
pix2vec(nside, ipix[, nest])	pix2vec : nside,ipix,nest=False -> x,y,z (default RING)
ang2pix(nside, theta, phi[, nest])	ang2pix : nside,theta[rad],phi[rad],nest=False -> ipix (default:RING)
vec2pix(nside, x, y, z[, nest])	vec2pix : nside,x,y,z,nest=False -> ipix (default:RING)
vec2ang(vectors)	vec2ang: vectors [x, y, z] -> theta[rad], phi[rad]
ang2vec(theta, phi)	ang2vec : convert angles to 3D position vector
get_neighbours(nside, theta[, phi, nest])	Return the 4 nearest pixels and corresponding weights.
get_all_neighbours(nside, theta[, phi, nest])	Return the 8 nearest pixels.

healpy.pixelfunc.pix2ang

healpy.pixelfunc.**pix2ang**(*nside*, *ipix*, *nest=False*)

pix2ang : nside,ipix,nest=False -> theta[rad],phi[rad] (default RING)

Parameters **nside** : int or array-like

The healpix nside parameter, must be a power of 2

ipix : int or array-like

Angular coordinates of a point on the sphere

nest : bool, optional

if True, assume NESTED pixel ordering, otherwise, RING pixel ordering

Returns **theta, phi** : float, scalar or array-like

The angular coordinates corresponding to ipix. Scalar if all input are scalar, array otherwise. Usual numpy broadcasting rules apply.

See also:

ang2pix, vec2pix, pix2vec

Examples

```
>>> import healpy as hp
>>> hp.pix2ang(16, 1440)
(1.5291175943723188, 0.0)

>>> hp.pix2ang(16, [1440,  427, 1520,    0, 3068])
(array([ 1.52911759,  0.78550497,  1.57079633,  0.05103658,  3.09055608]), array([ 0.        ,

>>> hp.pix2ang([1, 2, 4, 8], 11)
(array([ 2.30052398,  0.84106867,  0.41113786,  0.2044802 ]), array([ 5.49778714,  5.89048623,
```

healpy.pixelfunc.pix2vec

healpy.pixelfunc.**pix2vec**(*nside*, *ipix*, *nest=False*)

pix2vec : nside,ipix,nest=False -> x,y,z (default RING)

Parameters **nside** : int, scalar or array-like

The healpix nside parameter, must be a power of 2

ipix : int, scalar or array-like

Healpix pixel number

nest : bool, optional

if True, assume NESTED pixel ordering, otherwise, RING pixel ordering

Returns **x, y, z** : floats, scalar or array-like

The coordinates of vector corresponding to input pixels. Scalar if all input are scalar, array otherwise. Usual numpy broadcasting rules apply.

See also:

ang2pix, pix2ang, vec2pix

Examples

```
>>> import healpy as hp
>>> hp.pix2vec(16, 1504)
(0.99879545620517241, 0.049067674327418015, 0.0)

>>> hp.pix2vec(16, [1440,  427])
(array([ 0.99913157,  0.5000534 ]), array([ 0.        ,  0.5000534]), array([ 0.04166667,  0.7070

>>> hp.pix2vec([1, 2], 11)
(array([ 0.52704628,  0.68861915]), array([-0.52704628, -0.28523539]), array([-0.66666667,  0.66
```

healpy.pixelfunc.ang2pix

healpy.pixelfunc.**ang2pix**(*nside*, *theta*, *phi*, *nest=False*)

ang2pix : nside,theta[rad],phi[rad],nest=False -> ipix (default:RING)

Parameters **nside** : int, scalar or array-like

The healpix nside parameter, must be a power of 2

theta, phi : float, scalars or array-like

Angular coordinates of a point on the sphere

nest : bool, optional

if True, assume NESTED pixel ordering, otherwise, RING pixel ordering

Returns **pix** : int or array of int

The healpix pixel numbers. Scalar if all input are scalar, array otherwise. Usual numpy broadcasting rules apply.

See also:

pix2ang, pix2vec, vec2pix

Examples

```
>>> import healpy as hp
>>> hp.ang2pix(16, np.pi/2, 0)
1440

>>> hp.ang2pix(16, [np.pi/2, np.pi/4, np.pi/2, 0, np.pi], [0., np.pi/4, np.pi/2, 0, 0])
array([1440,  427, 1520,    0, 3068])

>>> hp.ang2pix(16, np.pi/2, [0, np.pi/2])
array([1440, 1520])

>>> hp.ang2pix([1, 2, 4, 8, 16], np.pi/2, 0)
array([   4,   12,   72,  336, 1440])
```

healpy.pixelfunc.vec2pix

healpy.pixelfunc.**vec2pix**(*nside*, *x*, *y*, *z*, *nest=False*)

vec2pix : nside,x,y,z,nest=False -> ipix (default:RING)

Parameters **nside** : int or array-like

The healpix nside parameter, must be a power of 2

x,y,z : floats or array-like

vector coordinates defining point on the sphere

nest : bool, optional

if True, assume NESTED pixel ordering, otherwise, RING pixel ordering

Returns **ipix** : int, scalar or array-like

The healpix pixel number corresponding to input vector. Scalar if all input are scalar, array otherwise. Usual numpy broadcasting rules apply.

See also:

ang2pix, pix2ang, pix2vec

Examples

```
>>> import healpy as hp
>>> hp.vec2pix(16, 1, 0, 0)
1504

>>> hp.vec2pix(16, [1, 0], [0, 1], [0, 0])
array([1504, 1520])

>>> hp.vec2pix([1, 2, 4, 8], 1, 0, 0)
array([  4,  20,  88, 368])
```

healpy.pixelfunc.vec2ang

`healpy.pixelfunc.`**`vec2ang`**(*vectors*)

vec2ang: vectors [x, y, z] -> theta[rad], phi[rad]

Parameters **vectors** : float, array-like

the vector(s) to convert, shape is (3,) or (N, 3)

Returns **theta, phi** : float, tuple of two arrays

the colatitude and longitude in radians

See also:

`ang2vec`, `rotator.vec2dir`, `rotator.dir2vec`

healpy.pixelfunc.ang2vec

`healpy.pixelfunc.`**`ang2vec`**(*theta*, *phi*)

ang2vec : convert angles to 3D position vector

Parameters **theta** : float, scalar or arry-like

colatitude in radians measured southward from north pole (in [0,pi]).

phi : float, scalar or array-like

longitude in radians measured eastward (in [0, 2*pi]).

Returns **vec** : float, array

if theta and phi are vectors, the result is a 2D array with a vector per row otherwise, it is a 1D array of shape (3,)

See also:

`vec2ang`, `rotator.dir2vec`, `rotator.vec2dir`

healpy.pixelfunc.get_neighbours

`healpy.pixelfunc.`**`get_neighbours`**(*nside*, *theta*, *phi=None*, *nest=False*)

Return the 4 nearest pixels and corresponding weights.

Parameters **nside** : int

the healpix nside

theta, phi : float, scalar or array-like

if phi is not given, theta is interpreted as pixel number, otherwise theta[rad],phi[rad] are angular coordinates

nest : bool

if True, NESTED ordering, otherwise RING ordering.

Returns **res** : tuple of length 2

contains pixel numbers in res[0] and weights in res[1]. Usual numpy broadcasting rules apply.

See also:

get_interp_val, get_all_neighbours

Examples

```
>>> import healpy as hp
>>> hp.get_neighbours(1, 0)
(array([0, 1, 4, 5]), array([ 1.,  0.,  0.,  0.]))

>>> hp.get_neighbours(1, 0, 0)
(array([1, 2, 3, 0]), array([ 0.25,  0.25,  0.25,  0.25]))

>>> hp.get_neighbours(1, [0, np.pi/2], 0)
(array([[ 1,  4],
       [ 2,  5],
       [ 3, 11],
       [ 0,  8]]), array([[ 0.25,  1.  ],
       [ 0.25,  0.  ],
       [ 0.25,  0.  ],
       [ 0.25,  0.  ]]))
```

healpy.pixelfunc.get_all_neighbours

healpy.pixelfunc.**get_all_neighbours**(*nside*, *theta*, *phi=None*, *nest=False*)

Return the 8 nearest pixels.

Parameters **nside** : int

the nside to work with

theta, phi : scalar or array-like

if phi is not given or None, theta is interpreted as pixel number, otherwise, theta[rad],phi[rad] are angular coordinates

nest : bool

if True, pixel number will be NESTED ordering, otherwise RING ordering.

Returns **ipix** : int, array

pixel number of the SW, W, NW, N, NE, E, SE and S neighbours, shape is (8,) if input is scalar, otherwise shape is (8, N) if input is of length N. If a neighbor does not exist (it can be the case for W, N, E and S) the corresponding pixel number will be -1.

See also:

get_neighbours, get_interp_val

Examples

```
>>> import healpy as hp
>>> hp.get_all_neighbours(1, 4)
array([11,  7,  3, -1,  0,  5,  8, -1])

>>> hp.get_all_neighbours(1, np.pi/2, np.pi/2)
array([ 8,  4,  0, -1,  1,  6,  9, -1])
```

3.1.2 conversion between NESTED and RING schemes

nest2ring(nside, ipix)	Convert pixel number from NESTED ordering to RING ordering.
ring2nest(nside, ipix)	Convert pixel number from RING ordering to NESTED ordering.
reorder(*args, **kwds)	Reorder an healpix map from RING/NESTED ordering to NESTED/RING

healpy.pixelfunc.nest2ring

healpy.pixelfunc.**nest2ring**(*nside*, *ipix*)

Convert pixel number from NESTED ordering to RING ordering.

Parameters nside : int, scalar or array-like

the healpix nside parameter

ipix : int, scalar or array-like

the pixel number in NESTED scheme

Returns ipix : int, scalar or array-like

the pixel number in RING scheme

See also:

ring2nest, reorder

Examples

```
>>> import healpy as hp
>>> hp.nest2ring(16, 1130)
1504

>>> hp.nest2ring(2, range(10))
array([13,  5,  4,  0, 15,  7,  6,  1, 17,  9])

>>> hp.nest2ring([1, 2, 4, 8], 11)
array([ 11,   2,  12, 211])
```

healpy.pixelfunc.ring2nest

healpy.pixelfunc.**ring2nest**(*nside*, *ipix*)

Convert pixel number from RING ordering to NESTED ordering.

Parameters **nside** : int, scalar or array-like

the healpix nside parameter

ipix : int, scalar or array-like

the pixel number in RING scheme

Returns **ipix** : int, scalar or array-like

the pixel number in NESTED scheme

See also:

nest2ring, reorder

Examples

```
>>> import healpy as hp
>>> hp.ring2nest(16, 1504)
1130

>>> hp.ring2nest(2, range(10))
array([ 3,  7, 11, 15,  2,  1,  6,  5, 10,  9])

>>> hp.ring2nest([1, 2, 4, 8], 11)
array([ 11,  13,  61, 253])
```

healpy.pixelfunc.reorder

healpy.pixelfunc.**reorder**(**args*, ***kwds*)

Reorder an healpix map from RING/NESTED ordering to NESTED/RING

Parameters **map_in** : array-like

the input map to reorder, accepts masked arrays

inp, out : 'RING' or 'NESTED'

define the input and output ordering

r2n : bool

if True, reorder from RING to NESTED

n2r : bool

if True, reorder from NESTED to RING

Returns **map_out** : array-like

the reordered map, as masked array if the input was a masked array

See also:

nest2ring, ring2nest

Notes

if r2n or n2r is defined, override inp and out.

Examples

```
>>> import healpy as hp
>>> hp.reorder(np.arange(48), r2n = True)
array([13,  5,  4,  0, 15,  7,  6,  1, 17,  9,  8,  2, 19, 11, 10,  3, 28,
       20, 27, 12, 30, 22, 21, 14, 32, 24, 23, 16, 34, 26, 25, 18, 44, 37,
       36, 29, 45, 39, 38, 31, 46, 41, 40, 33, 47, 43, 42, 35])
>>> hp.reorder(np.arange(12), n2r = True)
array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11])
>>> hp.reorder(hp.ma(np.arange(12)), n2r = True)
masked_array(data = [ 0  1  2  3  4  5  6  7  8  9 10 11],
             mask = False,
       fill_value = 999999)

>>> m = [range(12), range(12), range(12)]
>>> m[0][2] = hp.UNSEEN
>>> m[1][2] = hp.UNSEEN
>>> m[2][2] = hp.UNSEEN
>>> m = hp.ma(m)
>>> hp.reorder(m, n2r = True)
(masked_array(data = [0.0 1.0 -- 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0],
             mask = [False False  True False False False False False False False False False],
       fill_value = -1.6375e+30)
, masked_array(data = [0.0 1.0 -- 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0],
             mask = [False False  True False False False False False False False False False],
       fill_value = -1.6375e+30)
, masked_array(data = [0.0 1.0 -- 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0],
             mask = [False False  True False False False False False False False False False],
       fill_value = -1.6375e+30)
)
```

3.1.3 nside/npix/resolution

nside2npix(nside)	Give the number of pixel for the given nside.
npix2nside(npix)	Give the nside parameter for the given number of pixels.
nside2resol(nside[, arcmin])	Give approximate resolution for nside.
nside2pixarea(nside[, degrees])	Give pixel area given nside.
max_pixrad(nside)	Maximum angular distance between any pixel center and its corners
isnsideok(nside)	Returns True if nside is a valid nside parameter, False otherwise.
isnpixok(npix)	Return True if npix is a valid value for healpix map size, False otherwise.
get_map_size(m)	Returns the npix of a given map (implicit or explicit pixelization).
get_min_valid_nside(npix)	Returns the minimum acceptable nside so that npix <= nside2npix(nside).
get_nside(m)	Return the nside of the given map.
maptype(m)	Describe the type of the map (valid, single, sequence of maps).
ud_grade(*args, **kwds)	Upgrade or degrade resolution of a map (or list of maps).

healpy.pixelfunc.nside2npix

healpy.pixelfunc.**nside2npix**(*nside*)

Give the number of pixel for the given nside.

Parameters **nside** : int

healpix nside parameter; an exception is raised if nside is not valid (nside must be a power of 2)

Returns **npix** : int

corresponding number of pixels

Notes

Raise a ValueError exception if nside is not valid.

Examples

```
>>> import healpy as hp
>>> hp.nside2npix(8)
768
```

```
>>> np.all([hp.nside2npix(nside) == 12 * nside**2 for nside in [2**n for n in range(12)]])
True
```

```
>>> hp.nside2npix(7)
Traceback (most recent call last):
    ...
ValueError: Given number is not a valid nside parameter (must be a power of 2)
```

healpy.pixelfunc.npix2nside

healpy.pixelfunc.**npix2nside**(*npix*)

Give the nside parameter for the given number of pixels.

Parameters **npix** : int

the number of pixels

Returns **nside** : int

the nside parameter corresponding to npix

Notes

Raise a ValueError exception if number of pixel does not correspond to the number of pixel of an healpix map.

Examples

```
>>> import healpy as hp
>>> hp.npix2nside(768)
8
```

```
>>> np.all([hp.npix2nside(12 * nside**2) == nside for nside in [2**n for n in range(12)]])
True

>>> hp.npix2nside(1000)
Traceback (most recent call last):
    ...
ValueError: Wrong pixel number (it is not 12*nside**2)
```

healpy.pixelfunc.nside2resol

healpy.pixelfunc.**nside2resol**(*nside*, *arcmin=False*)

Give approximate resolution for nside.

Resolution is just the square root of the pixel area, which is a gross approximation given the different pixel shapes

Parameters **nside** : int

healpix nside parameter, must be a power of 2

arcmin : bool

if True, return resolution in arcmin, otherwise in radian

Returns **resol** : float

approximate pixel size in radians or arcmin

Notes

Raise a ValueError exception if nside is not valid.

Examples

```
>>> import healpy as hp
>>> hp.nside2resol(128, arcmin = True)
27.483891294539248

>>> hp.nside2resol(256)
0.0039973699529159707

>>> hp.nside2resol(7)
Traceback (most recent call last):
   ...
ValueError: Given number is not a valid nside parameter (must be a power of 2)
```

healpy.pixelfunc.nside2pixarea

healpy.pixelfunc.**nside2pixarea**(*nside*, *degrees=False*)

Give pixel area given nside.

Parameters **nside** : int

healpix nside parameter, must be a power of 2

degrees : bool

if True, returns pixel area in square degrees, in square radians otherwise

Returns **pixarea** : float

pixel area in square radian or square degree

Notes

Raise a ValueError exception if nside is not valid.

Examples

```
>>> import healpy as hp
>>> hp.nside2pixarea(128, degrees = True)
0.2098234113027917

>>> hp.nside2pixarea(256)
1.5978966540475428e-05

>>> hp.nside2pixarea(7)
Traceback (most recent call last):
   ...
ValueError: Given number is not a valid nside parameter (must be a power of 2)
```

healpy.pixelfunc.max_pixrad

`healpy.pixelfunc.`**`max_pixrad`**`(`*nside*`)`

Maximum angular distance between any pixel center and its corners

Parameters **nside** : int

the nside to work with

Returns **rads: double** :

angular distance (in radians)

Examples

```
>>> ’%.15f’ % max_pixrad(1)
’0.841068670567930’
>>> ’%.15f’ % max_pixrad(16)
’0.066014761432513’
```

healpy.pixelfunc.isnsideok

`healpy.pixelfunc.`**`isnsideok`**`(`*nside*`)`

Returns `True` if nside is a valid nside parameter, `False` otherwise.

Parameters **nside** : int, scalar or array-like

integer value to be tested

Returns **ok** : bool, scalar or array-like

`True` if given value is a valid nside, `False` otherwise.

Examples

```
>>> import healpy as hp
>>> hp.isnsideok(13)
False

>>> hp.isnsideok(32)
True

>>> hp.isnsideok([1, 2, 3, 4, 8, 16])
array([ True,  True, False,  True,  True,  True], dtype=bool)
```

healpy.pixelfunc.isnpixok

healpy.pixelfunc.**isnpixok**(*npix*)

Return True if npix is a valid value for healpix map size, False otherwise.

Parameters **npix** : int, scalar or array-like

integer value to be tested

Returns **ok** : bool, scalar or array-like

True if given value is a valid number of pixel, False otherwise

Examples

```
>>> import healpy as hp
>>> hp.isnpixok(12)
True

>>> hp.isnpixok(768)
True

>>> hp.isnpixok([12, 768, 1002])
array([ True,  True, False], dtype=bool)
```

healpy.pixelfunc.get_map_size

healpy.pixelfunc.**get_map_size**(*m*)

Returns the npix of a given map (implicit or explicit pixelization).

