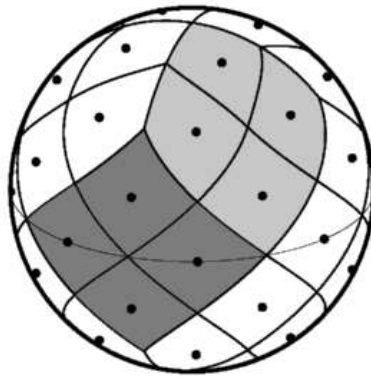


HEALPix C Subroutines Overview



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Abstract: This document is an overview of the **HEALPix** C subroutines.

<https://healpix.sourceforge.io>
<http://healpix.sf.net>

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Conventions

Here we list some conventions which are used in this document.

| | |
|-------------------|---|
| N_{side} | HEALPix resolution parameter — see the HEALPix Primer. |
| θ | The polar angle or colatitude on the sphere, ranging from 0 at the North Pole to π at the South Pole. |
| ϕ | The azimuthal angle on the sphere, $\phi \in [0, 2\pi[$. |

Compilation and Installation

A tentative compilation and installation script is provided in `src/C/doinstall`. If it does not work, you can try editing the `src/C/subs/Makefile` by hand.

Usage

To use in your 'C' code, include the line

```
#include "chealpix.h"
```

in your code and link with something like

```
gcc -o myprog myprog.c -I<incdir> -L<libdir> -lchealpix
```

where `<incdir>` is where you've installed the '.h' files and `<libdir>` is where you've installed the libraries (See the header of the 'subs/Makefile').

You will also need the 'cfitsio' library. See

<https://heasarc.gsfc.nasa.gov/docs/software/fitsio/>

Note on the C routines

This small set of C routines is provided as a start up kit to users wanting to link the **HEALPix** routines with some other languages (C, C++, IDL, perl, ...), and it was actually mainly provided by various users (see individual routines for details). As for the rest of the **HEALPix** package, all interested persons are welcome to contribute to this effort.

ang2vec

Location in HEALPix directory tree: [src/C/subs/chealpix.c](#)

Routine to convert the position angles (θ, ϕ) of a point on the sphere into its 3D position vector (x, y, z) with $x = \sin \theta \cos \phi$, $y = \sin \theta \sin \phi$, $z = \cos \theta$.

FORMAT void vec2ang(double theta, double phi, double
 *vector);

ARGUMENTS

| name & dimensionality | kind | in/out | description |
|-----------------------|--------|--------|---|
| theta | double | IN | colatitude in radians measured southward from north pole (in $[0, \pi]$). |
| phi | double | IN | longitude in radians measured eastward (in $[0, 2\pi]$). |
| vector(3) | double | OUT | three dimensional cartesian position vector (x, y, z) . The north pole is $(0, 0, 1)$ |

RELATED ROUTINES

This section lists the routines related to **ang2vec**.

vec2ang converts the 3D position vector of point into its position angles on the sphere.

get_fits_size

Location in HEALPix directory tree: [src/C/subs/chealpix.c](#)

This routine reads the number of pixels, the resolution parameter and the pixel ordering of a FITS file containing a **HEALPix** map.

FORMAT long get_fits_size(char *filename, long *nside, char *ordering)

ARGUMENTS

| name&dimensionality | kind | in/out | description |
|---------------------|------|--------|--|
| get_fits_size | long | OUT | number of pixels the FITS file |
| filename | char | IN | filename of the FITS-file containing the HEALPix map. |
| ordering | char | OUT | pixel ordering, either 'RING' or 'NESTED' |
| nside | long | OUT | Healpix resolution parameter Nside |

EXAMPLE:

```
long npix, nside ;
char file[180]="map.fits" ;
char order[10] ;
npix= get_fits_size(file, &nside, order)
```

Returns in npix the number of pixel in the file 'map.fits', and read in nside or order its resolution parameter or ordering scheme

RELATED ROUTINES

This section lists the routines related to **get_fits_size**.

| | |
|--------------------------------|---|
| <code>read_healpix_map</code> | subroutine to read HEALPix maps |
| <code>write_healpix_map</code> | subroutine to write HEALPix maps |

npix2nside

Location in HEALPix directory tree: [src/C/subs/chealpix.c](#)

Function to provide the resolution parameter N_{side} corresponding to the number of pixels N_{pix} over the full sky.

FORMAT long npix2nside(const long npix)

ARGUMENTS

| name&dimensionality | kind | in/out | description |
|---------------------|------|--------|---|
| npix | long | IN | the number of pixels N_{pix} of the map . |
| npix2nside | long | OUT | returns the N_{side} parameter of the map such that $N_{\text{pix}} = 12N_{\text{side}}^2$. |

EXAMPLE:

```
nside= npix2nside(786432);
```

Returns the resolution parameter (256) corresponding to 786432 **HEALPix** pixels.

