spheroidal_lib

0.1.0

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Chapter 1

<tt>spheroidal</tt>

1.1 Description

`spheroidal` is a library for constructing and manipulating spheroidal harmonics, evaluating boundary integral operators, and other operations necessary for solving boundary integral equations on spheroids. Additionally, this repository contains example files to demonstrate usage and test files to demonstrate correctness.

Additionally, this repository contains Yet Another Wrapper for GSL, or `yawg`. This library contains a lightweight interface for the GNU Scientific Library, or GSL. Its intentions are to simplify usage of these functions, such as with a `gsl::vector` class that automatically handles memory allocation and pointer management.

The full documentation is built with `doxygen`, and can be constructed by performing the `make docs` command.

1.2 Getting Started

Both the `spheroidal` and `yawg` libraries are built using CMake. To build from the command line, run

```
mkdir build
cd build
cmake ..
make (<specific target>)
```

An extensive library of testing functions and assertions is contained in the `tests` subfolder. These tests can also be built and executed using CMake.

1.2.1 Dependencies

Requires the following prerequisitres, along with the version used during testing:

- C++11
- CMake v3.22.1
- GNU Scientific Library v2.7.1
- Doxygen v1.9.1 (optional)
- Catch2 v3.0.1

1.3 Authors

[Jacob Spainhour](@jcs15c)

[Leo Crowder](@lcrowder)

1.4 Version History

- 0.1
  - Initial Release

1.5 Acknowledgments

We would like to acknowledge the existance of other GSL C++ wrappers, and hope that ours is comparable in utility.

The following are existing C++ gsl wrapper classes we have found.

- GSLwrap: https://gslwrap.sourceforge.net/
- ccgsl: https://ccgsl.sourceforge.net/
- GSL-lib: https://github.com/johanjoensson/GSL-lib
- ROOT: https://root.cern/root/html606/index.html

Chapter 2

Namespace Index

2.1 Namespace List

Here is a list of all namespaces with brief descriptions:

Chapter 3

Hierarchical Index

3.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

Chapter 4

Class Index

4.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

Chapter 5

File Index

5.1 File List

Here is a list of all files with brief descriptions:

Chapter 6

Namespace Documentation

6.1 gsl Namespace Reference

Namespaces

- complex_literals

Classes

- class cmatrix
- class cmatrix_view

  A wrapper class for gsl_matrix_complex_view.
- class complex

  Wrapper class for gsl_complex structs.
- class complex_ref

  Stores a refernce to a gsl::complex object.
- class cvector

  A wrapper class for gsl_vector_complex.
- class cvector_view

  A wrapper class for gsl_vector_complex_view.
- class crow_view

  A subclass of cvector_view for stride-1 vectors.
- class ccolumn_view

  A subclass of cvector_view for non-stride-1 cvectors.
- class matrix

  A wrapper class for gsl_matrix.
- class matrix_view

  A wrapper class for gsl_matrix_view.
- class vector

  A wrapper class for gsl_vector.
- class vector_view

  A wrapper class for gsl_vector_view.
- class row_view

  A subclass of vector_view for stride-1 vectors.
- class column_view

  A subclass of vector_view for non-stride-1 vectors.

Functions

- complex operator""_i (long double y)

  User defined literal overload for complex numbers.
- gsl::cvector fft (gsl::cvector &&x)

  Compute in-place fft of a gsl::(c)vector.
- gsl::cvector fft (const gsl::cvector &x)

  Compute fft of a gsl::(c)vector.
- gsl::cvector ifft (gsl::cvector &&x)

  Compute in-place inverse fft of a gsl::(c)vector.
- gsl::cvector ifft (const gsl::cvector &x)

  Compute inverse fft of a gsl::(c)vector.
- gsl::cmatrix fft (gsl::cmatrix &&x, int dim=1)

  Compute in-place 1D fft of each column/row of a gsl::(c)matrix.
- gsl::cmatrix fft (const gsl::cmatrix &x, int dim=1)

  Compute 1D fft of each column/row of a gsl::(c)matrix.
- gsl::cmatrix ifft (gsl::cmatrix &&x, int dim=1)

  Compute in-place 1D inverse fft of each column/row of a gsl::(c)matrix.
- gsl::cmatrix ifft (const gsl::cmatrix &x, int dim=1)

  Compute 1D inverse fft of each column/row of a gsl::(c)matrix.
- void leggauss (size_t n, gsl::vector &x, gsl::vector &w, double a=-1.0, double b=1.0)

  Store Gauss-Legendre quadrature nodes and weights.
- vector leggauss (size_t n, double a=-1.0, double b=1.0)

  Get a vector Gauss-Legendre quadrature nodes.
- gsl::vector linspace (double a, double b, size_t N=100)

  Get a gsl::vector of evenly spaced points on the interval [a, b] (inclusive)
- gsl::cvector linspace (gsl::complex a, gsl::complex b, size_t n)

  Complex version of linspace.
- gsl::vector arange (double a, double b, double step=1.0)
- void meshgrid (const gsl::vector &x, const gsl::vector &y, gsl::matrix &X, gsl::matrix &Y)

  Store 2D grid coordinates based on 1D input gsl::vectors.
- void meshgrid (const gsl::cvector &x, const gsl::cvector &y, gsl::cmatrix &X, gsl::cmatrix &Y)
- gsl::matrix eye (size_t n)

  Return the nxn identity matrix.
- template<typename Lambda >
  gsl::vector arrayfun (Lambda &&func, const gsl::vector &x)