If map is a dict type, assumes explicit pixelization: use nside key if present, or use nside attribute if present, otherwise use the smallest valid npix given the maximum key value. otherwise assumes implicit pixelization and returns len(m).

Parameters **m** : array-like or dict-like

a map with implicit (array-like) or explicit (dict-like) pixellization

Returns **npix** : int

a valid number of pixel

Notes

In implicit pixellization, raise a ValueError exception if the size of the input is not a valid pixel number.

Examples

```
>>> import healpy as hp
 >>> m = {0: 1, 1: 1, 2: 1, 'nside': 1}
 >>> print hp.get_map_size(m)
 12

>>> m = {0: 1, 767: 1}
>>> print hp.get_map_size(m)
768

>>> print hp.get_map_size(np.zeros(12 * 8 ** 2))
768
```

healpy.pixelfunc.get_min_valid_nside

healpy.pixelfunc.**get_min_valid_nside**(*npix*)

Returns the minimum acceptable nside so that npix <= nside2npix(nside).

Parameters **npix** : int

a minimal number of pixel

Returns **nside** : int

a valid healpix nside so that 12 * nside ** 2 >= npix

Examples

```
>>> import healpy as hp
>>> hp.pixelfunc.get_min_valid_nside(355)
8
>>> hp.pixelfunc.get_min_valid_nside(768)
8
```

healpy.pixelfunc.get_nside

healpy.pixelfunc.**get_nside**(*m*)

Return the nside of the given map.

Parameters **m** : sequence

the map to get the nside from.

Returns **nside** : int

the healpix nside parameter of the map (or sequence of maps)

Notes

If the input is a sequence of maps, all of them must have same size. If the input is not a valid map (not a sequence, unvalid number of pixels), a TypeError exception is raised.

healpy.pixelfunc.maptype

healpy.pixelfunc.**maptype**(*m*)

Describe the type of the map (valid, single, sequence of maps). Checks : the number of maps, that all maps have same length and that this length is a valid map size (using `isnpixok()`).

Parameters **m** : sequence

the map to get info from

Returns **info** : int

-1 if the given object is not a valid map, 0 if it is a single map, *info* > 0 if it is a sequence of maps (*info* is then the number of maps)

Examples

```
>>> import healpy as hp
>>> hp.pixelfunc.maptype(np.arange(12))
0
>>> hp.pixelfunc.maptype([np.arange(12), np.arange(12)])
2
```

healpy.pixelfunc.ud_grade

healpy.pixelfunc.**ud_grade**(**args*, ***kwds*)

Upgrade or degrade resolution of a map (or list of maps).

in degrading the resolution, ud_grade sets the value of the superpixel as the mean of the children pixels.

Parameters **map_in** : array-like or sequence of array-like

the input map(s) (if a sequence of maps, all must have same size)

nside_out : int

the desired nside of the output map(s)

pess : bool

if `True`, in degrading, reject pixels which contains a bad sub_pixel. Otherwise, estimate average with good pixels

order_in, order_out : str

pixel ordering of input and output ('RING' or 'NESTED')

power : float

if non-zero, multiply the result by (nside_in/nside_out)**power Examples: power=-2 keeps the sum of the map invariant (useful for hitmaps), power=2 divides the mean by another factor of (nside_in/nside_out)**2 (useful for variance maps)

dtype : type

the type of the output map

Returns **map_out** : array-like or sequence of array-like

the upgraded or degraded map(s)

Examples

```
>>> import healpy as hp
>>> hp.ud_grade(np.arange(48.), 1)
array([  5.5 ,    7.25,    9.  ,   10.75,   21.75,   21.75,   23.75,   25.75,
        36.5 ,   38.25,   40.  ,   41.75])
```

3.1.4 Masking pixels

UNSEEN	Special Healpix values for masked pixels.
mask_bad(m[, badval, rtol, atol])	Returns a bool array with True where m is close to badval.
mask_good(m[, badval, rtol, atol])	Returns a bool array with False where m is close to badval.
ma(m[, badval, rtol, atol, copy])	Return map as a masked array, with badval pixels masked.

healpy.pixelfunc.UNSEEN

healpy.pixelfunc.**UNSEEN**
alias of Mock

healpy.pixelfunc.mask_bad

healpy.pixelfunc.**mask_bad**(*m*, *badval=<class 'Mock'>*, *rtol=1e-05*, *atol=1e-08*)
Returns a bool array with True where m is close to badval.

Parameters **m** : a map (may be a sequence of maps)

badval : float, optional

The value of the pixel considered as bad (UNSEEN by default)

rtol : float, optional

The relative tolerance

atol : float, optional

The absolute tolerance

Returns **mask** :

a bool array with the same shape as the input map, True where input map is close to badval, and False elsewhere.

See also:

mask_good, ma

Examples

```
>>> import healpy as hp
>>> import numpy as np
>>> m = np.arange(12.)
>>> m[3] = hp.UNSEEN
>>> hp.mask_bad(m)
array([False, False, False,  True, False, False, False, False, False,
       False, False, False], dtype=bool)
```

healpy.pixelfunc.mask_good

healpy.pixelfunc.**mask_good**(*m*, *badval=<class 'Mock'>*, *rtol=1e-05*, *atol=1e-08*)

Returns a bool array with `False` where m is close to badval.

Parameters **m** : a map (may be a sequence of maps)

badval : float, optional

The value of the pixel considered as bad (`UNSEEN` by default)

rtol : float, optional

The relative tolerance

atol : float, optional

The absolute tolerance

Returns **a bool array with the same shape as the input map, ''False'' where input map is** :

close to badval, and ''True'' elsewhere. :

See also:

`mask_bad`, `ma`

Examples

```
>>> import healpy as hp
>>> m = np.arange(12.)
>>> m[3] = hp.UNSEEN
>>> hp.mask_good(m)
array([ True,  True,  True, False,  True,  True,  True,  True,  True,
        True,  True,  True], dtype=bool)
```

healpy.pixelfunc.ma

healpy.pixelfunc.**ma**(*m*, *badval=<class 'Mock'>*, *rtol=1e-05*, *atol=1e-08*, *copy=True*)

Return map as a masked array, with `badval` pixels masked.

Parameters **m** : a map (may be a sequence of maps)

badval : float, optional

The value of the pixel considered as bad (`UNSEEN` by default)

rtol : float, optional

The relative tolerance

atol : float, optional

The absolute tolerance

copy : bool, optional

If `True`, a copy of the input map is made.

Returns a masked array with the same shape as the input map, :

masked where input map is close to badval. :

See also:

`mask_good`, `mask_bad`, `numpy.ma.masked_values`

Examples

```
>>> import healpy as hp
>>> m = np.arange(12.)
>>> m[3] = hp.UNSEEN
>>> hp.ma(m)
masked_array(data = [0.0 1.0 2.0 -- 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0],
             mask = [False False False  True False False False False False False False False],
       fill_value = -1.6375e+30)
```

3.1.5 Map data manipulation

`fit_dipole`(m[, nest, bad, gal_cut])	Fit a dipole and a monopole to the map, excluding bad pixels.
`fit_monopole`(m[, nest, bad, gal_cut])	Fit a monopole to the map, excluding unseen pixels.
`remove_dipole`(m[, nest, bad, gal_cut, ...])	Fit and subtract the dipole and the monopole from the given map m.
`remove_monopole`(m[, nest, bad, gal_cut, ...])	Fit and subtract the monopole from the given map m.
`get_interp_val`(m, theta, phi[, nest])	Return the bi-linear interpolation value of a map using 4 nearest neighbours.

healpy.pixelfunc.fit_dipole

`healpy.pixelfunc.`**`fit_dipole`**(*m*, *nest=False*, *bad=<class 'Mock'>*, *gal_cut=0*)

Fit a dipole and a monopole to the map, excluding bad pixels.

Parameters m : float, array-like

the map to which a dipole is fitted and subtracted, accepts masked maps

nest : bool

if `False` m is assumed in RING scheme, otherwise map is NESTED

bad : float

bad values of pixel, default to `UNSEEN`.

gal_cut : float

pixels at latitude in [-gal_cut;+gal_cut] degrees are not taken into account

Returns res : tuple of length 2

the monopole value in res[0] and the dipole vector (as array) in res[1]

See also:

`remove_dipole`, `fit_monopole`, `remove_monopole`

healpy.pixelfunc.fit_monopole

`healpy.pixelfunc.`**`fit_monopole`**(*m*, *nest=False*, *bad=<class 'Mock'>*, *gal_cut=0*)

Fit a monopole to the map, excluding unseen pixels.

Parameters **m** : float, array-like

the map to which a dipole is fitted and subtracted, accepts masked arrays

nest : bool

if `False` m is assumed in RING scheme, otherwise map is NESTED

bad : float

bad values of pixel, default to `UNSEEN`.

gal_cut : float

pixels at latitude in [-gal_cut;+gal_cut] degrees are not taken into account

Returns **res: float** :

fitted monopole value

See also:

`fit_dipole`, `remove_monopole`, `remove_monopole`

healpy.pixelfunc.remove_dipole

`healpy.pixelfunc.`**`remove_dipole`**(*m*, *nest=False*, *bad=<class 'Mock'>*, *gal_cut=0*, *fitval=False*, *copy=True*, *verbose=True*)

Fit and subtract the dipole and the monopole from the given map m.

Parameters **m** : float, array-like

the map to which a dipole is fitted and subtracted, accepts masked arrays

nest : bool

if `False` m is assumed in RING scheme, otherwise map is NESTED

bad : float

bad values of pixel, default to `UNSEEN`.

gal_cut : float

pixels at latitude in [-gal_cut;+gal_cut] are not taken into account

fitval : bool

whether to return or not the fitted values of monopole and dipole

copy : bool

whether to modify input map or not (by default, make a copy)

verbose : bool

print values of monopole and dipole

Returns **res** : array or tuple of length 3

if fitval is False, returns map with monopole and dipole subtracted, otherwise, returns map (array, in res[0]), monopole (float, in res[1]), dipole_vector (array, in res[2])

See also:

`fit_dipole`, `fit_monopole`, `remove_monopole`

healpy.pixelfunc.remove_monopole

`healpy.pixelfunc.`**`remove_monopole`**(*m*, *nest=False*, *bad=<class 'Mock'>*, *gal_cut=0*, *fitval=False*, *copy=True*, *verbose=True*)

Fit and subtract the monopole from the given map m.

Parameters **m** : float, array-like

the map to which a monopole is fitted and subtracted

nest : bool

if `False` m is assumed in RING scheme, otherwise map is NESTED

bad : float

bad values of pixel, default to `UNSEEN`.

gal_cut : float

pixels at latitude in [-gal_cut;+gal_cut] are not taken into account

fitval : bool

whether to return or not the fitted value of monopole

copy : bool

whether to modify input map or not (by default, make a copy)

verbose: bool :

whether to print values of monopole

Returns **res** : array or tuple of length 3

if fitval is False, returns map with monopole subtracted, otherwise, returns map (array, in res[0]) and monopole (float, in res[1])

See also:

`fit_dipole`, `fit_monopole`, `remove_dipole`

healpy.pixelfunc.get_interp_val

`healpy.pixelfunc.`**`get_interp_val`**(*m*, *theta*, *phi*, *nest=False*)

Return the bi-linear interpolation value of a map using 4 nearest neighbours.

Parameters **m** : array-like

an healpix map, accepts masked arrays

theta, phi : float, scalar or array-like

angular coordinates of point at which to interpolate the map

nest : bool

if True, the is assumed to be in NESTED ordering.

Returns **val** : float, scalar or arry-like

the interpolated value(s), usual numpy broadcasting rules apply.

See also:

get_neighbours, get_all_neighbours

Examples

```
>>> import healpy as hp
>>> hp.get_interp_val(np.arange(12.), np.pi/2, 0)
4.0
>>> hp.get_interp_val(np.arange(12.), np.linspace(0, np.pi, 10), 0)
array([ 1.5        ,  1.5        ,  1.5        ,  2.20618428,  3.40206143,
        5.31546486,  7.94639458,  9.5        ,  9.5        ,  9.5        ])
```

3.2 sphtfunc – Spherical harmonic transforms

3.2.1 From map to spherical harmonics

anafast(map1[, map2, nspec, lmax, mmax, ...])	Computes the power spectrum of an Healpix map, or the cross-spectrum between
map2alm(maps[, lmax, mmax, iter, pol, ...])	Computes the alm of an Healpix map.

healpy.sphtfunc.anafast

healpy.sphtfunc.**anafast**(*map1*, *map2=None*, *nspec=None*, *lmax=None*, *mmax=None*, *iter=3*, *alm=False*, *pol=True*, *use_weights=False*, *regression=True*, *datapath=None*)

Computes the power spectrum of an Healpix map, or the cross-spectrum between two maps if *map2* is given.

Parameters **map1** : float, array-like shape (Npix,) or (3, Npix)

Either an array representing a map, or a sequence of 3 arrays representing I, Q, U maps

map2 : float, array-like shape (Npix,) or (3, Npix)

Either an array representing a map, or a sequence of 3 arrays representing I, Q, U maps

nspec : None or int, optional

The number of spectra to return. If None, returns all, otherwise returns cls[:nspec]

lmax : int, scalar, optional

Maximum l of the power spectrum (default: 3*nside-1)

mmax : int, scalar, optional

Maximum m of the alm (default: lmax)

iter : int, scalar, optional

Number of iteration (default: 3)

alm : bool, scalar, optional

If True, returns both cl and alm, otherwise only cl is returned

pol : bool, optional

If True, assumes input maps are TQU. Output will be TEB cl's and correlations (input must be 1 or 3 maps). If False, maps are assumed to be described by spin 0 spherical harmonics. (input can be any number of maps) If there is only one input map, it has no effect. Default: True.

regression : bool, scalar, optional

If True, map average is removed before computing alm. Default: True.

datapath : None or str, optional

If given, the directory where to find the weights data.

Returns **res** : array or sequence of arrays

If *alm* is False, returns cl or a list of cl's (TT, EE, BB, TE, EB, TB for polarized input map) Otherwise, returns a tuple (cl, alm), where cl is as above and alm is the spherical harmonic transform or a list of almT, almE, almB for polarized input

healpy.sphtfunc.map2alm

healpy.sphtfunc.**map2alm**(*maps*, *lmax=None*, *mmax=None*, *iter=3*, *pol=True*, *use_weights=False*, *regression=True*, *datapath=None*)

Computes the alm of an Healpix map.

Parameters **maps** : array-like, shape (Npix,) or (n, Npix)

The input map or a list of n input maps.

lmax : int, scalar, optional

Maximum l of the power spectrum. Default: 3*nside-1

mmax : int, scalar, optional

Maximum m of the alm. Default: lmax

iter : int, scalar, optional

Number of iteration (default: 3)

pol : bool, optional

If True, assumes input maps are TQU. Output will be TEB alm's. (input must be 1 or 3 maps) If False, apply spin 0 harmonic transform to each map. (input can be any number of maps) If there is only one input map, it has no effect. Default: True.

use_weights: bool, scalar, optional :

If True, use the ring weighting. Default: False.

regression: bool, scalar, optional :

If True, subtract map average before computing alm. Default: True.

datapath : None or str, optional

If given, the directory where to find the weights data.

Returns **alms** : array or tuple of array

alm or a tuple of 3 alm (almT, almE, almB) if polarized input.

Notes

The pixels which have the special *UNSEEN* value are replaced by zeros before spherical harmonic transform. They are converted back to *UNSEEN* value, so that the input maps are not modified. Each map have its own, independent mask.

3.2.2 From spherical harmonics to map

`synfast`(cls, nside[, lmax, mmax, alm, pol, ...])	Create a map(s) from cl(s).
`alm2map`(alms, nside[, lmax, mmax, pixwin, ...])	Computes an Healpix map given the alm.
`alm2map_der1`(alm, nside[, lmax, mmax])	Computes an Healpix map and its first derivatives given the alm.

healpy.sphtfunc.synfast

`healpy.sphtfunc.`**`synfast`**(*cls*, *nside*, *lmax=None*, *mmax=None*, *alm=False*, *pol=True*, *pixwin=False*, *fwhm=0.0*, *sigma=None*, *new=False*)

Create a map(s) from cl(s).

Parameters **cls** : array or tuple of array

A cl or a list of cl (either 4 or 6, see `synalm()`)

nside : int, scalar

The nside of the output map(s)

lmax : int, scalar, optional

Maximum l for alm. Default: min of 3*nside-1 or length of the cls - 1

mmax : int, scalar, optional

Maximum m for alm.

alm : bool, scalar, optional

If True, return also alm(s). Default: False.

pol : bool, optional

If True, assumes input cls are TEB and correlation. Output will be TQU maps. (input must be 1, 4 or 6 cl's) If False, fields are assumed to be described by spin 0 spherical harmonics. (input can be any number of cl's) If there is only one input cl, it has no effect. Default: True.

pixwin : bool, scalar, optional

If True, convolve the alm by the pixel window function. Default: False.

fwhm : float, scalar, optional

The fwhm of the Gaussian used to smooth the map (applied on alm) [in radians]

sigma : float, scalar, optional

The sigma of the Gaussian used to smooth the map (applied on alm) [in radians]

Returns **maps** : array or tuple of arrays

The output map (possibly list of maps if polarized input). or, if alm is True, a tuple of (map,alm) (alm possibly a list of alm if polarized input)

Notes

The order of the spectra will change in a future release. The new= parameter help to make the transition smoother. You can start using the new order by setting new=True. In the next version of healpy, the default will be new=True. This change is done for consistency between the different tools (alm2cl, synfast, anafast). In the new order, the spectra are ordered by diagonal of the correlation matrix. Eg, if fields are T, E, B, the spectra are TT, EE, BB, TE, EB, TB with new=True, and TT, TE, TB, EE, EB, BB if new=False.

healpy.sphtfunc.alm2map

`healpy.sphtfunc.`**`alm2map`**(*alms*, *nside*, *lmax=None*, *mmax=None*, *pixwin=False*, *fwhm=0.0*, *sigma=None*, *invert=False*, *pol=True*, *inplace=False*)

Computes an Healpix map given the alm.

The alm are given as a complex array. You can specify lmax and mmax, or they will be computed from array size (assuming lmax==mmax).