RELATED ROUTINES

This section lists the routines related to **npix2nside**.

| | |
|----------------------------|---|
| ang2vec | converts (θ, ϕ) spherical coordinates into (x, y, z) cartesian coordinates. |
| vec2ang | converts (x, y, z) cartesian coordinates into (θ, ϕ) spherical coordinates. |
| nside2npix | converts number of full sky pixels N_{pix} into resolution parameter N_{side} |

nside2npix

Location in HEALPix directory tree: [src/C/subs/chealpix.c](#)

Function to provide the number of pixels N_{pix} over the full sky corresponding to resolution parameter N_{side} .

FORMAT long nside2npix(const long nside)

ARGUMENTS

| name&dimensionality | kind | in/out | description |
|---------------------|------|--------|---|
| nside | long | IN | the N_{side} parameter of the map. |
| nside2npix | long | OUT | returns the number of pixels N_{pix} of the map $N_{\text{pix}} = 12N_{\text{side}}^2$. |

EXAMPLE:

```
npix= nside2npix(256);
```

Returns the number of **HEALPix** pixels (786432) for the resolution parameter 256.

RELATED ROUTINES

This section lists the routines related to **nside2npix**.

| | |
|----------------------------|---|
| ang2vec | converts (θ, ϕ) spherical coordinates into (x, y, z) cartesian coordinates. |
| vec2ang | converts (x, y, z) cartesian coordinates into (θ, ϕ) spherical coordinates. |
| npix2nside | converts N_{side} into number of full sky pixels N_{pix} . |

pix2xxx, ang2xxx, vec2xxx, nest2ring, ring2nest

Location in HEALPix directory tree: [src/C/subs/chealpix.c](#)

These subroutines can be used to convert between pixel number in the **HEALPix** map and (θ, ϕ) coordinates on the sphere. This is only a subset of the routines equivalent in Fortran90 or in IDL.

ARGUMENTS

| name & dimensionality | type | in/out | description |
|-----------------------|--------|--------|---|
| nside | long | IN | N_{side} parameter for the HEALPix map. |
| ipnest | long | — | pixel identification number in NESTED scheme over the range $\{0, N_{\text{pix}} - 1\}$. |
| ipring | long | — | pixel identification number in RING scheme over the range $\{0, N_{\text{pix}} - 1\}$. |
| theta | double | — | colatitude in radians measured southward from north pole in $[0, \pi]$. |
| phi | double | — | longitude in radians, measured eastward in $[0, 2\pi]$. |
| vector | double | — | 3D cartesian position vector (x, y, z) . The north pole is $(0, 0, 1)$. An output vector is normalised to unity. |

ROUTINES:

```
void pix2ang_ring(long nside, long ipring, double *theta, double *phi);
```

renders *theta* and *phi* coordinates of the nominal pixel center given the pixel number *ipring* and a map resolution parameter *nside*.

```
void pix2vec_ring(long nside, long ipring, double *vector);
```

renders cartesian vector coordinates of the nominal pixel center given the pixel number *ipring* and a map resolution parameter *nside*. Optionally renders cartesian vector coordinates of the considered pixel four vertices.

```
void ang2pix_ring(long nside, double theta, double phi, long *ipring);
```

renders the pixel number *ipring* for a pixel which, given the map resolution parameter *nside*, contains the point on the sphere at angular coordinates *theta* and *phi*.

```
void vec2pix_ring(long nside, double *vector, long *ipring);
```

renders the pixel number *ipring* for a pixel which, given the map resolution parameter *nside*, contains the point on the sphere at cartesian coordinates *vector*.

```
void pix2ang_nest(long nside, long ipnest, double *theta, double *phi);
```

renders *theta* and *phi* coordinates of the nominal pixel center given the pixel number *ipnest* and a map resolution parameter *nside*.

```
void pix2vec_nest(long nside, long ipnest, double *vector);
```

renders cartesian vector coordinates of the nominal pixel center given the pixel number *ipnest* and a map resolution parameter *nside*. Optionally renders cartesian vector coordinates of the considered pixel four vertices.

```
void ang2pix_nest(long nside, double theta, double phi, long *ipnest);
```

renders the pixel number *ipnest* for a pixel which, given the map resolution parameter *nside*, contains the point on the sphere at angular coordinates *theta* and *phi*.

```
void vec2pix_nest(long nside, double *vector, long *ipnest)
```

renders the pixel number *ipnest* for a pixel which, given the map resolution parameter *nside*, contains the point on the sphere at cartesian coordinates *vector*.

```
void nest2ring(long nside, long ipnest, long *ipring);
```

performs conversion from NESTED to RING pixel number.

```
void ring2nest(long nside, long ipring, long *ipnest);
```

performs conversion from RING to NESTED pixel number.