  Apply lambda function to each element of a gsl::vector, akin to MATLAB arrayfun.
- template<typename Lambda >
  gsl::vector arrayfun (Lambda &&func, gsl::vector &&x)

  Move version of arrayfun for vectors.
- template<typename Lambda >
  gsl::cvector arrayfun (Lambda &&func, const gsl::cvector &x)

  Copy version of arrayfun for complex vectors.
- template<typename Lambda >
  gsl::cvector arrayfun (Lambda &&func, gsl::cvector &&x)

  Move version of arrayfun for complex vectors.
- template<typename Lambda >
  gsl::matrix arrayfun (Lambda &&func, const gsl::matrix &x)

  Apply lambda function to each element of a gsl::matrix, akin to MATLAB arrayfun.
- template<typename Lambda >
  gsl::matrix arrayfun (Lambda &&func, gsl::matrix &&x)

  Move version of arrayfun.

- template<typename Lambda >
  gsl::cmatrix arrayfun (Lambda &&func, const gsl::cmatrix &x)

  Copy version of arrayfun for complex matrices.
- template<typename Lambda >
  gsl::cmatrix arrayfun (Lambda &&func, gsl::cmatrix &&x)

  Move version of arrayfun for complex matrices.

6.1.1 Function Documentation

6.1.1.1 arange()

```
gsl::vector gsl::arange (
            double a,
            double b,
            double step = 1.0 )
```

6.1.1.2 arrayfun() [1/8]

```
template<typename Lambda >
gsl::cmatrix gsl::arrayfun (
            Lambda && func,
            const gsl::cmatrix & x )
```

Copy version of arrayfun for complex matrices.

6.1.1.3 arrayfun() [2/8]

```
template<typename Lambda >
gsl::cvector gsl::arrayfun (
            Lambda && func,
            const gsl::cvector & x )
```

Copy version of arrayfun for complex vectors.

6.1.1.4 arrayfun() [3/8]

```
template<typename Lambda >
gsl::matrix gsl::arrayfun (
            Lambda && func,
            const gsl::matrix & x )
```

Apply lambda function to each element of a gsl::matrix, akin to MATLAB arrayfun.

Parameters

func	Lambda function to apply to each element
x	Input matrix

Note

This function is not optimized for speed, but rather for convenience, as there is overhead in using templated Lambda functions. If speed is necessary, add the function to gsl_utils specifically.

Returns

Matrix of same size as `x` with `func` applied to each element

6.1.1.5 arrayfun() [4/8]

```
template<typename Lambda >
gsl::vector gsl::arrayfun (
            Lambda && func,
            const gsl::vector & x )
```

Apply lambda function to each element of a gsl::vector, akin to MATLAB arrayfun.

Parameters

func	Lambda function to apply to each element
x	Input matrix

Note

This function is not optimized for speed, but rather for convenience, as there is overhead in using templated Lambda functions. If speed is necessary, add the function to gsl_utils specifically.

Returns

Matrix of same size as `x` with `func` applied to each element

6.1.1.6 arrayfun() [5/8]

```
template<typename Lambda >
gsl::cmatrix gsl::arrayfun (
            Lambda && func,
            gsl::cmatrix && x )
```

Move version of arrayfun for complex matrices.

6.1.1.7 arrayfun() [6/8]

```
template<typename Lambda >
gsl::cvector gsl::arrayfun (
             Lambda && func,
             gsl::cvector && x )
```

Move version of arrayfun for complex vectors.

6.1.1.8 arrayfun() [7/8]

```
template<typename Lambda >
gsl::matrix gsl::arrayfun (
             Lambda && func,
             gsl::matrix && x )
```

Move version of arrayfun.

6.1.1.9 arrayfun() [8/8]

```
template<typename Lambda >
gsl::vector gsl::arrayfun (
             Lambda && func,
             gsl::vector && x )
```

Move version of arrayfun for vectors.

6.1.1.10 eye()

```
gsl::matrix gsl::eye (
             size_t n )
```

Return the nxn identity matrix.

6.1.1.11 fft() [1/4]

```
gsl::cmatrix gsl::fft (
             const gsl::cmatrix & x,
             int dim = 1 )
```

Compute 1D fft of each column/row of a gsl::(c)matrix.

6.1.1.12 fft() [2/4]

```
gsl::cvector gsl::fft (
            const gsl::cvector & x )
```

Compute fft of a gsl::(c)vector.

6.1.1.13 fft() [3/4]

```
gsl::cmatrix gsl::fft (
            gsl::cmatrix && x,
            int dim = 1 )
```

Compute in-place 1D fft of each column/row of a gsl::(c)matrix.

6.1.1.14 fft() [4/4]

```
gsl::cvector gsl::fft (
            gsl::cvector && x )
```

Compute in-place fft of a gsl::(c)vector.

6.1.1.15 ifft() [1/4]

```
gsl::cmatrix gsl::ifft (
            const gsl::cmatrix & x,
            int dim = 1 )
```

Compute 1D inverse fft of each column/row of a gsl::(c)matrix.

6.1.1.16 ifft() [2/4]

```
gsl::cvector gsl::ifft (
            const gsl::cvector & x )
```

Compute inverse fft of a gsl::(c)vector.

6.1.1.17 ifft() [3/4]

```
gsl::cmatrix gsl::ifft (
            gsl::cmatrix && x,
            int dim = 1 )
```

Compute in-place 1D inverse fft of each column/row of a gsl::(c)matrix.

6.1.1.18 ifft() [4/4]

```
gsl::cvector gsl::ifft (
            gsl::cvector && x )
```

Compute in-place inverse fft of a gsl::(c)vector.