Parameters **alms** : complex, array or sequence of arrays

A complex array or a sequence of complex arrays. Each array must have a size of the form: mmax * (2 * lmax + 1 - mmax) / 2 + lmax + 1

nside : int, scalar

The nside of the output map.

lmax : None or int, scalar, optional

Explicitly define lmax (needed if mmax!=lmax)

mmax : None or int, scalar, optional

Explicitly define mmax (needed if mmax!=lmax)

pixwin : bool, optional

Smooth the alm using the pixel window functions. Default: False.

fwhm : float, scalar, optional

The fwhm of the Gaussian used to smooth the map (applied on alm) [in radians]

sigma : float, scalar, optional

The sigma of the Gaussian used to smooth the map (applied on alm) [in radians]

invert : bool, optional

If True, alms are divided by Gaussian beam function (un-smooth). Otherwise, alms are multiplied by Gaussian beam function (smooth). Default: False.

pol : bool, optional

If True, assumes input alms are TEB. Output will be TQU maps. (input must be 1 or 3 alms) If False, apply spin 0 harmonic transform to each alm. (input can be any number of alms) If there is only one input alm, it has no effect. Default: True.

inplace : bool, optional

If True, input alms may be modified by pixel window function and beam smoothing (if alm(s) are complex128 contiguous arrays). Otherwise, input alms are not modified. A copy is made if needed to apply beam smoothing or pixel window.

Returns **maps** : array or list of arrays

An Healpix map in RING scheme at nside or a list of T,Q,U maps (if polarized input)

healpy.sphtfunc.alm2map_der1

healpy.sphtfunc.**alm2map_der1**(*alm*, *nside*, *lmax=None*, *mmax=None*)

Computes an Healpix map and its first derivatives given the alm.

The alm are given as a complex array. You can specify lmax and mmax, or they will be computed from array size (assuming lmax==mmax).

Parameters **alm** : array, complex

A complex array of alm. Size must be of the form mmax(lmax-mmax+1)/2+lmax

nside : int

The nside of the output map.

lmax : None or int, optional

Explicitly define lmax (needed if mmax!=lmax)

mmax : None or int, optional

Explicitly define mmax (needed if mmax!=lmax)

Returns **m, d_theta, d_phi** : tuple of arrays

The maps correponding to alm, and its derivatives with respect to theta and phi. d_phi is already divided by sin(theta)

3.2.3 Spherical harmonic transform tools

smoothing(*args, **kwds)	Smooth a map with a Gaussian symmetric beam.
smoothalm(alms[, fwhm, sigma, invert, pol, ...])	Smooth alm with a Gaussian symmetric beam function.
alm2cl(alms1[, alms2, lmax, mmax, lmax_out, ...])	Computes (cross-)spectra from alm(s).
synalm(cls[, lmax, mmax, new])	Generate a set of alm given cl.
almxfl(alm, fl[, mmax, inplace])	Multiply alm by a function of l.
pixwin(nside[, pol])	Return the pixel window function for the given nside.
Alm()	This class provides some static methods for alm index computation.

healpy.sphtfunc.smoothing

healpy.sphtfunc.**smoothing**(**args*, ***kwds*)

Smooth a map with a Gaussian symmetric beam.

Parameters **maps** : array or sequence of 3 arrays

Either an array representing one map, or a sequence of 3 arrays representing 3 maps, accepts masked arrays

fwhm : float, optional

The full width half max parameter of the Gaussian [in radians]. Default:0.0

sigma : float, optional

The sigma of the Gaussian [in radians]. Override fwhm.

invert : bool, optional

If True, alms are divided by Gaussian beam function (un-smooth). Otherwise, alms are multiplied by Gaussian beam function (smooth). Default: False.

pol : bool, optional

If True, assumes input maps are TQU. Output will be TQU maps. (input must be 1 or 3 alms) If False, each map is assumed to be a spin 0 map and is treated independently (input can be any number of alms). If there is only one input map, it has no effect. Default: True.

iter : int, scalar, optional

Number of iteration (default: 3)

lmax : int, scalar, optional

Maximum l of the power spectrum. Default: 3*nside-1

mmax : int, scalar, optional

Maximum m of the alm. Default: lmax

use_weights: bool, scalar, optional :

If True, use the ring weighting. Default: False.

regression: bool, scalar, optional :

If True, subtract map average before computing alm. Default: True.

datapath : None or str, optional

If given, the directory where to find the weights data.

Returns **maps** : array or list of 3 arrays

The smoothed map(s)

healpy.sphtfunc.smoothalm

`healpy.sphtfunc.`**`smoothalm`**(*alms*, *fwhm=0.0*, *sigma=None*, *invert=False*, *pol=True*, *mmax=None*, *verbose=True*, *inplace=True*)

Smooth alm with a Gaussian symmetric beam function.

Parameters **alms** : array or sequence of 3 arrays

Either an array representing one alm, or a sequence of arrays. See *pol* parameter.

fwhm : float, optional

The full width half max parameter of the Gaussian. Default:0.0 [in radians]

sigma : float, optional

The sigma of the Gaussian. Override fwhm. [in radians]

invert : bool, optional

If True, alms are divided by Gaussian beam function (un-smooth). Otherwise, alms are multiplied by Gaussian beam function (smooth). Default: False.

pol : bool, optional

If True, assumes input alms are TEB. Output will be TQU maps. (input must be 1 or 3 alms) If False, apply spin 0 harmonic transform to each alm. (input can be any number of alms) If there is only one input alm, it has no effect. Default: True.

mmax : None or int, optional

The maximum m for alm. Default: mmax=lmax

inplace : bool, optional

If True, the alm's are modified inplace if they are contiguous arrays of type complex128. Otherwise, a copy of alm is made. Default: True.

verbose : bool, optional

If True prints diagnostic information. Default: False

Returns alms : array or sequence of 3 arrays

The smoothed alm. If alm[i] is a contiguous array of type complex128, and *inplace* is True the smoothing is applied inplace. Otherwise, a copy is made.

healpy.sphtfunc.alm2cl

healpy.sphtfunc.**alm2cl**(*alms1*, *alms2=None*, *lmax=None*, *mmax=None*, *lmax_out=None*, *nspec=None*)

Computes (cross-)spectra from alm(s). If alm2 is given, cross-spectra between alm and alm2 are computed. If alm (and alm2 if provided) contains n alm, then n(n+1)/2 auto and cross-spectra are returned.

Parameters alm : complex, array or sequence of arrays

The alm from which to compute the power spectrum. If n>=2 arrays are given, computes both auto- and cross-spectra.

alms2 : complex, array or sequence of 3 arrays, optional

If provided, computes cross-spectra between alm and alm2. Default: alm2=alm, so auto-spectra are computed.

lmax : None or int, optional

The maximum l of the input alm. Default: computed from size of alm and mmax_in

mmax : None or int, optional

The maximum m of the input alm. Default: assume mmax_in = lmax_in

lmax_out : None or int, optional

The maximum l of the returned spectra. By default: the lmax of the given alm(s).

nspec : None or int, optional

The number of spectra to return. None means all, otherwise returns cl[:nspec]

Returns cl : array or tuple of n(n+1)/2 arrays

the spectrum <*alm* x *alm2*> if *alm* (and *alm2*) is one alm, or the auto- and cross-spectra <alm*[i] x *alm2*[j]> if alm (and alm2) contains more than one spectra. If more than one spectrum is returned, they are ordered by diagonal. For example, if *alm is almT, almE, almB, then the returned spectra are: TT, EE, BB, TE, EB, TB.

healpy.sphtfunc.synalm

healpy.sphtfunc.**synalm**(*cls*, *lmax=None*, *mmax=None*, *new=False*)

Generate a set of alm given cl. The cl are given as a float array. Corresponding alm are generated. If lmax is None, it is assumed lmax=cl.size-1 If mmax is None, it is assumed mmax=lmax.

Parameters **cls** : float, array or tuple of arrays

Either one cl (1D array) or a tuple of either 4 cl or of n*(n+1)/2 cl. Some of the cl may be None, implying no cross-correlation. See *new* parameter.

lmax : int, scalar, optional

The lmax (if None or <0, the largest size-1 of cls)

mmax : int, scalar, optional

The mmax (if None or <0, =lmax)

new : bool, optional

If True, use the new ordering of cl's, ie by diagonal (e.g. TT, EE, BB, TE, EB, TB or TT, EE, BB, TE if 4 cl as input). If False, use the old ordering, ie by row (e.g. TT, TE, TB, EE, EB, BB or TT, TE, EE, BB if 4 cl as input).

Returns **alms** : array or list of arrays

the generated alm if one spectrum is given, or a list of n alms (with n(n+1)/2 the number of input cl, or n=3 if there are 4 input cl).

Notes

The order of the spectra will change in a future release. The new= parameter help to make the transition smoother. You can start using the new order by setting new=True. In the next version of healpy, the default will be new=True. This change is done for consistency between the different tools (alm2cl, synfast, anafast). In the new order, the spectra are ordered by diagonal of the correlation matrix. Eg, if fields are T, E, B, the spectra are TT, EE, BB, TE, EB, TB with new=True, and TT, TE, TB, EE, EB, BB if new=False.

healpy.sphtfunc.almxfl

`healpy.sphtfunc.`**`almxfl`**(*alm*, *fl*, *mmax=None*, *inplace=False*)

Multiply alm by a function of l. The function is assumed to be zero where not defined.

Parameters **alm** : array

The alm to multiply

fl : array

The function (at l=0..fl.size-1) by which alm must be multiplied.

mmax : None or int, optional

The maximum m defining the alm layout. Default: lmax.

inplace : bool, optional

If True, modify the given alm, otherwise make a copy before multiplying.

Returns **alm** : array

The modified alm, either a new array or a reference to input alm, if inplace is True.

healpy.sphtfunc.pixwin

healpy.sphtfunc.**pixwin**(*nside*, *pol=False*)

Return the pixel window function for the given nside.

Parameters **nside** : int

The nside for which to return the pixel window function

pol : bool, optional

If True, return also the polar pixel window. Default: False

Returns **pw or pwT,pwP** : array or tuple of 2 arrays

The temperature pixel window function, or a tuple with both temperature and polarisation pixel window functions.

healpy.sphtfunc.Alm

class healpy.sphtfunc.**Alm**

This class provides some static methods for alm index computation.

Methods

getlm(lmax[, i])	Get the l and m from index and lmax.
getidx(lmax, l, m)	Returns index corresponding to (l,m) in an array describing alm up to lmax.
getsize(lmax[, mmax])	Returns the size of the array needed to store alm up to *lmax* and *mmax*
getlmax(s[, mmax])	Returns the lmax corresponding to a given array size.

healpy.sphtfunc.Alm.getlm

static Alm.**getlm**(*lmax*, *i=None*)

Get the l and m from index and lmax.

Parameters **lmax** : int

The maximum l defining the alm layout

i : int or None

The index for which to compute the l and m. If None, the function return l and m for i=0..Alm.getsize(lmax)

healpy.sphtfunc.Alm.getidx

static Alm.**getidx**(*lmax*, *l*, *m*)

Returns index corresponding to (l,m) in an array describing alm up to lmax.

Parameters **lmax** : int

The maximum l, defines the alm layout

l : int

The l for which to get the index

m : int

The m for which to get the index

Returns idx : int

The index corresponding to (l,m)

healpy.sphtfunc.Alm.getsize

static `Alm.`**`getsize`**(*lmax*, *mmax=None*)

Returns the size of the array needed to store alm up to *lmax* and *mmax*

Parameters lmax : int

The maximum l, defines the alm layout

mmax : int, optional

The maximum m, defines the alm layout. Default: lmax.

Returns size : int

The size of the array needed to store alm up to lmax, mmax.

healpy.sphtfunc.Alm.getlmax

static `Alm.`**`getlmax`**(*s*, *mmax=None*)

Returns the lmax corresponding to a given array size.

Parameters s : int

Size of the array

mmax : None or int, optional

The maximum m, defines the alm layout. Default: lmax.

Returns lmax : int

The maximum l of the array, or -1 if it is not a valid size.

3.2.4 Other tools

`gauss_beam`(fwhm[, lmax, pol])	Gaussian beam window function

healpy.sphtfunc.gauss_beam

`healpy.sphtfunc.`**`gauss_beam`**(*fwhm*, *lmax=512*, *pol=False*)

Gaussian beam window function

Computes the spherical transform of an axisimmetric gaussian beam

For a sky of underlying power spectrum C(l) observed with beam of given FWHM, the measured power spectrum will be C(l)_meas = C(l) B(l)^2 where B(l) is given by gaussbeam(Fwhm,Lmax). The polarization beam is also provided (when pol = True) assuming a perfectly co-polarized beam (e.g., Challinor et al 2000, astro-ph/0008228)

Parameters fwhm : float

full width half max in radians

lmax : integer

ell max

pol : bool

if False, output has size (lmax+1) and is temperature beam if True output has size (lmax+1, 4) with components: * temperature beam * grad/electric polarization beam * curl/magnetic polarization beam * temperature * grad beam

Returns **beam** : array

beam window function [0, lmax] if dim not specified otherwise (lmax+1, 4) contains polarized beam

3.3 `visufunc` – Visualisation

3.3.1 Map projections

`mollview`([map, fig, rot, coord, unit, ...])	Plot an healpix map (given as an array) in Mollweide projection.
`gnomview`([map, fig, rot, coord, unit, ...])	Plot an healpix map (given as an array) in Gnomonic projection.
`cartview`([map, fig, rot, zat, coord, unit, ...])	Plot an healpix map (given as an array) in Cartesian 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.

Parameters **map** : float, array-like or None

An array containing the map, supports masked maps, see the *ma* function. If None, will display a blank map, useful for overplotting.

fig : int or None, optional

The figure number to use. Default: create a new figure

rot : scalar or sequence, optional

Describe the rotation to apply. In the form (lon, lat, psi) (unit: degrees) : the point at longitude *lon* and latitude *lat* will be at the center. An additional rotation of angle *psi* around this direction is applied.

coord : sequence of character, optional

Either one of 'G', 'E' or 'C' to describe the coordinate system of the map, or a sequence of 2 of these to rotate the map from the first to the second coordinate system.

unit : str, optional

A text describing the unit of the data. Default: ''

xsize : int, optional

The size of the image. Default: 800

title : str, optional

The title of the plot. Default: ‘Mollweide view’

nest : bool, optional

If True, ordering scheme is NESTED. Default: False (RING)

min : float, optional

The minimum range value

max : float, optional

The maximum range value

flip : {‘astro’, ‘geo’}, optional

Defines the convention of projection : ‘astro’ (default, east towards left, west towards right) or ‘geo’ (east towards roght, west towards left)

remove_dip : bool, optional

If `True`, remove the dipole+monopole

remove_mono : bool, optional

If `True`, remove the monopole

gal_cut : float, scalar, optional

Symmetric galactic cut for the dipole/monopole fit. Removes points in latitude range [-gal_cut, +gal_cut]

format : str, optional

The format of the scale label. Default: ‘%g’

format2 : str, optional

Format of the pixel value under mouse. Default: ‘%g’

cbar : bool, optional

Display the colorbar. Default: True

notext : bool, optional

If True, no text is printed around the map

norm : {‘hist’, ‘log’, None}

Color normalization, hist= histogram equalized color mapping, log= logarithmic color mapping, default: None (linear color mapping)

hold : bool, optional

If True, replace the current Axes by a MollweideAxes. use this if you want to have multiple maps on the same figure. Default: False

sub : int, scalar or sequence, optional

Use only a zone of the current figure (same syntax as subplot). Default: None

margins : None or sequence, optional

Either None, or a sequence (left,bottom,right,top) giving the margins on left,bottom,right and top of the axes. Values are relative to figure (0-1). Default: None

return_projected_map : bool

if True returns the projected map in a 2d numpy array

See also:

`gnomview`, `cartview`

healpy.visufunc.gnomview

`healpy.visufunc.`**`gnomview`**(*map=None*, *fig=None*, *rot=None*, *coord=None*, *unit=''*, *xsize=200*, *ysize=None*, *reso=1.5*, *degree=False*, *title='Gnomonic view'*, *nest=False*, *remove_dip=False*, *remove_mono=False*, *gal_cut=0*, *min=None*, *max=None*, *flip='astro'*, *format='%.3g'*, *cbar=True*, *cmap=None*, *norm=None*, *hold=False*, *sub=None*, *margins=None*, *notext=False*, *return_projected_map=False*)

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

Parameters map : array-like

The map to project, supports masked maps, see the *ma* function. If None, use a blank map, useful for overplotting.

fig : None or int, optional

A figure number. Default: None= create a new figure

rot : scalar or sequence, optional

Describe the rotation to apply. In the form (lon, lat, psi) (unit: degrees) : the point at longitude *lon* and latitude *lat* will be at the center. An additional rotation of angle *psi* around this direction is applied.

coord : sequence of character, optional

Either one of 'G', 'E' or 'C' to describe the coordinate system of the map, or a sequence of 2 of these to rotate the map from the first to the second coordinate system.

unit : str, optional

A text describing the unit of the data. Default: ''

xsize : int, optional

The size of the image. Default: 200

ysize : None or int, optional

The size of the image. Default: None= xsize

reso : float, optional

Resolution (in arcmin if degree is False). Default: 1.5 arcmin

degree : bool, optional

if True, reso is in degree. Default: False

title : str, optional

The title of the plot. Default: 'Gnomonic view'

nest : bool, optional

If True, ordering scheme is NESTED. Default: False (RING)

min : float, scalar, optional

The minimum range value

max : float, scalar, optional

The maximum range value

flip : {'astro', 'geo'}, optional

Defines the convention of projection : 'astro' (default, east towards left, west towards right) or 'geo' (east towards roght, west towards left)

remove_dip : bool, optional

If `True`, remove the dipole+monopole

remove_mono : bool, optional

If `True`, remove the monopole

gal_cut : float, scalar, optional

Symmetric galactic cut for the dipole/monopole fit. Removes points in latitude range [-gal_cut, +gal_cut]

format : str, optional

The format of the scale label. Default: '%g'

hold : bool, optional

If True, replace the current Axes by a MollweideAxes. use this if you want to have multiple maps on the same figure. Default: False

sub : int or sequence, optional

Use only a zone of the current figure (same syntax as subplot). Default: None

margins : None or sequence, optional

Either None, or a sequence (left,bottom,right,top) giving the margins on left,bottom,right and top of the axes. Values are relative to figure (0-1). Default: None

notext: bool, optional :

If True: do not add resolution info text. Default=False

return_projected_map : bool

if True returns the projected map in a 2d numpy array

See also:

`mollview`, `cartview`

healpy.visufunc.cartview

`healpy.visufunc.`**`cartview`**(*map=None*, *fig=None*, *rot=None*, *zat=None*, *coord=None*, *unit=''*, *xsize=800*, *ysize=None*, *lonra=None*, *latra=None*, *title='Cartesian view'*, *nest=False*, *remove_dip=False*, *remove_mono=False*, *gal_cut=0*, *min=None*, *max=None*, *flip='astro'*, *format='%.3g'*, *cbar=True*, *cmap=None*, *norm=None*, *aspect=None*, *hold=False*, *sub=None*, *margins=None*, *notext=False*, *return_projected_map=False*)

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

Parameters **map** : float, array-like or None

An array containing the map, supports masked maps, see the *ma* function. If None, will display a blank map, useful for overplotting.

fig : int or None, optional

The figure number to use. Default: create a new figure

rot : scalar or sequence, optional

Describe the rotation to apply. In the form (lon, lat, psi) (unit: degrees) : the point at longitude *lon* and latitude *lat* will be at the center. An additional rotation of angle *psi* around this direction is applied.

coord : sequence of character, optional

Either one of 'G', 'E' or 'C' to describe the coordinate system of the map, or a sequence of 2 of these to rotate the map from the first to the second coordinate system.

unit : str, optional

A text describing the unit of the data. Default: ''

xsize : int, optional

The size of the image. Default: 800

lonra : sequence, optional

Range in longitude. Default: [-180,180]

latra : sequence, optional

Range in latitude. Default: [-90,90]

title : str, optional

The title of the plot. Default: 'Mollweide view'

nest : bool, optional

If True, ordering scheme is NESTED. Default: False (RING)

min : float, optional

The minimum range value

max : float, optional

The maximum range value

flip : {'astro', 'geo'}, optional

Defines the convention of projection : 'astro' (default, east towards left, west towards right) or 'geo' (east towards roght, west towards left)

remove_dip : bool, optional

If True, remove the dipole+monopole

remove_mono : bool, optional

If True, remove the monopole

gal_cut : float, scalar, optional

Symmetric galactic cut for the dipole/monopole fit. Removes points in latitude range [-gal_cut, +gal_cut]

format : str, optional

The format of the scale label. Default: '%g'

cbar : bool, optional

Display the colorbar. Default: True

notext : bool, optional

If True, no text is printed around the map

norm : {'hist', 'log', None}, optional

Color normalization, hist= histogram equalized color mapping, log= logarithmic color mapping, default: None (linear color mapping)

hold : bool, optional

If True, replace the current Axes by a CartesianAxes. use this if you want to have multiple maps on the same figure. Default: False

sub : int, scalar or sequence, optional

Use only a zone of the current figure (same syntax as subplot). Default: None

margins : None or sequence, optional

Either None, or a sequence (left,bottom,right,top) giving the margins on left,bottom,right and top of the axes. Values are relative to figure (0-1). Default: None

return_projected_map : bool

if True returns the projected map in a 2d numpy array

See also:

mollview, gnomview

3.3.2 Graticules

graticule([dpar, dmer, coord, local])	Draw a graticule on the current Axes.
delgraticules()	Delete all graticules previously created on the Axes.

healpy.visufunc.graticule

healpy.visufunc.**graticule**(*dpar=None*, *dmer=None*, *coord=None*, *local=None*, ***kwds*)

Draw a graticule on the current Axes.

Parameters dpar, dmer : float, scalars

Interval in degrees between meridians and between parallels

coord : {‘E’, ‘G’, ‘C’}

The coordinate system of the graticule (make rotation if needed, using coordinate system of the map if it is defined).

local : bool

If True, draw a local graticule (no rotation is performed, useful for a gnomonic view, for example)

See also:

`delgraticules`

Notes

Other keyword parameters will be transmitted to the projplot function.

healpy.visufunc.delgraticules

`healpy.visufunc.`**`delgraticules`**`()`

Delete all graticules previously created on the Axes.

See also:

`graticule`

3.3.3 Tracing lines or points

`projplot`(*args, **kwds)	projplot is a wrapper around `matplotlib.Axes.plot()` to take into account the
`projscatter`(*args, **kwds)	Projscatter is a wrapper around `matplotlib.Axes.scatter()` to take into account the sphe
`projtext`(*args, **kwds)	Projtext is a wrapper around `matplotlib.Axes.text()` to take into account the spherical pr

healpy.visufunc.projplot

`healpy.visufunc.`**`projplot`**`(`**args*, ***kwds*`)`

projplot is a wrapper around `matplotlib.Axes.plot()` to take into account the spherical projection.

You can call this function as:

```
projplot(theta, phi)        # plot a line going through points at coord (theta, phi)
projplot(theta, phi, 'bo')  # plot 'o' in blue at coord (theta, phi)
projplot(thetaphi)          # plot a line going through points at coord (thetaphi[0], thetaphi[1
projplot(thetaphi, 'bx')    # idem but with blue 'x'
```

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

fmt : str

A format string (see `matplotlib.Axes.plot()` for details)

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {'E', 'G', 'C', None}

The coordinate system of the points, only used if the coordinate coordinate system of the Axes has been defined and in this case, a rotation is performed

rot : None or sequence

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool

if True, the rotation to center the projection is not taken into account

See also:

`projscatter`, `projtext`

Notes

Other keywords are passed to `matplotlib.Axes.plot()`.

healpy.visufunc.projscatter

`healpy.visufunc.`**`projscatter`**`(`**args*, ***kwds*`)`

Projscatter is a wrapper around `matplotlib.Axes.scatter()` to take into account the spherical projection.

You can call this function as:

```
projscatter(theta, phi)      # plot points at coord (theta, phi)
projplot(thetaphi)           # plot points at coord (thetaphi[0], thetaphi[1])
```

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {'E', 'G', 'C', None}, optional

The coordinate system of the points, only used if the coordinate coordinate system of the axes has been defined and in this case, a rotation is performed

rot : None or sequence, optional

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool, optional

if True, the rotation to center the projection is not taken into account

See also:

projplot, projtext

Notes

Other keywords are passed to `matplotlib.Axes.plot()`.

healpy.visufunc.projtext

`healpy.visufunc.projtext(*args, **kwds)`

Projtext is a wrapper around `matplotlib.Axes.text()` to take into account the spherical projection.

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

text : str

The text to be displayed.

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {'E', 'G', 'C', None}, optional

The coordinate system of the points, only used if the coordinate coordinate system of the axes has been defined and in this case, a rotation is performed

rot : None or sequence, optional

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool, optional

if True, the rotation to center the projection is not taken into account

See also:

projplot, projscatter

Notes

Other keywords are passed to `matplotlib.Axes.text()`.

3.4 `fitsfunc` – Pixelisation related functions

3.4.1 Reading/writing maps

read_map(filename[, field, dtype, nest, ...])	Read an healpix map from a fits file.
write_map(filename, m[, nest, dtype, ...])	Writes an healpix map into an healpix file.

healpy.fitsfunc.read_map

`healpy.fitsfunc.read_map`(*filename*, *field=0*, *dtype=<class 'Mock'>*, *nest=False*, *hdu=1*, *h=False*, *verbose=True*, *memmap=False*)

Read an healpix map from a fits file.

Parameters **filename** : str

the fits file name

field : int or tuple of int, optional

The column to read. Default: 0. By convention 0 is temperature, 1 is Q, 2 is U. Field can be a tuple to read multiple columns (0,1,2)

dtype : data type, optional

Force the conversion to some type. Default: np.float64

nest : bool, optional

If True return the map in NEST ordering, otherwise in RING ordering; use fits keyword ORDERING to decide whether conversion is needed or not If None, no conversion is performed.

hdu : int, optional

the header number to look at (start at 0)

h : bool, optional

If True, return also the header. Default: False.

verbose : bool, optional

If True, print a number of diagnostic messages

as_ma : bool, optional

If True, return also the header. Default: False.

memmap : bool, optional

Argument passed to pyfits.open, if True, the map is not read into memory, but only the required pixels are read when needed. Default: False.

Returns **m | (m0, m1, ...) [, header]** : array or a tuple of arrays, optionally with header appended

The map(s) read from the file, and the header if *h* is True.

healpy.fitsfunc.write_map

`healpy.fitsfunc.write_map`(*filename*, *m*, *nest=False*, *dtype=<class 'Mock'>*, *fits_IDL=True*, *coord=None*, *column_names=None*)

Writes an healpix map into an healpix file.

Parameters **filename** : str

the fits file name

m : array or sequence of 3 arrays

the map to write. Possibly a sequence of 3 maps of same size. They will be considered as I, Q, U maps. Supports masked maps, see the *ma* function.

nest : bool, optional

If False, ordering scheme is NESTED, otherwise, it is RING. Default: RING. The map ordering is not modified by this function, the input map array should already be in the desired ordering (run *ud_grade* beforehand).

fits_IDL : bool, optional

If True, reshapes columns in rows of 1024, otherwise all the data will go in one column. Default: True

coord : str

The coordinate system, typically 'E' for Ecliptic, 'G' for Galactic or 'C' for Celestial (equatorial)

column_names : str or list

Column name or list of column names, if None we use: I_STOKES for 1 component, I/Q/U_STOKES for 3 components, II, IQ, IU, QQ, QU, UU for 6 components, COLUMN_0, COLUMN_1... otherwise

3.4.2 Reading/writing alm

`read_alm`(filename[, hdu, return_mmax])	Read alm from a fits file.
`write_alm`(filename, alms[, out_dtype, lmax, ...])	Write alms to a fits file.

healpy.fitsfunc.read_alm

`healpy.fitsfunc.`**`read_alm`**(*filename*, *hdu=1*, *return_mmax=False*)

Read alm from a fits file.

In the fits file, the alm are written with explicit index scheme, index = l**2+l+m+1, while healpix cxx uses index = m*(2*lmax+1-m)/2+l. The conversion is done in this function.

Parameters **filename** : str

The name of the fits file to read

hdu : int, optional

The header to read. Start at 0. Default: hdu=1

return_mmax : bool, optional

If true, both the alms and mmax is returned in a tuple. Default: return_mmax=False

Returns **alms[, mmax]** : complex array or tuple of a complex array and an int

The alms read from the file and optionally mmax read from the file

healpy.fitsfunc.write_alm

`healpy.fitsfunc.`**`write_alm`**(*filename*, *alms*, *out_dtype=None*, *lmax=-1*, *mmax=-1*, *mmax_in=-1*)

Write alms to a fits file.

In the fits file the alms are written with explicit index scheme, index = l*l + l + m +1, possibly out of order. By default write_alm makes a table with the same precision as the alms. If specified, the lmax and mmax parameters truncate the input data to include only alms for which l <= lmax and m <= mmax.

Parameters **filename** : str

The filename of the output fits file

alms : array, complex

A complex ndarray holding the alms.

lmax : int, optional

The maximum l in the output file

mmax : int, optional

The maximum m in the output file

out_dtype : data type, optional

data type in the output file (must be a numpy dtype). Default: *alms*.real.dtype

mmax_in : int, optional

maximum m in the input array

3.4.3 Reading/writing cl

`read_cl`(filename[, dtype, h])	Reads Cl from an healpix file, as IDL fits2cl.
`write_cl`(filename, cl[, dtype])	Writes Cl into an healpix file, as IDL cl2fits.

healpy.fitsfunc.read_cl

`healpy.fitsfunc.`**`read_cl`** (*filename*, *dtype=<class 'Mock'>*, *h=False*)

Reads Cl from an healpix file, as IDL fits2cl.

Parameters **filename** : str

the fits file name

dtype : data type, optional

the data type of the returned array

Returns **cl** : array

the cl array

healpy.fitsfunc.write_cl

`healpy.fitsfunc.`**`write_cl`** (*filename*, *cl*, *dtype=<class 'Mock'>*)

Writes Cl into an healpix file, as IDL cl2fits.

Parameters **filename** : str

the fits file name

cl : array

the cl array to write to file, currently TT only

3.4.4 Reading/writing column in fits file

mrdfits(filename[, hdu])	Read a table in a fits file.
mwrfits(filename, data[, hdu, colnames, keys])	Write columns to a fits file in a table extension.

healpy.fitsfunc.mrdfits

healpy.fitsfunc.**mrdfits**(*filename*, *hdu=1*)

Read a table in a fits file.

Parameters **filename** : str

The name of the fits file to read

hdu : int, optional

The header to read. Start at 0. Default: hdu=1

Returns **cols** : a list of arrays

A list of column data in the given header

healpy.fitsfunc.mwrfits

healpy.fitsfunc.**mwrfits**(*filename*, *data*, *hdu=1*, *colnames=None*, *keys=None*)

Write columns to a fits file in a table extension.

Parameters **filename** : str

The fits file name

data : list of 1D arrays

A list of 1D arrays to write in the table

hdu : int, optional

The header where to write the data. Default: 1

colnames : list of str

The column names

keys : dict-like

A dictionary with keywords to write in the header

3.4.5 Helper

getformat(t)	Get the FITS convention format string of data type t.

healpy.fitsfunc.getformat

healpy.fitsfunc.**getformat**(*t*)

Get the FITS convention format string of data type t.

Parameters **t** : data type

The data type for which the FITS type is requested

Returns **fits_type** : str or None

The FITS string code describing the data type, or None if unknown type.

3.5 rotator – Rotation and geometry functions

3.5.1 Rotation

Rotator([rot, coord, inv, deg, eulertype])	Rotation operator, including astronomical coordinate systems.
rotateVector(rotmat, vec[, vy, vz, do_rot])	Rotate a vector (or a list of vectors) using the rotation matrix given as first argumen
rotateDirection(rotmat, theta[, phi, ...])	Rotate the vector described by angles theta,phi using the rotation matrix given as fir

healpy.rotator.Rotator

class healpy.rotator.**Rotator**(*rot=None*, *coord=None*, *inv=None*, *deg=True*, *eulertype=’ZYX’*)

Rotation operator, including astronomical coordinate systems.

This class provides tools for spherical rotations. It is meant to be used in the healpy library for plotting, and for this reason reflects the convention used in the Healpix IDL library.

Parameters rot : None or sequence

Describe the rotation by its euler angle. See euler_matrix_new().

coord : None or sequence of str

Describe the coordinate system transform. If *rot* is also given, the coordinate transform is applied first, and then the rotation.

inv : bool

If True, the inverse rotation is defined. (Default: False)

deg : bool

If True, angles are assumed to be in degree. (Default: True)

eulertype : str

The Euler angle convention used. See euler_matrix_new().

Examples

```
>>> r = Rotator(coord=[’G’,’E’])  # Transforms galactic to ecliptic coordinates
>>> theta_gal, phi_gal = np.pi/2., 0.
>>> theta_ecl, phi_ecl = r(theta_gal, phi_gal)  # Apply the conversion
>>> print theta_ecl, phi_ecl
1.66742286715 -1.62596400306
>>> theta_ecl, phi_ecl = Rotator(coord=’ge’)(theta_gal, phi_gal) # In one line
>>> print theta_ecl, phi_ecl
1.66742286715 -1.62596400306
>>> vec_gal = np.array([1, 0, 0]) #Using vectors
>>> vec_ecl = r(vec_gal)
>>> print vec_ecl
[-0.05488249 -0.99382103 -0.09647625]
```

Attributes

mat	The matrix representing the rotation.
coordin	The input coordinate system.
coordout	The output coordinate system.
coordinstr	The input coordinate system in str.
coordoutstr	The output coordinate system in str.
rots	The sequence of rots defining the rotation.
coords	The sequence of coords defining the rotation.

healpy.rotator.Rotator.mat

Rotator.**mat**

The matrix representing the rotation.

healpy.rotator.Rotator.coordin

Rotator.**coordin**

The input coordinate system.

healpy.rotator.Rotator.coordout

Rotator.**coordout**

The output coordinate system.

healpy.rotator.Rotator.coordinstr

Rotator.**coordinstr**

The input coordinate system in str.

healpy.rotator.Rotator.coordoutstr

Rotator.**coordoutstr**

The output coordinate system in str.

healpy.rotator.Rotator.rots

Rotator.**rots**

The sequence of rots defining the rotation.

healpy.rotator.Rotator.coords

Rotator.**coords**

The sequence of coords defining the rotation.

Methods

I(*args, **kwds)	Rotate the given vector or direction using the inverse matrix.
__call__(*args, **kwds)	Use the rotator to rotate either spherical coordinates (theta, phi) or a vector (x,y,z).
angle_ref(*args, **kwds)	Compute the angle between transverse reference direction of initial and final frames
do_rot(i)	Returns True if rotation is not (close to) identity.
get_inverse()	

healpy.rotator.Rotator.I

Rotator.**I**(**args*, ***kwds*)

Rotate the given vector or direction using the inverse matrix. rot.I(vec) <==> rot(vec,inv=True)

healpy.rotator.Rotator.__call__

Rotator.**__call__**(**args*, ***kwds*)

Use the rotator to rotate either spherical coordinates (theta, phi) or a vector (x,y,z). You can use lonla keyword to use longitude, latitude (in degree) instead of theta, phi (in radian). In this case, returns longitude, latitude in degree.

Accepted forms:

r(x,y,z) # x,y,z either scalars or arrays r(theta,phi) # theta, phi scalars or arrays r(lon,lat,lonlat=True) # lon, lat scalars or arrays r(vec) # vec 1-D array with 3 elements, or 2-D array 3xN r(direction) # direction 1-D array with 2 elements, or 2xN array

Parameters **vec_or_dir** : array or multiple arrays

The direction to rotate. See above for accepted formats.

lonlat : bool, optional

If True, assumes the input direction is longitude/latitude in degrees. Otherwise, assumes co-latitude/longitude in radians. Default: False

inv : bool, optional

If True, applies the inverse rotation. Default: False.

healpy.rotator.Rotator.angle_ref

Rotator.**angle_ref**(**args*, ***kwds*)

Compute the angle between transverse reference direction of initial and final frames

For example, if angle of polarisation is psi in initial frame, it will be psi+angle_ref in final frame.

Parameters **dir_or_vec** : array

Direction or vector (see Rotator.__call__)

lonlat: bool, optional :

If True, assume input is longitude,latitude in degrees. Otherwise, theta,phi in radian. Default: False

inv : bool, optional

If True, use the inverse transforms. Default: False

Returns **angle** : float, scalar or array

Angle in radian (a scalar or an array if input is a sequence of direction/vector)

healpy.rotator.Rotator.do_rot

`Rotator.do_rot(i)`

Returns True if rotation is not (close to) identity.

healpy.rotator.Rotator.get_inverse

`Rotator.get_inverse()`

healpy.rotator.rotateVector

`healpy.rotator.rotateVector(`*rotmat*, *vec*, *vy=None*, *vz=None*, *do_rot=True*`)`

Rotate a vector (or a list of vectors) using the rotation matrix given as first argument.