MODULES & ROUTINES

This section lists the modules and routines used by **pix2xxx**, **ang2xxx**, **vec2xxx**, **nest2ring**, **ring2nest**.

| | |
|---|---|
| <code>mk_pix2xy</code> , <code>mk_xy2pix</code> | routines used in the conversion between pixel values and “cartesian” coordinates on the Healpix face. |
|---|---|

RELATED ROUTINES

This section lists the routines related to **pix2xxx**, **ang2xxx**, **vec2xxx**, **nest2ring**, **ring2nest**.

| | |
|-------------------------|---|
| <code>ang2vec</code> | converts (θ, ϕ) spherical coordinates into (x, y, z) cartesian coordinates. |
| <code>vec2ang</code> | converts (x, y, z) cartesian coordinates into (θ, ϕ) spherical coordinates. |
| <code>nside2npix</code> | converts number of full sky pixels N_{pix} into resolution parameter N_{side} |
| <code>npix2nside</code> | converts N_{side} into number of full sky pixels N_{pix} . |

read_healpix_map

Location in HEALPix directory tree: [src/C/subs/chealpix.c](#)

This routine reads a full sky **HEALPix** map from a FITS file

FORMAT float *read_healpix_map(char *infile, long *nside, char *coordsys, char *ordering)

ARGUMENTS

| name&dimensionality | kind | in/out | description |
|---------------------|-------|--------|--|
| read_healpix_map | float | OUT | array containing the map read from the file |
| infile | char | IN | FITS file containing a full sky to be read |
| nside | long | OUT | HEALPix resolution parameter of the map |
| coordsys | char | OUT | astronomical coordinate system of pixelation (either 'C', 'E' or 'G' standing respectively for Celestial=equatorial, Ecliptic or Galactic) |
| ordering | char | OUT | HEALPix pixel ordering (either 'RING' or 'NESTED') |

RELATED ROUTINES

This section lists the routines related to **read_healpix_map**.

| | |
|-----------------------------------|---|
| anafast | executable that reads a HEALPix map and analyses it. |
| synfast | executable that generate full sky HEALPix maps |
| write_healpix_map | subroutine to write HEALPix maps |
| get_fits_size | subroutine to determine the size of a map |

vec2ang

Location in HEALPix directory tree: [src/C/subs/chealpix.c](#)

Routine to convert the 3D position vector (x, y, z) of point into its position angles (θ, ϕ) on the sphere with $x = \sin \theta \cos \phi$, $y = \sin \theta \sin \phi$, $z = \cos \theta$.

FORMAT void vec2ang(double *vector, double *theta,
double *phi);

ARGUMENTS

| name & dimensionality | kind | in/out | description |
|-----------------------|--------|--------|---|
| vector(3) | double | IN | three dimensional cartesian position vector (x, y, z) . The north pole is $(0, 0, 1)$ |
| theta | double | OUT | colatitude in radians measured southward from north pole (in $[0, \pi]$). |
| phi | double | OUT | longitude in radians measured eastward (in $[0, 2\pi]$). |

RELATED ROUTINES

This section lists the routines related to **vec2ang**.

ang2vec converts the position angles of a point on the sphere into its 3D position vector.

write_healpix_map

Location in HEALPix directory tree: [src/C/subs/chealpix.c](#)

This routine writes a full sky **HEALPix** map into a FITS file

FORMAT int write_healpix_map(float *signal, long
 nside, char *filename, char nest, char *co-
 ordsys)

ARGUMENTS

| name&dimensionality | kind | in/out | description |
|---------------------|-------|--------|---|
| write_healpix_map | int | OUT | returns a non zero value in case of error |
| signal | float | IN | full sky map to be written |
| nside | long | IN | HEALPix resolution parameter of the map (the map should have 12 * nside * nside pix- els). |
| filename | char | IN | FITS file in which to write the full sky map |
| nest | char | IN | flag specifying the HEALPix pixel ordering of the map. 0: 'RING' and 1: 'NESTED' |
| coordsys | char | IN | astronomical coordinate system of map (must be either 'C', 'E' or 'G' standing respectively for Celestial=equatorial, Ecliptic or Galactic) |

RELATED ROUTINES

This section lists the routines related to **write_healpix_map**.

| | |
|----------------------------------|--|
| anafast | executable that reads a HEALPix map and anal- yses it. |
| synfast | executable that generate full sky HEALPix maps |
| read_healpix_map | subroutine to read HEALPix maps |
| get_fits_size | subroutine to determine the size of a map |