6.1.1.19 leggauss() [1/2]

```
vector gsl::leggauss (
            size_t n,
            double a = -1.0,
            double b = 1.0 )
```

Get a vector Gauss-Legendre quadrature nodes.

6.1.1.20 leggauss() [2/2]

```
void gsl::leggauss (
            size_t n,
            gsl::vector & x,
            gsl::vector & w,
            double a = -1.0,
            double b = 1.0 )
```

Store Gauss-Legendre quadrature nodes and weights.

6.1.1.21 linspace() [1/2]

```
gsl::vector gsl::linspace (
            double a,
            double b,
            size_t N = 100 )
```

Get a gsl::vector of evenly spaced points on the interval [a, b] (inclusive)

6.1.1.22 linspace() [2/2]

```
gsl::cvector gsl::linspace (
            gsl::complex a,
            gsl::complex b,
            size_t n )
```

Complex version of linspace.

6.1.1.23 meshgrid() [1/2]

```
void gsl::meshgrid (
            const gsl::cvector & x,
            const gsl::cvector & y,
            gsl::cmatrix & X,
            gsl::cmatrix & Y )
```

Complex version of gsl::meshgrid

6.1.1.24 meshgrid() [2/2]

```
void gsl::meshgrid (
            const gsl::vector & x,
            const gsl::vector & y,
            gsl::matrix & X,
            gsl::matrix & Y )
```

Store 2D grid coordinates based on 1D input gsl::vectors.

6.2 gsl::complex_literals Namespace Reference

Functions

- complex operator""_i (long double y)
  User defined literal overload for complex numbers.

6.2.1 Function Documentation

6.2.1.1 operator""_i()

```
complex gsl::complex_literals::operator""_i (
            long double y )  [inline]
```

User defined literal overload for complex numbers.

Chapter 7

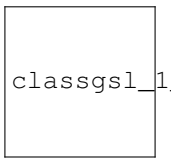
Class Documentation

7.1 gsl::ccolumn_view Class Reference

A subclass of cvector_view for non-stride-1 cvectors.

`#include <cvector.h>`

Inheritance diagram for gsl::ccolumn_view:



Public Member Functions

- ccolumn_view (gsl_vector_complex_view gvec_view)
  Construct ccolumn_view from existing cvector view.
- ccolumn_view (const cvector &v)
  Construct ccolumn_view from cvector.

Additional Inherited Members

7.1.1 Detailed Description

A subclass of cvector_view for non-stride-1 cvectors.

7.1.2 Constructor & Destructor Documentation

7.1.2.1 ccolumn_view() [1/2]

```
gsl::ccolumn_view::ccolumn_view (
            gsl_vector_complex_view gvec_view )  [inline]
```

Construct ccolumn_view from existing cvector view.

7.1.2.2 ccolumn_view() [2/2]

```
gsl::ccolumn_view::ccolumn_view (
            const cvector & v )  [inline]
```

Construct ccolumn_view from cvector.

The documentation for this class was generated from the following file:

- /home/jspainhour/spheroidal_cpp/include/yawg/cvector.h

7.2 gsl::cmatrix Class Reference

```
#include <cmatrix.h>
```

Public Member Functions

- cmatrix ()
  Construct empty matrix.
- cmatrix (size_t n, size_t m)
  Construct zero matrix of size n x m.
- cmatrix (const gsl_matrix_complex *gmat_other)
  Construct new gsl::matrix from gsl_matrix.
- cmatrix (const cvector &v)
  Construct new n x 1 gsl::cmatrix from a gsl::cvector.
- cmatrix (const cmatrix &M, size_t n, size_t m)
  Copy constructor creating n x m complex matrix.
- cmatrix (const cmatrix &M)
- cmatrix (cmatrix &&M)
- cmatrix (const matrix &M)
  Construct new gsl::cmatrix from gsl::matrix.
- cmatrix & operator= (const cmatrix &gvec_other)
- cmatrix & operator= (cmatrix &&gvec_other)
- ~cmatrix ()
- complex_ref operator() (size_t i, size_t j)
  Return a reference to the element at position (i,j)
- void set (size_t i, size_t j, complex z)
- complex get (size_t i, size_t j) const
  Return a const reference to the element at position (i,j)
- const complex_ref operator() (size_t i, size_t j) const

- size_t size () const
- size_t nrows () const
- size_t ncols () const
- gsl_matrix_complex * get_gsl_ptr () const

  Access the pointer to the underlying gsl_matrix_complex.
- void resize (size_t n, size_t m)

  Resize the gsl::cmatrix, setting elements to zero.
- void clear ()

  CLear the gsl::cmatrix, free underlying memory.
- cmatrix reshape (size_t n, size_t m) const

  Return a new n x m gsl::cmatrix with same elements.
- void print (FILE *out=stdout) const

  Pretty-print the complex matrix to file stream.
- cmatrix_view submatrix (size_t i, size_t j, size_t n, size_t m)

  Return a view to a submatrix of the complex matrix.
- crow_view row (size_t i)

  Return a view to a row of the complex matrix.
- ccolumn_view column (size_t j)

  Return a view to a column of the complex matrix.

Protected Member Functions

- void free ()

  Private function to free allocated memory.
- void calloc (size_t n, size_t m)

  Private function to (continuously) allocate memory.

Protected Attributes

- gsl_matrix_complex * gmat

Friends

- class matrix
- class cmatrix_view
- class crow_view
- class ccolumn_view
- cmatrix operator* (const cmatrix &A, const cmatrix &B)

7.2.1 Constructor & Destructor Documentation

7.2.1.1 cmatrix() [1/8]

```
gsl::cmatrix::cmatrix ( )
```

Construct empty matrix.