Parameters **rotmat** : float, array-like shape (3,3)

The rotation matrix

vec : float, scalar or array-like

The vector to transform (shape (3,) or (3,N)), or x component (scalar or shape (N,)) if vy and vz are given

vy : float, scalar or array-like, optional

The y component of the vector (scalar or shape (N,))

vz : float, scalar or array-like, optional

The z component of the vector (scalar or shape (N,))

do_rot : bool, optional

if True, really perform the operation, if False do nothing.

Returns **vec** : float, array

The component of the rotated vector(s).

See also:

`Rotator`

healpy.rotator.rotateDirection

`healpy.rotator.rotateDirection(`*rotmat*, *theta*, *phi=None*, *do_rot=True*, *lonlat=False*`)`

Rotate the vector described by angles theta,phi using the rotation matrix given as first argument.

Parameters **rotmat** : float, array-like shape (3,3)

The rotation matrix

theta : float, scalar or array-like

The angle theta (scalar or shape (N,)) or both angles (scalar or shape (2, N)) if phi is not given.

phi : float, scalar or array-like, optionnal

The angle phi (scalar or shape (N,)).

do_rot : bool, optional

if True, really perform the operation, if False do nothing.

lonlat : bool

If True, input angles are assumed to be longitude and latitude in degree, otherwise, they are co-latitude and longitude in radians.

Returns **angles** : float, array

The angles of describing the rotated vector(s).

See also:

`Rotator`

3.5.2 Geometrical helpers

`vec2dir`(vec[, vy, vz, lonlat])	Transform a vector to angle given by theta,phi.
`dir2vec`(theta[, phi, lonlat])	Transform a direction theta,phi to a unit vector.
`angdist`(dir1, dir2[, lonlat])	Returns the angular distance between dir1 and dir2.

healpy.rotator.vec2dir

`healpy.rotator.`**`vec2dir`**(*vec*, *vy=None*, *vz=None*, *lonlat=False*)

Transform a vector to angle given by theta,phi.

Parameters **vec** : float, scalar or array-like

The vector to transform (shape (3,) or (3,N)), or x component (scalar or shape (N,)) if vy and vz are given

vy : float, scalar or array-like, optional

The y component of the vector (scalar or shape (N,))

vz : float, scalar or array-like, optional

The z component of the vector (scalar or shape (N,))

lonlat : bool, optional

If True, return angles will be longitude and latitude in degree, otherwise, angles will be longitude and co-latitude in radians (default)

Returns **angles** : float, array

The angles (unit depending on *lonlat*) in an array of shape (2,) (if scalar input) or (2, N)

See also:

`dir2vec()`, `pixelfunc.ang2vec()`, `pixelfunc.vec2ang()`

healpy.rotator.dir2vec

`healpy.rotator.`**`dir2vec`**(*theta*, *phi=None*, *lonlat=False*)

Transform a direction theta,phi to a unit vector.

Parameters **theta** : float, scalar or array-like

The angle theta (scalar or shape (N,)) or both angles (scalar or shape (2, N)) if phi is not given.

phi : float, scalar or array-like, optionnal

The angle phi (scalar or shape (N,)).

lonlat : bool

If True, input angles are assumed to be longitude and latitude in degree, otherwise, they are co-latitude and longitude in radians.

Returns **vec** : array

The vector(s) corresponding to given angles, shape is (3,) or (3, N).

See also:

`vec2dir()`, `pixelfunc.ang2vec()`, `pixelfunc.vec2ang()`

healpy.rotator.angdist

`healpy.rotator.`**`angdist`**(*dir1*, *dir2*, *lonlat=False*)

Returns the angular distance between dir1 and dir2.

Parameters **dir1, dir2** : float, array-like

The directions between which computing the angular distance. Angular if len(dir) == 2 or vector if len(dir) == 3. See *lonlat* for unit

lonlat : bool, scalar or sequence

If True, angles are assumed to be longitude and latitude in degree, otherwise they are interpreted as colatitude and longitude in radian. If a sequence, lonlat[0] applies to dir1 and lonlat[1] applies to dir2.

Returns **angles** : float, scalar or array-like

The angle(s) between dir1 and dir2 in radian.

3.6 `projector` – Spherical projections

3.6.1 Basic classes

`SphericalProj`([rot, coord, flipconv])	This class defines functions for spherical projection.
`GnomonicProj`([rot, coord, xsize, ysize, reso])	This class provides class methods for Gnomonic projection.
`MollweideProj`([rot, coord, xsize])	This class provides class methods for Mollweide projection.
`CartesianProj`([rot, coord, xsize, ysize, ...])	This class provides class methods for Cartesian projection.

healpy.projector.SphericalProj

class `healpy.projector.`**`SphericalProj`**(*rot=None*, *coord=None*, *flipconv=None*, ***kwds*)

This class defines functions for spherical projection.

This class contains class method for spherical projection computation. It should not be instantiated. It should be inherited from and methods should be overloaded for desired projection.

Methods

ang2xy(theta[, phi, lonlat, direct])	From angular direction to position in the projection plane (%s).
get_center([lonlat])	Get the center of the projection.
get_extent()	Get the extension of the projection plane.
get_fov()	Get the field of view in degree of the plane of projection
get_proj_plane_info()	
ij2xy([i, j])	From image array indices to position in projection plane (%s).
mkcoord(coord)	
projmap(map, vec2pix_func[, rot, coord])	Create an array containing the projection of the map.
set_flip(flipconv)	flipconv is either 'astro' or 'geo'. None will be default.
set_proj_plane_info(**kwds)	
vec2xy(vx[, vy, vz, direct])	From unit vector direction to position in the projection plane (%s).
xy2ang(x[, y, lonlat, direct])	From position in the projection plane to angular direction (%s).
xy2ij(x[, y])	From position in the projection plane to image array index (%s).
xy2vec(x[, y, direct])	From position in the projection plane to unit vector direction (%s).

healpy.projector.SphericalProj.ang2xy

SphericalProj.**ang2xy**(*theta*, *phi=None*, *lonlat=False*, *direct=False*)

From angular direction to position in the projection plane (%s).

Input:

- theta: if phi is None, theta[0] contains theta, theta[1] contains phi
- phi : if phi is not None, theta,phi are direction
- lonlat: if True, angle are assumed in degree, and longitude, latitude
- flipconv is either 'astro' or 'geo'. None will be default.

Return:

- x, y: position in %s plane.

healpy.projector.SphericalProj.get_center

SphericalProj.**get_center**(*lonlat=False*)

Get the center of the projection.

Input:

- **lonlat** [if True, will return longitude and latitude in degree,] otherwise, theta and phi in radian

Return:

- theta,phi or lonlat depending on lonlat keyword

healpy.projector.SphericalProj.get_extent

SphericalProj.**get_extent**()

Get the extension of the projection plane.

Return: extent = (left,right,bottom,top)

healpy.projector.SphericalProj.get_fov

`SphericalProj.get_fov()`

Get the field of view in degree of the plane of projection

Return: fov: the diameter in radian of the field of view

healpy.projector.SphericalProj.get_proj_plane_info

`SphericalProj.get_proj_plane_info()`

healpy.projector.SphericalProj.ij2xy

`SphericalProj.ij2xy(i=None, j=None)`

From image array indices to position in projection plane (%s).

Input:

- if i and j are None, generate arrays of i and j as input
- i : if j is None, i[0], j[1] define array indices in %s image.
- j : if defined, i,j define array indices in image.
- projinfo : additional projection information.

Return:

- x,y : position in projection plane.

healpy.projector.SphericalProj.mkcoord

`SphericalProj.mkcoord(coord)`

healpy.projector.SphericalProj.projmap

`SphericalProj.projmap(map, vec2pix_func, rot=None, coord=None)`

Create an array containing the projection of the map.

Input:

- vec2pix_func: a function taking theta,phi and returning pixel number
- **map: an array containing the spherical map to project,** the pixelisation is described by vec2pix_func

Return:

- a 2D array with the projection of the map.

Note: the Projector must contain information on the array.

healpy.projector.SphericalProj.set_flip

`SphericalProj.`**`set_flip`**`(`*flipconv*`)`

flipconv is either 'astro' or 'geo'. None will be default.

With 'astro', east is toward left and west toward right. It is the opposite for 'geo'

healpy.projector.SphericalProj.set_proj_plane_info

`SphericalProj.`**`set_proj_plane_info`**`(`***kwds*`)`

healpy.projector.SphericalProj.vec2xy

`SphericalProj.`**`vec2xy`**`(`*vx*, *vy=None*, *vz=None*, *direct=False*`)`

From unit vector direction to position in the projection plane (%s).

Input:

- vx: if vy and vz are None, vx[0],vx[1],vx[2] defines the unit vector.
- vy,vz: if defined, vx,vy,vz define the unit vector
- lonlat: if True, angle are assumed in degree, and longitude, latitude
- flipconv is either 'astro' or 'geo'. None will be default.

Return:

- x, y: position in %s plane.

healpy.projector.SphericalProj.xy2ang

`SphericalProj.`**`xy2ang`**`(`*x*, *y=None*, *lonlat=False*, *direct=False*`)`

From position in the projection plane to angular direction (%s).

Input:

- x : if y is None, x[0], x[1] define the position in %s plane.
- y : if defined, x,y define the position in projection plane.
- lonlat: if True, angle are assumed in degree, and longitude, latitude
- flipconv is either 'astro' or 'geo'. None will be default.

Return:

- theta, phi : angular direction.

healpy.projector.SphericalProj.xy2ij

`SphericalProj.`**`xy2ij`**`(`*x*, *y=None*`)`

From position in the projection plane to image array index (%s).

Input:

- x : if y is None, x[0], x[1] define the position in %s plane.
- y : if defined, x,y define the position in projection plane.

- projinfo : additional projection information.

Return:

- i,j : image array indices.

healpy.projector.SphericalProj.xy2vec

SphericalProj.**xy2vec**(*x*, *y=None*, *direct=False*)
From position in the projection plane to unit vector direction (%s).

Input:

- x : if y is None, x[0], x[1] define the position in %s plane.
- y : if defined, x,y define the position in projection plane.
- lonlat: if True, angle are assumed in degree, and longitude, latitude
- flipconv is either 'astro' or 'geo'. None will be default.

Return:

- theta, phi : angular direction.

healpy.projector.GnomonicProj

class healpy.projector.**GnomonicProj**(*rot=None*, *coord=None*, *xsize=None*, *ysize=None*, *reso=None*, ***kwds*)
This class provides class methods for Gnomonic projection.

Methods

ang2xy(theta[, phi, lonlat, direct])	From angular direction to position in the projection plane (Gnomonic).
get_center([lonlat])	Get the center of the projection.
get_extent()	
get_fov()	
get_proj_plane_info()	
ij2xy([i, j])	From image array indices to position in projection plane (Gnomonic).
mkcoord(coord)	
projmap(map, vec2pix_func[, rot, coord])	Create an array containing the projection of the map.
set_flip(flipconv)	flipconv is either 'astro' or 'geo'. None will be default.
set_proj_plane_info([xsize, ysize, reso])	
vec2xy(vx[, vy, vz, direct])	From angular direction to position in the projection plane (Gnomonic).
xy2ang(x[, y, lonlat, direct])	From position in the projection plane to angular direction (Gnomonic).
xy2ij(x[, y])	From position in the projection plane to image array index (Gnomonic).
xy2vec(x[, y, direct])	From position in the projection plane to unit vector direction (Gnomonic).

healpy.projector.GnomonicProj.ang2xy

GnomonicProj.**ang2xy**(*theta*, *phi=None*, *lonlat=False*, *direct=False*)
From angular direction to position in the projection plane (Gnomonic).

Input:

- theta: if phi is None, theta[0] contains theta, theta[1] contains phi

- phi : if phi is not None, theta,phi are direction
- lonlat: if True, angle are assumed in degree, and longitude, latitude
- flipconv is either 'astro' or 'geo'. None will be default.

Return:

- x, y: position in Gnomonic plane.

healpy.projector.GnomonicProj.get_center

`GnomonicProj.`**`get_center`**`(`*lonlat=False*`)`

Get the center of the projection.

Input:

- **lonlat** [if True, will return longitude and latitude in degree,] otherwise, theta and phi in radian

Return:

- theta,phi or lonlat depending on lonlat keyword

healpy.projector.GnomonicProj.get_extent

`GnomonicProj.`**`get_extent`**`()`

healpy.projector.GnomonicProj.get_fov

`GnomonicProj.`**`get_fov`**`()`

healpy.projector.GnomonicProj.get_proj_plane_info

`GnomonicProj.`**`get_proj_plane_info`**`()`

healpy.projector.GnomonicProj.ij2xy

`GnomonicProj.`**`ij2xy`**`(`*i=None*, *j=None*`)`

From image array indices to position in projection plane (Gnomonic).

Input:

- if i and j are None, generate arrays of i and j as input
- i : if j is None, i[0], j[1] define array indices in Gnomonic image.
- j : if defined, i,j define array indices in image.
- projinfo : additional projection information.

Return:

- x,y : position in projection plane.

healpy.projector.GnomonicProj.mkcoord

`GnomonicProj.mkcoord(coord)`

healpy.projector.GnomonicProj.projmap

`GnomonicProj.projmap(map, vec2pix_func, rot=None, coord=None)`

Create an array containing the projection of the map.

Input:

- vec2pix_func: a function taking theta,phi and returning pixel number
- **map: an array containing the spherical map to project,** the pixelisation is described by vec2pix_func

Return:

- a 2D array with the projection of the map.

Note: the Projector must contain information on the array.

healpy.projector.GnomonicProj.set_flip

`GnomonicProj.set_flip(flipconv)`

flipconv is either 'astro' or 'geo'. None will be default.

With 'astro', east is toward left and west toward right. It is the opposite for 'geo'

healpy.projector.GnomonicProj.set_proj_plane_info

`GnomonicProj.set_proj_plane_info(xsize=200, ysize=None, reso=1.5)`

healpy.projector.GnomonicProj.vec2xy

`GnomonicProj.vec2xy(vx, vy=None, vz=None, direct=False)`

From angular direction to position in the projection plane (Gnomonic).

Input:

- theta: if phi is None, theta[0] contains theta, theta[1] contains phi
- phi : if phi is not None, theta,phi are direction
- lonlat: if True, angle are assumed in degree, and longitude, latitude
- flipconv is either 'astro' or 'geo'. None will be default.

Return:

- x, y: position in Gnomonic plane.

healpy.projector.GnomonicProj.xy2ang

GnomonicProj.**xy2ang**(*x*, *y=None*, *lonlat=False*, *direct=False*)
From position in the projection plane to angular direction (Gnomonic).

Input:

- x : if y is None, x[0], x[1] define the position in Gnomonic plane.
- y : if defined, x,y define the position in projection plane.
- lonlat: if True, angle are assumed in degree, and longitude, latitude
- flipconv is either 'astro' or 'geo'. None will be default.

Return:

- theta, phi : angular direction.

healpy.projector.GnomonicProj.xy2ij

GnomonicProj.**xy2ij**(*x*, *y=None*)
From position in the projection plane to image array index (Gnomonic).

Input:

- x : if y is None, x[0], x[1] define the position in Gnomonic plane.
- y : if defined, x,y define the position in projection plane.
- projinfo : additional projection information.

Return:

- i,j : image array indices.

healpy.projector.GnomonicProj.xy2vec

GnomonicProj.**xy2vec**(*x*, *y=None*, *direct=False*)
From position in the projection plane to unit vector direction (Gnomonic).

Input:

- x : if y is None, x[0], x[1] define the position in Gnomonic plane.
- y : if defined, x,y define the position in projection plane.
- lonlat: if True, angle are assumed in degree, and longitude, latitude
- flipconv is either 'astro' or 'geo'. None will be default.

Return:

- theta, phi : angular direction.

healpy.projector.MollweideProj

class healpy.projector.**MollweideProj**(*rot=None*, *coord=None*, *xsize=800*, ***kwds*)
This class provides class methods for Mollweide projection.

Methods

ang2xy(theta[, phi, lonlat, direct])	From angular direction to position in the projection plane (Mollweide).
get_center([lonlat])	Get the center of the projection.
get_extent()	
get_fov()	Get the field of view in degree of the plane of projection
get_proj_plane_info()	
ij2xy([i, j])	From image array indices to position in projection plane (Mollweide).
mkcoord(coord)	
projmap(map, vec2pix_func[, rot, coord])	Create an array containing the projection of the map.
set_flip(flipconv)	flipconv is either 'astro' or 'geo'. None will be default.
set_proj_plane_info(xsize)	
vec2xy(vx[, vy, vz, direct])	From unit vector direction to position in the projection plane (Mollweide).
xy2ang(x[, y, lonlat, direct])	From position in the projection plane to angular direction (Mollweide).
xy2ij(x[, y])	From position in the projection plane to image array index (Mollweide).
xy2vec(x[, y, direct])	From position in the projection plane to unit vector direction (Mollweide).

healpy.projector.MollweideProj.ang2xy

MollweideProj.**ang2xy**(*theta*, *phi=None*, *lonlat=False*, *direct=False*)

From angular direction to position in the projection plane (Mollweide).

Input:

- theta: if phi is None, theta[0] contains theta, theta[1] contains phi
- phi : if phi is not None, theta,phi are direction
- lonlat: if True, angle are assumed in degree, and longitude, latitude
- flipconv is either 'astro' or 'geo'. None will be default.

Return:

- x, y: position in Mollweide plane.

healpy.projector.MollweideProj.get_center

MollweideProj.**get_center**(*lonlat=False*)

Get the center of the projection.

Input:

- **lonlat** [if True, will return longitude and latitude in degree,] otherwise, theta and phi in radian

Return:

- theta,phi or lonlat depending on lonlat keyword

healpy.projector.MollweideProj.get_extent

MollweideProj.**get_extent**()

healpy.projector.MollweideProj.get_fov

`MollweideProj.get_fov()`

Get the field of view in degree of the plane of projection

Return: fov: the diameter in radian of the field of view

healpy.projector.MollweideProj.get_proj_plane_info

`MollweideProj.get_proj_plane_info()`

healpy.projector.MollweideProj.ij2xy

`MollweideProj.ij2xy(i=None, j=None)`

From image array indices to position in projection plane (Mollweide).