7.2.1.2 cmatrix() [2/8]

```
gsl::cmatrix::cmatrix (
            size_t n,
            size_t m )
```

Construct zero matrix of size n x m.

7.2.1.3 cmatrix() [3/8]

```
gsl::cmatrix::cmatrix (
            const gsl_matrix_complex * gmat_other )
```

Construct new gsl::matrix from gsl_matrix.

7.2.1.4 cmatrix() [4/8]

```
gsl::cmatrix::cmatrix (
            const cvector & v )
```

Construct new n x 1 gsl::cmatrix from a gsl::cvector.

7.2.1.5 cmatrix() [5/8]

```
gsl::cmatrix::cmatrix (
            const cmatrix & M,
            size_t n,
            size_t m )
```

Copy constructor creating n x m complex matrix.

7.2.1.6 cmatrix() [6/8]

```
gsl::cmatrix::cmatrix (
            const cmatrix & M )
```

7.2.1.7 cmatrix() [7/8]

```
gsl::cmatrix::cmatrix (
            cmatrix && M )
```

7.2.1.8 cmatrix() [8/8]

```
gsl::cmatrix::cmatrix (
            const matrix & M )
```

Construct new gsl::cmatrix from gsl::matrix.

7.2.1.9 ~cmatrix()

```
gsl::cmatrix::~cmatrix ( )
```

7.2.2 Member Function Documentation

7.2.2.1 calloc()

```
void gsl::cmatrix::calloc (
            size_t n,
            size_t m )  [protected]
```

Private function to (continuously) allocate memory.

7.2.2.2 clear()

```
void gsl::cmatrix::clear ( )
```

CLear the gsl::cmatrix, free underlying memory.

7.2.2.3 column()

```
ccolumn_view gsl::cmatrix::column (
            size_t j )
```

Return a view to a column of the complex matrix.

7.2.2.4 free()

```
void gsl::cmatrix::free ( )  [protected]
```

Private function to free allocated memory.

7.2.2.5 get()

```
complex gsl::cmatrix::get (
            size_t i,
            size_t j ) const
```

Return a const reference to the element at position (i,j)

7.2.2.6 get_gsl_ptr()

```
gsl_matrix_complex* gsl::cmatrix::get_gsl_ptr ( ) const  [inline]
```

Access the pointer to the underlying gsl_matrix_complex.

7.2.2.7 ncols()

```
size_t gsl::cmatrix::ncols ( ) const
```

7.2.2.8 nrows()

```
size_t gsl::cmatrix::nrows ( ) const
```

7.2.2.9 operator()() [1/2]

```
complex_ref gsl::cmatrix::operator() (
            size_t i,
            size_t j )
```

Return a reference to the element at position (i,j)

7.2.2.10 operator()() [2/2]

```
const complex_ref gsl::cmatrix::operator() (
            size_t i,
            size_t j ) const
```

7.2.2.11 operator=() [1/2]

```
cmatrix& gsl::cmatrix::operator= (
            cmatrix && gvec_other )
```

7.2.2.12 operator=() [2/2]

```
cmatrix& gsl::cmatrix::operator= (
            const cmatrix & gvec_other )
```

7.2.2.13 print()

```
void gsl::cmatrix::print (
            FILE * out = stdout ) const
```

Pretty-print the complex matrix to file stream.

7.2.2.14 reshape()

```
cmatrix gsl::cmatrix::reshape (
            size_t n,
            size_t m ) const
```

Return a new n x m gsl::cmatrix with same elements.

7.2.2.15 resize()

```
void gsl::cmatrix::resize (
            size_t n,
            size_t m )
```

Resize the gsl::cmatrix, setting elements to zero.

7.2.2.16 row()

```
crow_view gsl::cmatrix::row (
            size_t i )
```

Return a view to a row of the complex matrix.

7.2.2.17 set()

```
void gsl::cmatrix::set (
            size_t i,
            size_t j,
            complex z )
```

7.2.2.18 size()

```
size_t gsl::cmatrix::size ( ) const
```

7.2.2.19 submatrix()

```
cmatrix_view gsl::cmatrix::submatrix (
            size_t i,
            size_t j,
            size_t n,
            size_t m )
```

Return a view to a submatrix of the complex matrix.

7.2.3 Friends And Related Function Documentation

7.2.3.1 ccolumn_view

```
friend class ccolumn_view  [friend]
```

7.2.3.2 cmatrix_view

```
friend class cmatrix_view  [friend]
```

7.2.3.3 crow_view

```
friend class crow_view  [friend]
```

7.2.3.4 matrix

```
friend class matrix  [friend]
```

7.2.3.5 operator∗

```
cmatrix operator* (
            const cmatrix & A,
            const cmatrix & B )  [friend]
```

7.2.4 Member Data Documentation

7.2.4.1 gmat

```
gsl_matrix_complex* gsl::cmatrix::gmat  [protected]
```

The documentation for this class was generated from the following file:

- /home/jspainhour/spheroidal_cpp/include/yawg/cmatrix.h

7.3 gsl::cmatrix_view Class Reference

A wrapper class for gsl_matrix_complex_view.

`#include <cmatrix.h>`

Public Member Functions

- operator cmatrix () const
  "Dereferences" a matrix_view into independent gsl::cmatrix object
- cmatrix_view (gsl_matrix_complex_view gmat_view)
  Construct a view of a gsl::cmatrix through another cmatrix_view.
- cmatrix_view (const cmatrix &m)
  Construct a view of the given gsl::cmatrix.
- cmatrix_view & operator= (const cmatrix &v)
  Assignment to a complex matrix view from a complex matrix.
- cmatrix_view & operator= (cmatrix_view v)
  Assignment to a complex matrix view from another complex matrix view.
- void print (FILE ∗out=stdout) const
  Pretty-print the viewed complex matrix to file stream.
- const gsl_matrix_complex ∗ get_gsl_ptr () const
  Return a constant pointer to the underlying gsl_matrix_complex.

Protected Attributes

- gsl_matrix_complex_view gmat_view

7.3.1 Detailed Description

A wrapper class for gsl_matrix_complex_view.

Stores a gsl_matrix_complex_view and uses it to access original member data.

7.3.2 Constructor & Destructor Documentation

7.3.2.1 cmatrix_view() [1/2]

```
gsl::cmatrix_view::cmatrix_view (
            gsl_matrix_complex_view gmat_view )  [inline]
```

Construct a view of a gsl::cmatrix through another cmatrix_view.

7.3.2.2 cmatrix_view() [2/2]

```
gsl::cmatrix_view::cmatrix_view (
            const cmatrix & m )  [inline]
```

Construct a view of the given gsl::cmatrix.

7.3.3 Member Function Documentation

7.3.3.1 get_gsl_ptr()

```
const gsl_matrix_complex* gsl::cmatrix_view::get_gsl_ptr ( ) const  [inline]
```

Return a constant pointer to the underlying gsl_matrix_complex.

7.3.3.2 operator cmatrix()

```
gsl::cmatrix_view::operator cmatrix ( ) const  [inline]
```

"Dereferences" a matrix_view into independent gsl::cmatrix object

7.3.3.3 operator=() [1/2]

```
cmatrix_view& gsl::cmatrix_view::operator= (
            cmatrix_view v )
```

Assignment to a complex matrix view from another complex matrix view.

7.3.3.4 operator=() [2/2]

```
cmatrix_view& gsl::cmatrix_view::operator= (
            const cmatrix & v )
```

Assignment to a complex matrix view from a complex matrix.

7.3.3.5 print()

```
void gsl::cmatrix_view::print (
            FILE * out = stdout ) const
```

Pretty-print the viewed complex matrix to file stream.

7.3.4 Member Data Documentation

7.3.4.1 gmat_view

```
gsl_matrix_complex_view gsl::cmatrix_view::gmat_view  [protected]
```

The documentation for this class was generated from the following file:

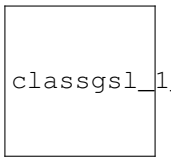
- /home/jspainhour/spheroidal_cpp/include/yawg/cmatrix.h

7.4 gsl::column_view Class Reference

A subclass of vector_view for non-stride-1 vectors.

`#include <vector.h>`

Inheritance diagram for gsl::column_view:



Public Member Functions

- column_view (gsl_vector_view gvec_view)
  Construct column_view from existing vector view.
- column_view (const vector &v)
  Construct column_view from vector.

Additional Inherited Members

7.4.1 Detailed Description

A subclass of vector_view for non-stride-1 vectors.

7.4.2 Constructor & Destructor Documentation

7.4.2.1 column_view() [1/2]

```
gsl::column_view::column_view (
            gsl_vector_view gvec_view )  [inline]
```

Construct column_view from existing vector view.

7.4.2.2 column_view() [2/2]

```
gsl::column_view::column_view (
            const vector & v )  [inline]
```

Construct column_view from vector.

The documentation for this class was generated from the following file:

- /home/jspainhour/spheroidal_cpp/include/yawg/vector.h

7.5 gsl::complex Class Reference

Wrapper class for gsl_complex structs.

`#include <complex.h>`

Inheritance diagram for gsl::complex:

Public Member Functions

- complex ()
- complex (double x)
- complex (double re, double im)
- complex (gsl_complex z)
- double real () const
- double imag () const
- double abs () const
- double abs2 () const
- double arg () const
- complex & operator+= (complex gsl_complex_other)
- complex & operator-= (complex gsl_complex_other)
- complex & operator∗= (complex gsl_complex_other)
- complex & operator/= (complex gsl_complex_other)
- complex & operator+= (double x)
- complex & operator-= (double x)
- complex & operator∗= (double x)
- complex & operator/= (double x)
- complex & operator= (complex gsl_complex_other)
- void set (double re, double im)
- void set (complex z)
- complex operator- () const
- void print () const

Friends

- class complex_ref
- complex operator+ (complex a, complex b)
- complex operator- (complex a, complex b)
- complex operator∗ (complex a, complex b)
- complex operator/ (complex a, complex b)
- bool operator== (complex a, complex b)

7.5.1 Detailed Description

Wrapper class for gsl_complex structs.

Inherits `double dat[2]` from gsl_complex and provides a number of convenience functions.