Input:

- if i and j are None, generate arrays of i and j as input
- i : if j is None, i[0], j[1] define array indices in Mollweide image.
- j : if defined, i,j define array indices in image.
- projinfo : additional projection information.

Return:

- x,y : position in projection plane.

healpy.projector.MollweideProj.mkcoord

`MollweideProj.mkcoord(coord)`

healpy.projector.MollweideProj.projmap

`MollweideProj.projmap(map, vec2pix_func, rot=None, coord=None)`

Create an array containing the projection of the map.

Input:

- vec2pix_func: a function taking theta,phi and returning pixel number
- **map: an array containing the spherical map to project,** the pixelisation is described by vec2pix_func

Return:

- a 2D array with the projection of the map.

Note: the Projector must contain information on the array.

healpy.projector.MollweideProj.set_flip

`MollweideProj.`**`set_flip`**(*flipconv*)

flipconv is either 'astro' or 'geo'. None will be default.

With 'astro', east is toward left and west toward right. It is the opposite for 'geo'

healpy.projector.MollweideProj.set_proj_plane_info

`MollweideProj.`**`set_proj_plane_info`**(*xsize*)

healpy.projector.MollweideProj.vec2xy

`MollweideProj.`**`vec2xy`**(*vx*, *vy=None*, *vz=None*, *direct=False*)

From unit vector direction to position in the projection plane (Mollweide).

Input:

- vx: if vy and vz are None, vx[0],vx[1],vx[2] defines the unit vector.
- vy,vz: if defined, vx,vy,vz define the unit vector
- lonlat: if True, angle are assumed in degree, and longitude, latitude
- flipconv is either 'astro' or 'geo'. None will be default.

Return:

- x, y: position in Mollweide plane.

healpy.projector.MollweideProj.xy2ang

`MollweideProj.`**`xy2ang`**(*x*, *y=None*, *lonlat=False*, *direct=False*)

From position in the projection plane to angular direction (Mollweide).

Input:

- x : if y is None, x[0], x[1] define the position in Mollweide plane.
- y : if defined, x,y define the position in projection plane.
- lonlat: if True, angle are assumed in degree, and longitude, latitude
- flipconv is either 'astro' or 'geo'. None will be default.

Return:

- theta, phi : angular direction.

healpy.projector.MollweideProj.xy2ij

`MollweideProj.`**`xy2ij`**(*x*, *y=None*)

From position in the projection plane to image array index (Mollweide).

Input:

- x : if y is None, x[0], x[1] define the position in Mollweide plane.
- y : if defined, x,y define the position in projection plane.

- projinfo : additional projection information.

Return:

- i,j : image array indices.

healpy.projector.MollweideProj.xy2vec

MollweideProj.**xy2vec**(*x*, *y=None*, *direct=False*)

From position in the projection plane to unit vector direction (Mollweide).

Input:

- x : if y is None, x[0], x[1] define the position in Mollweide plane.
- y : if defined, x,y define the position in projection plane.
- lonlat: if True, angle are assumed in degree, and longitude, latitude
- flipconv is either 'astro' or 'geo'. None will be default.

Return:

- theta, phi : angular direction.

healpy.projector.CartesianProj

class healpy.projector.**CartesianProj**(*rot=None*, *coord=None*, *xsize=800*, *ysize=None*, *lonra=None*, *latra=None*, ***kwds*)

This class provides class methods for Cartesian projection.

Methods

ang2xy(theta[, phi, lonlat, direct])	From angular direction to position in the projection plane (Cartesian).
get_center([lonlat])	Get the center of the projection.
get_extent()	Get the extension of the projection plane.
get_fov()	
get_proj_plane_info()	
ij2xy([i, j])	From image array indices to position in projection plane (Cartesian).
mkcoord(coord)	
projmap(map, vec2pix_func[, rot, coord])	Create an array containing the projection of the map.
set_flip(flipconv)	flipconv is either 'astro' or 'geo'. None will be default.
set_proj_plane_info(xsize, ysize, lonra, latra)	
vec2xy(vx[, vy, vz, direct])	From unit vector direction to position in the projection plane (Cartesian).
xy2ang(x[, y, lonlat, direct])	From position in the projection plane to angular direction (Cartesian).
xy2ij(x[, y])	From position in the projection plane to image array index (Cartesian).
xy2vec(x[, y, direct])	From position in the projection plane to unit vector direction (Cartesian).

healpy.projector.CartesianProj.ang2xy

CartesianProj.**ang2xy**(*theta*, *phi=None*, *lonlat=False*, *direct=False*)

From angular direction to position in the projection plane (Cartesian).

Input:

- theta: if phi is None, theta[0] contains theta, theta[1] contains phi

- phi : if phi is not None, theta,phi are direction
- lonlat: if True, angle are assumed in degree, and longitude, latitude
- flipconv is either 'astro' or 'geo'. None will be default.

Return:

- x, y: position in Cartesian plane.

healpy.projector.CartesianProj.get_center

`CartesianProj.get_center(lonlat=False)`

Get the center of the projection.

Input:

- **lonlat** [if True, will return longitude and latitude in degree,] otherwise, theta and phi in radian

Return:

- theta,phi or lonlat depending on lonlat keyword

healpy.projector.CartesianProj.get_extent

`CartesianProj.get_extent()`

Get the extension of the projection plane.

Return: extent = (left,right,bottom,top)

healpy.projector.CartesianProj.get_fov

`CartesianProj.get_fov()`

healpy.projector.CartesianProj.get_proj_plane_info

`CartesianProj.get_proj_plane_info()`

healpy.projector.CartesianProj.ij2xy

`CartesianProj.ij2xy(i=None, j=None)`

From image array indices to position in projection plane (Cartesian).

Input:

- if i and j are None, generate arrays of i and j as input
- i : if j is None, i[0], j[1] define array indices in Cartesian image.
- j : if defined, i,j define array indices in image.
- projinfo : additional projection information.

Return:

- x,y : position in projection plane.

healpy.projector.CartesianProj.mkcoord

`CartesianProj.`**`mkcoord`**(*coord*)

healpy.projector.CartesianProj.projmap

`CartesianProj.`**`projmap`**(*map*, *vec2pix_func*, *rot=None*, *coord=None*)

Create an array containing the projection of the map.

Input:

- vec2pix_func: a function taking theta,phi and returning pixel number
- **map: an array containing the spherical map to project,** the pixelisation is described by vec2pix_func

Return:

- a 2D array with the projection of the map.

Note: the Projector must contain information on the array.

healpy.projector.CartesianProj.set_flip

`CartesianProj.`**`set_flip`**(*flipconv*)

flipconv is either 'astro' or 'geo'. None will be default.

With 'astro', east is toward left and west toward right. It is the opposite for 'geo'

healpy.projector.CartesianProj.set_proj_plane_info

`CartesianProj.`**`set_proj_plane_info`**(*xsize*, *ysize*, *lonra*, *latra*)

healpy.projector.CartesianProj.vec2xy

`CartesianProj.`**`vec2xy`**(*vx*, *vy=None*, *vz=None*, *direct=False*)

From unit vector direction to position in the projection plane (Cartesian).

Input:

- vx: if vy and vz are None, vx[0],vx[1],vx[2] defines the unit vector.
- vy,vz: if defined, vx,vy,vz define the unit vector
- lonlat: if True, angle are assumed in degree, and longitude, latitude
- flipconv is either 'astro' or 'geo'. None will be default.

Return:

- x, y: position in Cartesian plane.

healpy.projector.CartesianProj.xy2ang

`CartesianProj.`**`xy2ang`**(*x*, *y=None*, *lonlat=False*, *direct=False*)

From position in the projection plane to angular direction (Cartesian).

Input:

- x : if y is None, x[0], x[1] define the position in Cartesian plane.
- y : if defined, x,y define the position in projection plane.
- lonlat: if True, angle are assumed in degree, and longitude, latitude
- flipconv is either 'astro' or 'geo'. None will be default.

Return:

- theta, phi : angular direction.

healpy.projector.CartesianProj.xy2ij

`CartesianProj.`**`xy2ij`**(*x*, *y=None*)

From position in the projection plane to image array index (Cartesian).

Input:

- x : if y is None, x[0], x[1] define the position in Cartesian plane.
- y : if defined, x,y define the position in projection plane.
- projinfo : additional projection information.

Return:

- i,j : image array indices.

healpy.projector.CartesianProj.xy2vec

`CartesianProj.`**`xy2vec`**(*x*, *y=None*, *direct=False*)

From position in the projection plane to unit vector direction (Cartesian).

Input:

- x : if y is None, x[0], x[1] define the position in Cartesian plane.
- y : if defined, x,y define the position in projection plane.
- lonlat: if True, angle are assumed in degree, and longitude, latitude
- flipconv is either 'astro' or 'geo'. None will be default.

Return:

- theta, phi : angular direction.

3.7 `projaxes` – Axes for projection

3.7.1 Basic classes

`SphericalProjAxes`(ProjClass, *args, **kwds)	Define a special Axes to take care of spherical projection.
`GnomonicAxes`(*args, **kwds)	Define a gnomonic Axes to handle gnomonic projection.
`HpxGnomonicAxes`(*args, **kwds)	
`MollweideAxes`(*args, **kwds)	Define a mollweide Axes to handle mollweide projection.
`HpxMollweideAxes`(*args, **kwds)	
`CartesianAxes`(*args, **kwds)	Define a cylindrical Axes to handle cylindrical projection.
`HpxCartesianAxes`(*args, **kwds)	

healpy.projaxes.SphericalProjAxes

class `healpy.projaxes.`**`SphericalProjAxes`**(*ProjClass*, **args*, ***kwds*)

Define a special Axes to take care of spherical projection.

Parameters **projection** : a SphericalProj class or a class derived from it.

type of projection

rot : list or string

define rotation. See rotator.

coord : list or string

define coordinate system. See rotator.

coordprec : number of digit after floating point for coordinates display.

format : format string for value display.

Notes

Other keywords from Axes (see Axes).

Methods

`delgraticules`()	Delete all graticules previously created on the Axes.
`format_coord`(x, y)	Format the coordinate for display in status bar.
`get_lonlat`(x, y)	Get the coordinate in the coord system of the image, in lon/lat in deg.
`get_meridian_interval`(vx[, vy, vz])	Get the min and max value of phi of the meridians to cover the field of view.
`get_parallel_interval`(vx[, vy, vz])	Get the min and max value of theta of the parallel to cover the field of view.
`get_value`(x, y)	Get the value of the map at position x,y
`graticule`([dpar, dmer, coord, local, verbose])	Draw a graticule.
`projmap`(map, vec2pix_func[, vmin, vmax, ...])	Project a map on the SphericalProjAxes.
`projplot`(*args, **kwds)	projplot is a wrapper around `matplotlib.Axes.plot()` to take into accoun
`projscatter`(theta[, phi])	Projscatter is a wrapper around `matplotlib.Axes.scatter()` to take into
`projtext`(theta, phi, s, **kwds)	Projtext is a wrapper around `matplotlib.Axes.text()` to take into accoun
`set_coordprec`(n)	Set the number of digits after floating point for coord display.
`set_format`(f)	Set the format string for value display

healpy.projaxes.SphericalProjAxes.delgraticules

`SphericalProjAxes.`**`delgraticules`**()

Delete all graticules previously created on the Axes.

healpy.projaxes.SphericalProjAxes.format_coord

`SphericalProjAxes.`**`format_coord`**(*x*, *y*)

Format the coordinate for display in status bar. Take projection into account.

healpy.projaxes.SphericalProjAxes.get_lonlat

`SphericalProjAxes.`**`get_lonlat`**(*x*, *y*)

Get the coordinate in the coord system of the image, in lon/lat in deg.

healpy.projaxes.SphericalProjAxes.get_meridian_interval

`SphericalProjAxes.`**`get_meridian_interval`**(*vx*, *vy=None*, *vz=None*)

Get the min and max value of phi of the meridians to cover the field of view.

Input:

- the normalized vector of the direction of the center of the projection, in the reference frame of the graticule.

Return:

- **vmin,vmax** [the interval of phi for the] meridians crossing the field of view.

healpy.projaxes.SphericalProjAxes.get_parallel_interval

`SphericalProjAxes.`**`get_parallel_interval`**(*vx*, *vy=None*, *vz=None*)

Get the min and max value of theta of the parallel to cover the field of view.

Input:

- the normalized vector of the direction of the center of the projection, in the reference frame of the graticule.

Return:

- **vmin,vmax** [between 0 and pi, vmin<vmax, the interval of theta] for the parallels crossing the field of view

healpy.projaxes.SphericalProjAxes.get_value

`SphericalProjAxes.`**`get_value`**(*x*, *y*)

Get the value of the map at position x,y

healpy.projaxes.SphericalProjAxes.graticule

`SphericalProjAxes.`**`graticule`**(*dpar=None*, *dmer=None*, *coord=None*, *local=None*, *verbose=True*, ***kwds*)

Draw a graticule.

Input:

- dpar: angular separation between parallels in degree
- dmer: angular separation between meridians in degree

- coord: coordinate system of the graticule (‘G’, ‘E’ or ‘C’)
- local: if True, no rotation performed at all

healpy.projaxes.SphericalProjAxes.projmap

`SphericalProjAxes.`**`projmap`**(*map*, *vec2pix_func*, *vmin=None*, *vmax=None*, *badval=<class ‘Mock’>*, *cmap=None*, *norm=None*, *rot=None*, *coord=None*, ***kwds*)

Project a map on the SphericalProjAxes.

Parameters **map** : array-like

The map to project.

vec2pix_func : function

The function describing the pixelisation.

vmin, vmax : float, scalars

min and max value to use instead of min max of the map

badval : float

The value of the bad pixels

cmap : a color map

The colormap to use (see matplotlib.cm)

rot : sequence

In the form (lon, lat, psi) (unit: degree):the center of the map is at (lon, lat) and rotated by angle psi around that direction.

coord : {‘G’, ‘E’, ‘C’, None}

The coordinate system of the map (‘G’,’E’ or ‘C’), rotate the map if different from the axes coord syst.

Notes

Other keywords are transmitted to `matplotlib.Axes.imshow()`

healpy.projaxes.SphericalProjAxes.projplot

`SphericalProjAxes.`**`projplot`**(**args*, ***kwds*)

projplot is a wrapper around `matplotlib.Axes.plot()` to take into account the spherical projection.

You can call this function as:

```
projplot(theta, phi)        # plot a line going through points at coord (theta, phi)
projplot(theta, phi, 'bo')  # plot 'o' in blue at coord (theta, phi)
projplot(thetaphi)          # plot a line going through points at coord (thetaphi[0], thetap
projplot(thetaphi, 'bx')    # idem but with blue 'x'
```

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

fmt : str

A format string (see `matplotlib.Axes.plot()` for details)

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {'E', 'G', 'C', None}

The coordinate system of the points, only used if the coordinate coordinate system of the Axes has been defined and in this case, a rotation is performed

rot : None or sequence

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool

if True, the rotation to center the projection is not taken into account

See also:

`projscatter`, `projtext`

Notes

Other keywords are passed to `matplotlib.Axes.plot()`.

healpy.projaxes.SphericalProjAxes.projscatter

`SphericalProjAxes.`**`projscatter`**`(`*theta*, *phi=None*, **args*, ***kwds*`)`

Projscatter is a wrapper around `matplotlib.Axes.scatter()` to take into account the spherical projection.

You can call this function as:

```
projscatter(theta, phi)      # plot points at coord (theta, phi)
projplot(thetaphi)           # plot points at coord (thetaphi[0], thetaphi[1])
```

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {'E', 'G', 'C', None}, optional

The coordinate system of the points, only used if the coordinate coordinate system of the axes has been defined and in this case, a rotation is performed

rot : None or sequence, optional

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool, optional

if True, the rotation to center the projection is not taken into account

See also:

`projplot`, `projtext`

Notes

Other keywords are passed to `matplotlib.Axes.plot()`.

healpy.projaxes.SphericalProjAxes.projtext

`SphericalProjAxes.`**`projtext`**`(`*theta*, *phi*, *s*, ***kwds*`)`

Projtext is a wrapper around `matplotlib.Axes.text()` to take into account the spherical projection.

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

text : str

The text to be displayed.

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {'E', 'G', 'C', None}, optional

The coordinate system of the points, only used if the coordinate coordinate system of the axes has been defined and in this case, a rotation is performed

rot : None or sequence, optional

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool, optional

if True, the rotation to center the projection is not taken into account

See also:

`projplot`, `projscatter`

Notes

Other keywords are passed to `matplotlib.Axes.text()`.

healpy.projaxes.SphericalProjAxes.set_coordprec

SphericalProjAxes.**set_coordprec**(*n*)
Set the number of digits after floating point for coord display.

healpy.projaxes.SphericalProjAxes.set_format

SphericalProjAxes.**set_format**(*f*)
Set the format string for value display

healpy.projaxes.GnomonicAxes

class healpy.projaxes.**GnomonicAxes**(**args*, ***kwds*)
Define a gnomonic Axes to handle gnomonic projection.

Input:

- rot=, coord= : define rotation and coordinate system. See rotator.
- coordprec= : number of digit after floating point for coordinates display.
- format= : format string for value display.

Other keywords from Axes (see Axes).

Methods

delgraticules()	Delete all graticules previously created on the Axes.
format_coord(x, y)	Format the coordinate for display in status bar.
get_lonlat(x, y)	Get the coordinate in the coord system of the image, in lon/lat in deg.
get_meridian_interval(vx[, vy, vz])	Get the min and max value of phi of the meridians to cover the field of view.
get_parallel_interval(vx[, vy, vz])	Get the min and max value of theta of the parallel to cover the field of view.
get_value(x, y)	Get the value of the map at position x,y
graticule([dpar, dmer, coord, local, verbose])	Draw a graticule.
projmap(map, vec2pix_func[, xsize, ysize, reso])	
projplot(*args, **kwds)	projplot is a wrapper around `matplotlib.Axes.plot()` to take into accou
projscatter(theta[, phi])	Projscatter is a wrapper around `matplotlib.Axes.scatter()` to take int
projtext(theta, phi, s, **kwds)	Projtext is a wrapper around `matplotlib.Axes.text()` to take into accou
set_coordprec(n)	Set the number of digits after floating point for coord display.
set_format(f)	Set the format string for value display

healpy.projaxes.GnomonicAxes.delgraticules

GnomonicAxes.**delgraticules**()
Delete all graticules previously created on the Axes.

healpy.projaxes.GnomonicAxes.format_coord

GnomonicAxes.**format_coord**(*x*, *y*)
Format the coordinate for display in status bar. Take projection into account.

healpy.projaxes.GnomonicAxes.get_lonlat

GnomonicAxes.**get_lonlat**(*x*, *y*)

Get the coordinate in the coord system of the image, in lon/lat in deg.

healpy.projaxes.GnomonicAxes.get_meridian_interval

GnomonicAxes.**get_meridian_interval**(*vx*, *vy=None*, *vz=None*)

Get the min and max value of phi of the meridians to cover the field of view.