7.5.2 Constructor & Destructor Documentation

7.5.2.1 complex() [1/4]

```
gsl::complex::complex ( )  [inline]
```

7.5.2.2 complex() [2/4]

```
gsl::complex::complex (
            double x )  [inline]
```

7.5.2.3 complex() [3/4]

```
gsl::complex::complex (
            double re,
            double im )  [inline]
```

7.5.2.4 complex() [4/4]

```
gsl::complex::complex (
            gsl_complex z )  [inline]
```

7.5.3 Member Function Documentation

7.5.3.1 abs()

```
double gsl::complex::abs ( ) const  [inline]
```

7.5.3.2 abs2()

```
double gsl::complex::abs2 ( ) const  [inline]
```

7.5.3.3 arg()

```
double gsl::complex::arg ( ) const  [inline]
```

7.5.3.4 imag()

```
double gsl::complex::imag ( ) const  [inline]
```

7.5.3.5 operator*=() [1/2]

```
complex& gsl::complex::operator*= (
            complex gsl_complex_other )
```

7.5.3.6 operator*=() [2/2]

```
complex& gsl::complex::operator*= (
            double x )
```

7.5.3.7 operator+=() [1/2]

```
complex& gsl::complex::operator+= (
            complex gsl_complex_other )
```

7.5.3.8 operator+=() [2/2]

```
complex& gsl::complex::operator+= (
            double x )
```

7.5.3.9 operator-()

```
complex gsl::complex::operator- ( ) const  [inline]
```

7.5.3.10 operator-=() [1/2]

```
complex& gsl::complex::operator-= (
            complex gsl_complex_other )
```

7.5.3.11 operator-=() [2/2]

```
complex& gsl::complex::operator-= (
            double x )
```

7.5.3.12 operator/=() [1/2]

```
complex& gsl::complex::operator/= (
            complex gsl_complex_other )
```

7.5.3.13 operator/=() [2/2]

```
complex& gsl::complex::operator/= (
            double x )
```

7.5.3.14 operator=()

```
complex& gsl::complex::operator= (
            complex gsl_complex_other )
```

7.5.3.15 print()

```
void gsl::complex::print ( ) const
```

7.5.3.16 real()

```
double gsl::complex::real ( ) const  [inline]
```

7.5.3.17 set() [1/2]

```
void gsl::complex::set (
            complex z )  [inline]
```

7.5.3.18 set() [2/2]

```
void gsl::complex::set (
            double re,
            double im )  [inline]
```

7.5.4 Friends And Related Function Documentation

7.5.4.1 complex_ref

```
friend class complex_ref  [friend]
```

7.5.4.2 operator*

```
complex operator* (
            complex a,
            complex b )  [friend]
```

7.5.4.3 operator+

```
complex operator+ (
            complex a,
            complex b )  [friend]
```

7.5.4.4 operator-

```
complex operator- (
            complex a,
            complex b )  [friend]
```

7.5.4.5 operator/

```
complex operator/ (
            complex a,
            complex b )  [friend]
```

7.5.4.6 operator==

```
bool operator== (
            complex a,
            complex b )  [friend]
```

The documentation for this class was generated from the following file:

- /home/jspainhour/spheroidal_cpp/include/yawg/complex.h

7.6 gsl::complex_ref Class Reference

Stores a refernce to a gsl::complex object.

`#include <complex.h>`

Public Member Functions

- operator complex () const
  "Dereferences" a complex_ref into independent gsl::complex object
- complex_ref (complex_ref &z)
  Constructs a reference to another compelx_ref object.
- complex_ref (gsl_complex *z)
  Constructs a reference to a gsl_complex struct.
- complex_ref (complex &z)
  Constructs a reference to a gsl::complex object.
- complex_ref & operator= (complex z)
  Assigns values of gsl::complex object to the reference.
- complex_ref & operator= (complex_ref z)
  Assigns values of one complex_ref object to another.
- double real () const
- double imag () const

Protected Member Functions

- complex_ref ()

Protected Attributes

- double * dat

7.6.1 Detailed Description

Stores a refernce to a gsl::complex object.

This class is necessary to communicate between gsl_complex and gsl::complex so that overloads of () work gsl::cvector and gsl::cmatrix.

Implementation heavily inspired by ccgsl (https://ccgsl.sourceforge.net/)

7.6.2 Constructor & Destructor Documentation

7.6.2.1 complex_ref() [1/4]

```
gsl::complex_ref::complex_ref ( )  [inline], [protected]
```

7.6.2.2 complex_ref() [2/4]

```
gsl::complex_ref::complex_ref (
            complex_ref & z )  [inline]
```

Constructs a reference to another compelx_ref object.

7.6.2.3 complex_ref() [3/4]

```
gsl::complex_ref::complex_ref (
            gsl_complex * z )  [inline]
```

Constructs a reference to a gsl_complex struct.

7.6.2.4 complex_ref() [4/4]

```
gsl::complex_ref::complex_ref (
            complex & z )  [inline]
```

Constructs a reference to a gsl::complex object.

7.6.3 Member Function Documentation

7.6.3.1 imag()

```
double gsl::complex_ref::imag ( ) const  [inline]
```

7.6.3.2 operator complex()

```
gsl::complex_ref::operator complex ( ) const  [inline]
```

"Dereferences" a complex_ref into independent gsl::complex object

7.6.3.3 operator=() [1/2]

```
complex_ref& gsl::complex_ref::operator= (
            complex z )  [inline]
```

Assigns values of gsl::complex object to the reference.

7.6.3.4 operator=() [2/2]

```
complex_ref& gsl::complex_ref::operator= (
            complex_ref z )  [inline]
```

Assigns values of one complex_ref object to another.

Note

This is an alternative to the default assignment operator, which does not work for unknown reasons.

7.6.3.5 real()

```
double gsl::complex_ref::real ( ) const  [inline]
```

7.6.4 Member Data Documentation

7.6.4.1 dat

```
double* gsl::complex_ref::dat  [protected]
```

The documentation for this class was generated from the following file:

- /home/jspainhour/spheroidal_cpp/include/yawg/complex.h

7.7 gsl::crow_view Class Reference

A subclass of cvector_view for stride-1 vectors.

```
#include <cvector.h>
```

Inheritance diagram for gsl::crow_view:

Public Member Functions

- crow_view (gsl_vector_complex_view gvec_view)
  Construct crow_view from existing cvector view, checking that stride is 1.
- crow_view (const cvector &v)
  Construct crow_view from cvector, checking that stride is 1.
- cmatrix_view reshape (size_t n, size_t m)
  Return a cmatrix view out of the elements of the row.

Additional Inherited Members

7.7.1 Detailed Description

A subclass of cvector_view for stride-1 vectors.

7.7.2 Constructor & Destructor Documentation

7.7.2.1 crow_view() [1/2]

```
gsl::crow_view::crow_view (
            gsl_vector_complex_view gvec_view )  [inline]
```

Construct crow_view from existing cvector view, checking that stride is 1.

7.7.2.2 crow_view() [2/2]

```
gsl::crow_view::crow_view (
            const cvector & v )  [inline]
```

Construct crow_view from cvector, checking that stride is 1.

7.7.3 Member Function Documentation

7.7.3.1 reshape()

```
cmatrix_view gsl::crow_view::reshape (
            size_t n,
            size_t m )
```

Return a cmatrix view out of the elements of the row.

The documentation for this class was generated from the following file:

- /home/jspainhour/spheroidal_cpp/include/yawg/cvector.h

7.8 gsl::cvector Class Reference

A wrapper class for gsl_vector_complex.

```
#include <cvector.h>
```

Public Member Functions

- cvector ()
  Construct empty vector.
- cvector (size_t n)
  Construct zero vector of size n.
- cvector (const gsl_vector_complex *gvec_other)
  Construct new gsl::cvector from gsl_vector_complex.
- cvector (const cvector &gvec_other)
- cvector (cvector &&gvec_other)
- cvector (const vector &vec)
  Construct new gsl::cvector from gsl::vector.
- cvector & operator= (const cvector &gvec_other)
- cvector & operator= (cvector &&gvec_other)
- ~cvector ()
- complex_ref operator() (size_t i)
  Return a reference to the element at position (i,j)
- void set (size_t i, complex z)
- const complex_ref operator() (size_t i) const

- complex get (size_t i) const
- size_t size () const
- gsl_vector_complex * get_gsl_ptr () const

  Access the pointer to the underlying gsl_vector_complex.
- void resize (size_t n)

  Resize the gsl::cvector, setting elements to zero.
- void clear ()

  Clear the gsl::cvector, free underlying memory.
- void print (FILE *out=stdout) const

  Pretty-print the complex vector to file stream.
- double norm () const

  Return the 2-norm of the vector.
- cvector & operator+= (const cvector &gvec_other)
- cvector & operator-= (const cvector &gvec_other)
- cvector_view subvector (size_t offset, size_t size)

  Return a view to a subvector of the vector.
- cvector_view view ()

  Return a view to the entire vector.

Protected Member Functions

- void free ()

  Private function to free allocated memory.
- void calloc (size_t n)

  Private function to (continuously) allocate memory.

Protected Attributes

- gsl_vector_complex * gvec

Friends

- class vector
- class cvector_view
- class crow_view
- class ccolumn_view
- class cmatrix
- cvector operator* (complex a, const cvector &v)
- cvector operator* (complex a, cvector &&v)
- cvector operator* (const cvector &v, complex a)
- cvector operator* (cvector &&v, complex a)
- cvector operator+ (const cvector &v1, const cvector &v2)
- cvector operator+ (cvector &&v1, const cvector &v2)
- cvector operator+ (const cvector &v1, cvector &&v2)
- cvector operator+ (cvector &&v1, cvector &&v2)
- cvector operator- (const cvector &v1, const cvector &v2)
- cvector operator- (cvector &&v1, const cvector &v2)
- cvector operator- (const cvector &v1, cvector &&v2)
- cvector operator- (cvector &&v1, cvector &&v2)
- bool operator== (const cvector &v1, const cvector &v2)

7.8.1 Detailed Description

A wrapper class for gsl_vector_complex.

Stores and operates on a pointer to a gsl_vector_complex.

7.8.2 Constructor & Destructor Documentation

7.8.2.1 cvector() [1/6]

```
gsl::cvector::cvector ( )
```

Construct empty vector.

7.8.2.2 cvector() [2/6]

```
gsl::cvector::cvector (
            size_t n )  [explicit]
```

Construct zero vector of size n.

7.8.2.3 cvector() [3/6]

```
gsl::cvector::cvector (
            const gsl_vector_complex * gvec_other )
```

Construct new gsl::cvector from gsl_vector_complex.

7.8.2.4 cvector() [4/6]

```
gsl::cvector::cvector (
            const cvector & gvec_other )
```

7.8.2.5 cvector() [5/6]

```
gsl::cvector::cvector (
            cvector && gvec_other )
```

7.8.2.6 cvector() [6/6]

```
gsl::cvector::cvector (
            const vector & vec )
```

Construct new gsl::cvector from gsl::vector.

7.8.2.7 ~cvector()

```
gsl::cvector::~cvector ( )
```

7.8.3 Member Function Documentation

7.8.3.1 calloc()

```
void gsl::cvector::calloc (
            size_t n )  [protected]
```

Private function to (continuously) allocate memory.

7.8.3.2 clear()

```
void gsl::cvector::clear ( )
```

Clear the gsl::cvector, free underlying memory.

7.8.3.3 free()

```
void gsl::cvector::free ( )  [protected]
```

Private function to free allocated memory.