Input:

- the normalized vector of the direction of the center of the projection, in the reference frame of the graticule.

Return:

- **vmin,vmax** [the interval of phi for the] meridians crossing the field of view.

healpy.projaxes.GnomonicAxes.get_parallel_interval

GnomonicAxes.**get_parallel_interval**(*vx*, *vy=None*, *vz=None*)

Get the min and max value of theta of the parallel to cover the field of view.

Input:

- the normalized vector of the direction of the center of the projection, in the reference frame of the graticule.

Return:

- **vmin,vmax** [between 0 and pi, vmin<vmax, the interval of theta] for the parallels crossing the field of view

healpy.projaxes.GnomonicAxes.get_value

GnomonicAxes.**get_value**(*x*, *y*)

Get the value of the map at position x,y

healpy.projaxes.GnomonicAxes.graticule

GnomonicAxes.**graticule**(*dpar=None*, *dmer=None*, *coord=None*, *local=None*, *verbose=True*, ***kwds*)

Draw a graticule.

Input:

- dpar: angular separation between parallels in degree
- dmer: angular separation between meridians in degree
- coord: coordinate system of the graticule (‘G’, ‘E’ or ‘C’)
- local: if True, no rotation performed at all

healpy.projaxes.GnomonicAxes.projmap

GnomonicAxes.**projmap**(*map*, *vec2pix_func*, *xsize=200*, *ysize=None*, *reso=1.5*, ***kwds*)

healpy.projaxes.GnomonicAxes.projplot

GnomonicAxes.**projplot**(**args*, ***kwds*)

projplot is a wrapper around `matplotlib.Axes.plot()` to take into account the spherical projection.

You can call this function as:

```
projplot(theta, phi)         # plot a line going through points at coord (theta, phi)
projplot(theta, phi, 'bo')   # plot 'o' in blue at coord (theta, phi)
projplot(thetaphi)           # plot a line going through points at coord (thetaphi[0], thetap
projplot(thetaphi, 'bx')     # idem but with blue 'x'
```

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

fmt : str

A format string (see `matplotlib.Axes.plot()` for details)

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {'E', 'G', 'C', None}

The coordinate system of the points, only used if the coordinate coordinate system of the Axes has been defined and in this case, a rotation is performed

rot : None or sequence

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool

if True, the rotation to center the projection is not taken into account

See also:

`projscatter`, `projtext`

Notes

Other keywords are passed to `matplotlib.Axes.plot()`.

healpy.projaxes.GnomonicAxes.projscatter

GnomonicAxes.**projscatter**(*theta*, *phi=None*, **args*, ***kwds*)

Projscatter is a wrapper around `matplotlib.Axes.scatter()` to take into account the spherical projection.

You can call this function as:

```
projscatter(theta, phi)      # plot points at coord (theta, phi)
projplot(thetaphi)           # plot points at coord (thetaphi[0], thetaphi[1])
```

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {'E', 'G', 'C', None}, optional

The coordinate system of the points, only used if the coordinate coordinate system of the axes has been defined and in this case, a rotation is performed

rot : None or sequence, optional

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool, optional

if True, the rotation to center the projection is not taken into account

See also:

`projplot`, `projtext`

Notes

Other keywords are passed to `matplotlib.Axes.plot()`.

healpy.projaxes.GnomonicAxes.projtext

`GnomonicAxes.`**`projtext`**`(`*theta*, *phi*, *s*, ***kwds*`)`

Projtext is a wrapper around `matplotlib.Axes.text()` to take into account the spherical projection.

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

text : str

The text to be displayed.

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {'E', 'G', 'C', None}, optional

The coordinate system of the points, only used if the coordinate coordinate system of the axes has been defined and in this case, a rotation is performed

rot : None or sequence, optional

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool, optional

if True, the rotation to center the projection is not taken into account

See also:

projplot, projscatter

Notes

Other keywords are passed to `matplotlib.Axes.text()`.

healpy.projaxes.GnomonicAxes.set_coordprec

`GnomonicAxes.`**`set_coordprec`**`(`*n*`)`
Set the number of digits after floating point for coord display.

healpy.projaxes.GnomonicAxes.set_format

`GnomonicAxes.`**`set_format`**`(`*f*`)`
Set the format string for value display

healpy.projaxes.HpxGnomonicAxes

class `healpy.projaxes.`**`HpxGnomonicAxes`**`(`**args*, ***kwds*`)`

Methods

`delgraticules`()	Delete all graticules previously created on the Axes.
`format_coord`(x, y)	Format the coordinate for display in status bar.
`get_lonlat`(x, y)	Get the coordinate in the coord system of the image, in lon/lat in deg.
`get_meridian_interval`(vx[, vy, vz])	Get the min and max value of phi of the meridians to cover the field of view.
`get_parallel_interval`(vx[, vy, vz])	Get the min and max value of theta of the parallel to cover the field of view.
`get_value`(x, y)	Get the value of the map at position x,y
`graticule`([dpar, dmer, coord, local, verbose])	Draw a graticule.
`projmap`(map[, nest])	
`projplot`(*args, **kwds)	projplot is a wrapper around `matplotlib.Axes.plot()` to take into accoun
`projscatter`(theta[, phi])	Projscatter is a wrapper around `matplotlib.Axes.scatter()` to take into
`projtext`(theta, phi, s, **kwds)	Projtext is a wrapper around `matplotlib.Axes.text()` to take into accoun
`set_coordprec`(n)	Set the number of digits after floating point for coord display.
`set_format`(f)	Set the format string for value display

healpy.projaxes.HpxGnomonicAxes.delgraticules

`HpxGnomonicAxes.`**`delgraticules`**`()`
Delete all graticules previously created on the Axes.

healpy.projaxes.HpxGnomonicAxes.format_coord

HpxGnomonicAxes.**format_coord**(*x*, *y*)
Format the coordinate for display in status bar. Take projection into account.

healpy.projaxes.HpxGnomonicAxes.get_lonlat

HpxGnomonicAxes.**get_lonlat**(*x*, *y*)
Get the coordinate in the coord system of the image, in lon/lat in deg.

healpy.projaxes.HpxGnomonicAxes.get_meridian_interval

HpxGnomonicAxes.**get_meridian_interval**(*vx*, *vy=None*, *vz=None*)
Get the min and max value of phi of the meridians to cover the field of view.

Input:

- the normalized vector of the direction of the center of the projection, in the reference frame of the graticule.

Return:

- **vmin,vmax** [the interval of phi for the] meridians crossing the field of view.

healpy.projaxes.HpxGnomonicAxes.get_parallel_interval

HpxGnomonicAxes.**get_parallel_interval**(*vx*, *vy=None*, *vz=None*)
Get the min and max value of theta of the parallel to cover the field of view.

Input:

- the normalized vector of the direction of the center of the projection, in the reference frame of the graticule.

Return:

- **vmin,vmax** [between 0 and pi, vmin<vmax, the interval of theta] for the parallels crossing the field of view

healpy.projaxes.HpxGnomonicAxes.get_value

HpxGnomonicAxes.**get_value**(*x*, *y*)
Get the value of the map at position x,y

healpy.projaxes.HpxGnomonicAxes.graticule

HpxGnomonicAxes.**graticule**(*dpar=None*, *dmer=None*, *coord=None*, *local=None*, *verbose=True*, ***kwds*)
Draw a graticule.

Input:

- dpar: angular separation between parallels in degree
- dmer: angular separation between meridians in degree

- coord: coordinate system of the graticule (‘G’, ‘E’ or ‘C’)
- local: if True, no rotation performed at all

healpy.projaxes.HpxGnomonicAxes.projmap

HpxGnomonicAxes.**projmap**(*map*, *nest=False*, ***kwds*)

healpy.projaxes.HpxGnomonicAxes.projplot

HpxGnomonicAxes.**projplot**(**args*, ***kwds*)

projplot is a wrapper around `matplotlib.Axes.plot()` to take into account the spherical projection.

You can call this function as:

```
projplot(theta, phi)        # plot a line going through points at coord (theta, phi)
projplot(theta, phi, 'bo')  # plot 'o' in blue at coord (theta, phi)
projplot(thetaphi)          # plot a line going through points at coord (thetaphi[0], thetap
projplot(thetaphi, 'bx')    # idem but with blue 'x'
```

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

fmt : str

A format string (see `matplotlib.Axes.plot()` for details)

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {‘E’, ‘G’, ‘C’, None}

The coordinate system of the points, only used if the coordinate coordinate system of the Axes has been defined and in this case, a rotation is performed

rot : None or sequence

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool

if True, the rotation to center the projection is not taken into account

See also:

`projscatter`, `projtext`

Notes

Other keywords are passed to `matplotlib.Axes.plot()`.

healpy.projaxes.HpxGnomonicAxes.projscatter

HpxGnomonicAxes.**projscatter**(*theta*, *phi=None*, **args*, ***kwds*)

Projscatter is a wrapper around `matplotlib.Axes.scatter()` to take into account the spherical projection.

You can call this function as:

```
projscatter(theta, phi)      # plot points at coord (theta, phi)
projplot(thetaphi)           # plot points at coord (thetaphi[0], thetaphi[1])
```

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {'E', 'G', 'C', None}, optional

The coordinate system of the points, only used if the coordinate coordinate system of the axes has been defined and in this case, a rotation is performed

rot : None or sequence, optional

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool, optional

if True, the rotation to center the projection is not taken into account

See also:

`projplot`, `projtext`

Notes

Other keywords are passed to `matplotlib.Axes.plot()`.

healpy.projaxes.HpxGnomonicAxes.projtext

HpxGnomonicAxes.**projtext**(*theta*, *phi*, *s*, ***kwds*)

Projtext is a wrapper around `matplotlib.Axes.text()` to take into account the spherical projection.

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

text : str

The text to be displayed.

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {'E', 'G', 'C', None}, optional

The coordinate system of the points, only used if the coordinate coordinate system of the axes has been defined and in this case, a rotation is performed

rot : None or sequence, optional

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool, optional

if True, the rotation to center the projection is not taken into account

See also:

projplot, projscatter

Notes

Other keywords are passed to `matplotlib.Axes.text()`.

healpy.projaxes.HpxGnomonicAxes.set_coordprec

HpxGnomonicAxes.**set_coordprec**(*n*)
Set the number of digits after floating point for coord display.

healpy.projaxes.HpxGnomonicAxes.set_format

HpxGnomonicAxes.**set_format**(*f*)
Set the format string for value display

healpy.projaxes.MollweideAxes

class healpy.projaxes.**MollweideAxes**(**args*, ***kwds*)
Define a mollweide Axes to handle mollweide projection.

Input:

- rot=, coord= : define rotation and coordinate system. See rotator.
- coordprec= : number of digit after floating point for coordinates display.
- format= : format string for value display.

Other keywords from Axes (see Axes).

Methods

delgraticules()	Delete all graticules previously created on the Axes.
format_coord(x, y)	Format the coordinate for display in status bar.
get_lonlat(x, y)	Get the coordinate in the coord system of the image, in lon/lat in deg.

Table 3.32 – continued from previous page

`get_meridian_interval`(vx[, vy, vz])	Get the min and max value of phi of the meridians to cover the field of view.
`get_parallel_interval`(vx[, vy, vz])	Get the min and max value of theta of the parallel to cover the field of view.
`get_value`(x, y)	Get the value of the map at position x,y
`graticule`([dpar, dmer, coord, local, verbose])	Draw a graticule.
`projmap`(map, vec2pix_func[, xsize])	
`projplot`(*args, **kwds)	projplot is a wrapper around `matplotlib.Axes.plot()` to take into accoun
`projscatter`(theta[, phi])	Projscatter is a wrapper around `matplotlib.Axes.scatter()` to take into
`projtext`(theta, phi, s, **kwds)	Projtext is a wrapper around `matplotlib.Axes.text()` to take into accoun
`set_coordprec`(n)	Set the number of digits after floating point for coord display.
`set_format`(f)	Set the format string for value display

healpy.projaxes.MollweideAxes.delgraticules

`MollweideAxes.`**`delgraticules`**`()`

Delete all graticules previously created on the Axes.

healpy.projaxes.MollweideAxes.format_coord

`MollweideAxes.`**`format_coord`**`(`*x*, *y*`)`

Format the coordinate for display in status bar. Take projection into account.

healpy.projaxes.MollweideAxes.get_lonlat

`MollweideAxes.`**`get_lonlat`**`(`*x*, *y*`)`

Get the coordinate in the coord system of the image, in lon/lat in deg.

healpy.projaxes.MollweideAxes.get_meridian_interval

`MollweideAxes.`**`get_meridian_interval`**`(`*vx*, *vy=None*, *vz=None*`)`

Get the min and max value of phi of the meridians to cover the field of view.

Input:

- the normalized vector of the direction of the center of the projection, in the reference frame of the graticule.

Return:

- **vmin,vmax** [the interval of phi for the] meridians crossing the field of view.

healpy.projaxes.MollweideAxes.get_parallel_interval

`MollweideAxes.`**`get_parallel_interval`**`(`*vx*, *vy=None*, *vz=None*`)`

Get the min and max value of theta of the parallel to cover the field of view.

Input:

- the normalized vector of the direction of the center of the projection, in the reference frame of the graticule.

Return:

- **vmin,vmax** [between 0 and pi, vmin<vmax, the interval of theta] for the parallels crossing the field of view

healpy.projaxes.MollweideAxes.get_value

MollweideAxes.**get_value**(*x*, *y*)

Get the value of the map at position x,y

healpy.projaxes.MollweideAxes.graticule

MollweideAxes.**graticule**(*dpar=None*, *dmer=None*, *coord=None*, *local=None*, *verbose=True*, ***kwds*)

Draw a graticule.

Input:

- dpar: angular separation between parallels in degree
- dmer: angular separation between meridians in degree
- coord: coordinate system of the graticule ('G', 'E' or 'C')
- local: if True, no rotation performed at all

healpy.projaxes.MollweideAxes.projmap

MollweideAxes.**projmap**(*map*, *vec2pix_func*, *xsize=800*, ***kwds*)

healpy.projaxes.MollweideAxes.projplot

MollweideAxes.**projplot**(**args*, ***kwds*)

projplot is a wrapper around `matplotlib.Axes.plot()` to take into account the spherical projection.

You can call this function as:

```
projplot(theta, phi)        # plot a line going through points at coord (theta, phi)
projplot(theta, phi, 'bo')  # plot 'o' in blue at coord (theta, phi)
projplot(thetaphi)          # plot a line going through points at coord (thetaphi[0], thetap
projplot(thetaphi, 'bx')    # idem but with blue 'x'
```

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

fmt : str

A format string (see `matplotlib.Axes.plot()` for details)

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {'E', 'G', 'C', None}

The coordinate system of the points, only used if the coordinate coordinate system of the Axes has been defined and in this case, a rotation is performed

rot : None or sequence

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool

if True, the rotation to center the projection is not taken into account

See also:

`projscatter`, `projtext`

Notes

Other keywords are passed to `matplotlib.Axes.plot()`.

healpy.projaxes.MollweideAxes.projscatter

`MollweideAxes.`**`projscatter`**`(`*theta*, *phi=None*, **args*, ***kwds*`)`

Projscatter is a wrapper around `matplotlib.Axes.scatter()` to take into account the spherical projection.

You can call this function as:

```
projscatter(theta, phi)     # plot points at coord (theta, phi)
projplot(thetaphi)          # plot points at coord (thetaphi[0], thetaphi[1])
```

Parameters theta, phi : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {'E', 'G', 'C', None}, optional

The coordinate system of the points, only used if the coordinate coordinate system of the axes has been defined and in this case, a rotation is performed

rot : None or sequence, optional

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool, optional

if True, the rotation to center the projection is not taken into account

See also:

`projplot`, `projtext`

Notes

Other keywords are passed to `matplotlib.Axes.plot()`.

healpy.projaxes.MollweideAxes.projtext

`MollweideAxes.`**`projtext`**`(`*theta*, *phi*, *s*, ***kwds*`)`

Projtext is a wrapper around `matplotlib.Axes.text()` to take into account the spherical projection.

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

text : str

The text to be displayed.

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {'E', 'G', 'C', None}, optional

The coordinate system of the points, only used if the coordinate coordinate system of the axes has been defined and in this case, a rotation is performed

rot : None or sequence, optional

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool, optional

if True, the rotation to center the projection is not taken into account

See also:

`projplot`, `projscatter`

Notes

Other keywords are passed to `matplotlib.Axes.text()`.

healpy.projaxes.MollweideAxes.set_coordprec

`MollweideAxes.`**`set_coordprec`**`(`*n*`)`

Set the number of digits after floating point for coord display.

healpy.projaxes.MollweideAxes.set_format

`MollweideAxes.`**`set_format`**`(`*f*`)`

Set the format string for value display

healpy.projaxes.HpxMollweideAxes

class healpy.projaxes.**HpxMollweideAxes**(**args*, ***kwds*)

Methods

delgraticules()	Delete all graticules previously created on the Axes.
format_coord(x, y)	Format the coordinate for display in status bar.
get_lonlat(x, y)	Get the coordinate in the coord system of the image, in lon/lat in deg.
get_meridian_interval(vx[, vy, vz])	Get the min and max value of phi of the meridians to cover the field of view.
get_parallel_interval(vx[, vy, vz])	Get the min and max value of theta of the parallel to cover the field of view.
get_value(x, y)	Get the value of the map at position x,y
graticule([dpar, dmer, coord, local, verbose])	Draw a graticule.
projmap(map[, nest])	
projplot(*args, **kwds)	projplot is a wrapper around matplotlib.Axes.plot() to take into accoun
projscatter(theta[, phi])	Projscatter is a wrapper around matplotlib.Axes.scatter() to take into
projtext(theta, phi, s, **kwds)	Projtext is a wrapper around matplotlib.Axes.text() to take into accoun
set_coordprec(n)	Set the number of digits after floating point for coord display.
set_format(f)	Set the format string for value display

healpy.projaxes.HpxMollweideAxes.delgraticules

HpxMollweideAxes.**delgraticules**()

Delete all graticules previously created on the Axes.

healpy.projaxes.HpxMollweideAxes.format_coord

HpxMollweideAxes.**format_coord**(*x*, *y*)

Format the coordinate for display in status bar. Take projection into account.

healpy.projaxes.HpxMollweideAxes.get_lonlat

HpxMollweideAxes.**get_lonlat**(*x*, *y*)

Get the coordinate in the coord system of the image, in lon/lat in deg.

healpy.projaxes.HpxMollweideAxes.get_meridian_interval

HpxMollweideAxes.**get_meridian_interval**(*vx*, *vy=None*, *vz=None*)

Get the min and max value of phi of the meridians to cover the field of view.

Input:

- the normalized vector of the direction of the center of the projection, in the reference frame of the graticule.

Return:

- **vmin,vmax** [the interval of phi for the] meridians crossing the field of view.

healpy.projaxes.HpxMollweideAxes.get_parallel_interval

`HpxMollweideAxes.`**`get_parallel_interval`**(*vx*, *vy=None*, *vz=None*)

Get the min and max value of theta of the parallel to cover the field of view.

Input:

- the normalized vector of the direction of the center of the projection, in the reference frame of the graticule.

Return:

- **vmin,vmax** [between 0 and pi, vmin<vmax, the interval of theta] for the parallels crossing the field of view

healpy.projaxes.HpxMollweideAxes.get_value

`HpxMollweideAxes.`**`get_value`**(*x*, *y*)

Get the value of the map at position x,y

healpy.projaxes.HpxMollweideAxes.graticule

`HpxMollweideAxes.`**`graticule`**(*dpar=None*, *dmer=None*, *coord=None*, *local=None*, *verbose=True*, ***kwds*)

Draw a graticule.

Input:

- dpar: angular separation between parallels in degree
- dmer: angular separation between meridians in degree
- coord: coordinate system of the graticule (‘G’, ‘E’ or ‘C’)
- local: if True, no rotation performed at all

healpy.projaxes.HpxMollweideAxes.projmap

`HpxMollweideAxes.`**`projmap`**(*map*, *nest=False*, ***kwds*)

healpy.projaxes.HpxMollweideAxes.projplot

`HpxMollweideAxes.`**`projplot`**(**args*, ***kwds*)

projplot is a wrapper around `matplotlib.Axes.plot()` to take into account the spherical projection.

You can call this function as:

```
projplot(theta, phi)         # plot a line going through points at coord (theta, phi)
projplot(theta, phi, 'bo')   # plot 'o' in blue at coord (theta, phi)
projplot(thetaphi)           # plot a line going through points at coord (thetaphi[0], thetap
projplot(thetaphi, 'bx')     # idem but with blue 'x'
```

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

fmt : str

A format string (see `matplotlib.Axes.plot()` for details)

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {'E', 'G', 'C', None}

The coordinate system of the points, only used if the coordinate coordinate system of the Axes has been defined and in this case, a rotation is performed

rot : None or sequence

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool

if True, the rotation to center the projection is not taken into account

See also:

`projscatter`, `projtext`

Notes

Other keywords are passed to `matplotlib.Axes.plot()`.

healpy.projaxes.HpxMollweideAxes.projscatter

`HpxMollweideAxes.`**`projscatter`**(*theta*, *phi=None*, **args*, ***kwds*)

Projscatter is a wrapper around `matplotlib.Axes.scatter()` to take into account the spherical projection.

You can call this function as:

```
projscatter(theta, phi)      # plot points at coord (theta, phi)
projplot(thetaphi)           # plot points at coord (thetaphi[0], thetaphi[1])
```

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {'E', 'G', 'C', None}, optional

The coordinate system of the points, only used if the coordinate coordinate system of the axes has been defined and in this case, a rotation is performed

rot : None or sequence, optional

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool, optional

if True, the rotation to center the projection is not taken into account

See also:

`projplot`, `projtext`

Notes

Other keywords are passed to `matplotlib.Axes.plot()`.

healpy.projaxes.HpxMollweideAxes.projtext

`HpxMollweideAxes.`**`projtext`**(*theta*, *phi*, *s*, ***kwds*)

Projtext is a wrapper around `matplotlib.Axes.text()` to take into account the spherical projection.

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

text : str

The text to be displayed.

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {'E', 'G', 'C', None}, optional

The coordinate system of the points, only used if the coordinate coordinate system of the axes has been defined and in this case, a rotation is performed

rot : None or sequence, optional

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool, optional

if True, the rotation to center the projection is not taken into account

See also:

`projplot`, `projscatter`

Notes

Other keywords are passed to `matplotlib.Axes.text()`.

healpy.projaxes.HpxMollweideAxes.set_coordprec

`HpxMollweideAxes.`**`set_coordprec`**(*n*)

Set the number of digits after floating point for coord display.

healpy.projaxes.HpxMollweideAxes.set_format

`HpxMollweideAxes.`**`set_format`**`(`*f*`)`

Set the format string for value display

healpy.projaxes.CartesianAxes

class `healpy.projaxes.`**`CartesianAxes`**`(`**args*, ***kwds*`)`

Define a cylindrical Axes to handle cylindrical projection.

Methods

`delgraticules`()	Delete all graticules previously created on the Axes.
`format_coord`(x, y)	Format the coordinate for display in status bar.
`get_lonlat`(x, y)	Get the coordinate in the coord system of the image, in lon/lat in deg.
`get_meridian_interval`(vx[, vy, vz])	Get the min and max value of phi of the meridians to cover the field of view.
`get_parallel_interval`(vx[, vy, vz])	Get the min and max value of theta of the parallel to cover the field of view.
`get_value`(x, y)	Get the value of the map at position x,y
`graticule`([dpar, dmer, coord, local, verbose])	Draw a graticule.
`projmap`(map, vec2pix_func[, xsize, ysize, ...])	
`projplot`(*args, **kwds)	projplot is a wrapper around `matplotlib.Axes.plot()` to take into accoun
`projscatter`(theta[, phi])	Projscatter is a wrapper around `matplotlib.Axes.scatter()` to take into
`projtext`(theta, phi, s, **kwds)	Projtext is a wrapper around `matplotlib.Axes.text()` to take into accoun
`set_coordprec`(n)	Set the number of digits after floating point for coord display.
`set_format`(f)	Set the format string for value display

healpy.projaxes.CartesianAxes.delgraticules

`CartesianAxes.`**`delgraticules`**`()`

Delete all graticules previously created on the Axes.

healpy.projaxes.CartesianAxes.format_coord

`CartesianAxes.`**`format_coord`**`(`*x*, *y*`)`

Format the coordinate for display in status bar. Take projection into account.

healpy.projaxes.CartesianAxes.get_lonlat

`CartesianAxes.`**`get_lonlat`**`(`*x*, *y*`)`

Get the coordinate in the coord system of the image, in lon/lat in deg.

healpy.projaxes.CartesianAxes.get_meridian_interval

`CartesianAxes.`**`get_meridian_interval`**`(`*vx*, *vy=None*, *vz=None*`)`

Get the min and max value of phi of the meridians to cover the field of view.

Input:

- the normalized vector of the direction of the center of the projection, in the reference frame of the graticule.

Return:

- **vmin,vmax** [the interval of phi for the] meridians crossing the field of view.

healpy.projaxes.CartesianAxes.get_parallel_interval

`CartesianAxes.`**`get_parallel_interval`**`(`*vx*, *vy=None*, *vz=None*`)`

Get the min and max value of theta of the parallel to cover the field of view.

Input:

- the normalized vector of the direction of the center of the projection, in the reference frame of the graticule.

Return:

- **vmin,vmax** [between 0 and pi, vmin<vmax, the interval of theta] for the parallels crossing the field of view

healpy.projaxes.CartesianAxes.get_value

`CartesianAxes.`**`get_value`**`(`*x*, *y*`)`

Get the value of the map at position x,y

healpy.projaxes.CartesianAxes.graticule

`CartesianAxes.`**`graticule`**`(`*dpar=None*, *dmer=None*, *coord=None*, *local=None*, *verbose=True*, ***kwds*`)`

Draw a graticule.

Input:

- dpar: angular separation between parallels in degree
- dmer: angular separation between meridians in degree
- coord: coordinate system of the graticule (‘G’, ‘E’ or ‘C’)
- local: if True, no rotation performed at all

healpy.projaxes.CartesianAxes.projmap

`CartesianAxes.`**`projmap`**`(`*map*, *vec2pix_func*, *xsize=800*, *ysize=None*, *lonra=None*, *latra=None*, ***kwds*`)`

healpy.projaxes.CartesianAxes.projplot

`CartesianAxes.`**`projplot`**`(`**args*, ***kwds*`)`

projplot is a wrapper around `matplotlib.Axes.plot()` to take into account the spherical projection.

You can call this function as:

```
projplot(theta, phi)        # plot a line going through points at coord (theta, phi)
projplot(theta, phi, ’bo’)  # plot ’o’ in blue at coord (theta, phi)
projplot(thetaphi)          # plot a line going through points at coord (thetaphi[0], thetap
projplot(thetaphi, ’bx’)    # idem but with blue ’x’
```

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

fmt : str

A format string (see `matplotlib.Axes.plot()` for details)

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {‘E’, ‘G’, ‘C’, None}

The coordinate system of the points, only used if the coordinate coordinate system of the Axes has been defined and in this case, a rotation is performed

rot : None or sequence

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool

if True, the rotation to center the projection is not taken into account

See also:

`projscatter`, `projtext`

Notes

Other keywords are passed to `matplotlib.Axes.plot()`.

healpy.projaxes.CartesianAxes.projscatter

`CartesianAxes.`**`projscatter`**(*theta*, *phi=None*, **args*, ***kwds*)

Projscatter is a wrapper around `matplotlib.Axes.scatter()` to take into account the spherical projection.

You can call this function as:

```
projscatter(theta, phi)     # plot points at coord (theta, phi)
projplot(thetaphi)          # plot points at coord (thetaphi[0], thetaphi[1])
```

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {'E', 'G', 'C', None}, optional

The coordinate system of the points, only used if the coordinate coordinate system of the axes has been defined and in this case, a rotation is performed

rot : None or sequence, optional

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool, optional

if True, the rotation to center the projection is not taken into account

See also:

`projplot`, `projtext`

Notes

Other keywords are passed to `matplotlib.Axes.plot()`.

healpy.projaxes.CartesianAxes.projtext

`CartesianAxes.`**`projtext`**`(`*theta*, *phi*, *s*, ***kwds*`)`

Projtext is a wrapper around `matplotlib.Axes.text()` to take into account the spherical projection.

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

text : str

The text to be displayed.

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {'E', 'G', 'C', None}, optional

The coordinate system of the points, only used if the coordinate coordinate system of the axes has been defined and in this case, a rotation is performed

rot : None or sequence, optional

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool, optional

if True, the rotation to center the projection is not taken into account

See also:

`projplot`, `projscatter`

Notes

Other keywords are passed to `matplotlib.Axes.text()`.

healpy.projaxes.CartesianAxes.set_coordprec

CartesianAxes.**set_coordprec**(*n*)

Set the number of digits after floating point for coord display.

healpy.projaxes.CartesianAxes.set_format

CartesianAxes.**set_format**(*f*)

Set the format string for value display

healpy.projaxes.HpxCartesianAxes

class healpy.projaxes.**HpxCartesianAxes**(**args*, ***kwds*)

Methods

delgraticules()	Delete all graticules previously created on the Axes.
format_coord(x, y)	Format the coordinate for display in status bar.
get_lonlat(x, y)	Get the coordinate in the coord system of the image, in lon/lat in deg.
get_meridian_interval(vx[, vy, vz])	Get the min and max value of phi of the meridians to cover the field of view.
get_parallel_interval(vx[, vy, vz])	Get the min and max value of theta of the parallel to cover the field of view.
get_value(x, y)	Get the value of the map at position x,y
graticule([dpar, dmer, coord, local, verbose])	Draw a graticule.
projmap(map[, nest])	
projplot(*args, **kwds)	projplot is a wrapper around `matplotlib.Axes.plot()` to take into accoun
projscatter(theta[, phi])	Projscatter is a wrapper around `matplotlib.Axes.scatter()` to take into
projtext(theta, phi, s, **kwds)	Projtext is a wrapper around `matplotlib.Axes.text()` to take into accoun
set_coordprec(n)	Set the number of digits after floating point for coord display.
set_format(f)	Set the format string for value display

healpy.projaxes.HpxCartesianAxes.delgraticules

HpxCartesianAxes.**delgraticules**()

Delete all graticules previously created on the Axes.

healpy.projaxes.HpxCartesianAxes.format_coord

HpxCartesianAxes.**format_coord**(*x*, *y*)

Format the coordinate for display in status bar. Take projection into account.

healpy.projaxes.HpxCartesianAxes.get_lonlat

HpxCartesianAxes.**get_lonlat**(*x*, *y*)

Get the coordinate in the coord system of the image, in lon/lat in deg.

healpy.projaxes.HpxCartesianAxes.get_meridian_interval

HpxCartesianAxes.**get_meridian_interval**(*vx*, *vy=None*, *vz=None*)

Get the min and max value of phi of the meridians to cover the field of view.

Input:

- the normalized vector of the direction of the center of the projection, in the reference frame of the graticule.

Return:

- **vmin,vmax** [the interval of phi for the] meridians crossing the field of view.

healpy.projaxes.HpxCartesianAxes.get_parallel_interval

HpxCartesianAxes.**get_parallel_interval**(*vx*, *vy=None*, *vz=None*)

Get the min and max value of theta of the parallel to cover the field of view.

Input:

- the normalized vector of the direction of the center of the projection, in the reference frame of the graticule.

Return:

- **vmin,vmax** [between 0 and pi, vmin<vmax, the interval of theta] for the parallels crossing the field of view

healpy.projaxes.HpxCartesianAxes.get_value

HpxCartesianAxes.**get_value**(*x*, *y*)

Get the value of the map at position x,y

healpy.projaxes.HpxCartesianAxes.graticule

HpxCartesianAxes.**graticule**(*dpar=None*, *dmer=None*, *coord=None*, *local=None*, *verbose=True*, ***kwds*)

Draw a graticule.

Input:

- dpar: angular separation between parallels in degree
- dmer: angular separation between meridians in degree
- coord: coordinate system of the graticule (‘G’, ‘E’ or ‘C’)
- local: if True, no rotation performed at all

healpy.projaxes.HpxCartesianAxes.projmap

HpxCartesianAxes.**projmap**(*map*, *nest=False*, ***kwds*)

healpy.projaxes.HpxCartesianAxes.projplot

HpxCartesianAxes.**projplot**(**args*, ***kwds*)

projplot is a wrapper around `matplotlib.Axes.plot()` to take into account the spherical projection.

You can call this function as:

```
projplot(theta, phi)         # plot a line going through points at coord (theta, phi)
projplot(theta, phi, 'bo')   # plot 'o' in blue at coord (theta, phi)
projplot(thetaphi)           # plot a line going through points at coord (thetaphi[0], thetap
projplot(thetaphi, 'bx')     # idem but with blue 'x'
```

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

fmt : str

A format string (see `matplotlib.Axes.plot()` for details)

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {'E', 'G', 'C', None}

The coordinate system of the points, only used if the coordinate coordinate system of the Axes has been defined and in this case, a rotation is performed

rot : None or sequence

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool

if True, the rotation to center the projection is not taken into account

See also:

`projscatter`, `projtext`

Notes

Other keywords are passed to `matplotlib.Axes.plot()`.

healpy.projaxes.HpxCartesianAxes.projscatter

HpxCartesianAxes.**projscatter**(*theta*, *phi=None*, **args*, ***kwds*)

Projscatter is a wrapper around `matplotlib.Axes.scatter()` to take into account the spherical projection.

You can call this function as:

```
projscatter(theta, phi)      # plot points at coord (theta, phi)
projplot(thetaphi)           # plot points at coord (thetaphi[0], thetaphi[1])
```

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {'E', 'G', 'C', None}, optional

The coordinate system of the points, only used if the coordinate coordinate system of the axes has been defined and in this case, a rotation is performed

rot : None or sequence, optional

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool, optional

if True, the rotation to center the projection is not taken into account

See also:

`projplot`, `projtext`

Notes

Other keywords are passed to `matplotlib.Axes.plot()`.

healpy.projaxes.HpxCartesianAxes.projtext

`HpxCartesianAxes.`**`projtext`**`(`*theta*, *phi*, *s*, ***kwds*`)`

Projtext is a wrapper around `matplotlib.Axes.text()` to take into account the spherical projection.

Parameters **theta, phi** : float, array-like

Coordinates of point to plot. Can be put into one 2-d array, first line is then *theta* and second line is *phi*. See *lonlat* parameter for unit.

text : str

The text to be displayed.

lonlat : bool, optional

If True, theta and phi are interpreted as longitude and latitude in degree, otherwise, as colatitude and longitude in radian

coord : {'E', 'G', 'C', None}, optional

The coordinate system of the points, only used if the coordinate coordinate system of the axes has been defined and in this case, a rotation is performed

rot : None or sequence, optional

rotation to be applied =(lon, lat, psi) : lon, lat will be position of the new Z axis, and psi is rotation around this axis, all in degree. if None, no rotation is performed

direct : bool, optional

if True, the rotation to center the projection is not taken into account

See also:

`projplot`, `projscatter`

Notes

Other keywords are passed to `matplotlib.Axes.text()`.

healpy.projaxes.HpxCartesianAxes.set_coordprec

`HpxCartesianAxes.`**`set_coordprec`**`(`*n*`)`

Set the number of digits after floating point for coord display.

healpy.projaxes.HpxCartesianAxes.set_format

`HpxCartesianAxes.`**`set_format`**`(`*f*`)`

Set the format string for value display

3.8 `zoomtool` – Interactive visualisation

3.8.1 Interactive map visualization

`mollzoom`([map, fig, rot, coord, unit, ...])	Interactive mollweide plot with zoomed gnomview.

healpy.zoomtool.mollzoom

`healpy.zoomtool.`**`mollzoom`**`(`*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'*, *cmap=None*, *norm=None*, *hold=False*, *margins=None*, *sub=None*`)`

Interactive mollweide plot with zoomed gnomview.

CHAPTER 4

Indices and tables

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