7.8.3.4 get()

```
complex gsl::cvector::get (
            size_t i ) const
```

7.8.3.5 get_gsl_ptr()

```
gsl_vector_complex* gsl::cvector::get_gsl_ptr ( ) const  [inline]
```

Access the pointer to the underlying gsl_vector_complex.

7.8.3.6 norm()

```
double gsl::cvector::norm ( ) const  [inline]
```

Return the 2-norm of the vector.

7.8.3.7 operator()() [1/2]

```
complex_ref gsl::cvector::operator() (
            size_t i )
```

Return a reference to the element at position (i,j)

7.8.3.8 operator()() [2/2]

```
const complex_ref gsl::cvector::operator() (
            size_t i ) const
```

7.8.3.9 operator+=()

```
cvector& gsl::cvector::operator+= (
            const cvector & gvec_other )
```

7.8.3.10 operator-=()

```
cvector& gsl::cvector::operator-= (
            const cvector & gvec_other )
```

7.8.3.11 operator=() [1/2]

```
cvector& gsl::cvector::operator= (
            const cvector & gvec_other )
```

7.8.3.12 operator=() [2/2]

```
cvector& gsl::cvector::operator= (
            cvector && gvec_other )
```

7.8.3.13 print()

```
void gsl::cvector::print (
            FILE * out = stdout ) const
```

Pretty-print the complex vector to file stream.

7.8.3.14 resize()

```
void gsl::cvector::resize (
            size_t n )
```

Resize the gsl::cvector, setting elements to zero.

7.8.3.15 set()

```
void gsl::cvector::set (
            size_t i,
            complex z )
```

7.8.3.16 size()

```
size_t gsl::cvector::size ( ) const
```

7.8.3.17 subvector()

```
cvector_view gsl::cvector::subvector (
            size_t offset,
            size_t size )
```

Return a view to a subvector of the vector.

7.8.3.18 view()

```
cvector_view gsl::cvector::view ( )
```

Return a view to the entire vector.

7.8.4 Friends And Related Function Documentation

7.8.4.1 ccolumn_view

```
friend class ccolumn_view  [friend]
```

7.8.4.2 cmatrix

```
friend class cmatrix  [friend]
```

7.8.4.3 crow_view

```
friend class crow_view  [friend]
```

7.8.4.4 cvector_view

```
friend class cvector_view  [friend]
```

7.8.4.5 operator* [1/4]

```
cvector operator* (
            complex a,
            const cvector & v )  [friend]
```

7.8.4.6 operator* [2/4]

```
cvector operator* (
            complex a,
            cvector && v )  [friend]
```

7.8.4.7 operator* [3/4]

```
cvector operator* (
            const cvector & v,
            complex a )  [friend]
```

7.8.4.8 operator* [4/4]

```
cvector operator* (
            cvector && v,
            complex a )  [friend]
```

7.8.4.9 operator+ [1/4]

```
cvector operator+ (
            const cvector & v1,
            const cvector & v2 )  [friend]
```

7.8.4.10 operator+ [2/4]

```
cvector operator+ (
            const cvector & v1,
            cvector && v2 )  [friend]
```

7.8.4.11 operator+ [3/4]

```
cvector operator+ (
            cvector && v1,
            const cvector & v2 )  [friend]
```

7.8.4.12 operator+ [4/4]

```
cvector operator+ (
            cvector && v1,
            cvector && v2 )  [friend]
```

7.8.4.13 operator- [1/4]

```
cvector operator- (
            const cvector & v1,
            const cvector & v2 )  [friend]
```

7.8.4.14 operator- [2/4]

```
cvector operator- (
            const cvector & v1,
            cvector && v2 )  [friend]
```

7.8.4.15 operator- [3/4]

```
cvector operator- (
            cvector && v1,
            const cvector & v2 )  [friend]
```

7.8.4.16 operator- [4/4]

```
cvector operator- (
            cvector && v1,
            cvector && v2 )  [friend]
```

7.8.4.17 operator==

```
bool operator== (
            const cvector & v1,
            const cvector & v2 )  [friend]
```

7.8.4.18 vector

```
friend class vector  [friend]
```

7.8.5 Member Data Documentation

7.8.5.1 gvec

```
gsl_vector_complex* gsl::cvector::gvec  [protected]
```

The documentation for this class was generated from the following file:

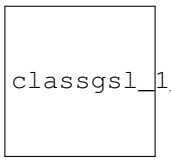
- /home/jspainhour/spheroidal_cpp/include/yawg/cvector.h

7.9 gsl::cvector_view Class Reference

A wrapper class for gsl_vector_complex_view.

`#include <cvector.h>`

Inheritance diagram for gsl::cvector_view:



Public Member Functions

- operator cvector () const
  "Dereferences" a cvector_view into independent gsl::cvector object
- cvector_view (gsl_vector_complex_view gvec_view)
  Construct a view of a gsl::cvector through another cvector_view.
- cvector_view (const cvector &v)
  Construct a view of the given gsl::cvector.
- cvector_view & operator= (const cvector &v)
  Assignment to a cvector view from a cvector.
- cvector_view & operator= (cvector_view v)
  Assignment to a cvector view from another cvector view.
- void print (FILE *out=stdout) const
  Pretty-print the viewed vector to file stream.
- const gsl_vector_complex * get_gsl_ptr () const
  Return a constant pointer to the underlying gsl_vector_complex.

Protected Attributes

- gsl_vector_complex_view gvec_view

7.9.1 Detailed Description

A wrapper class for gsl_vector_complex_view.

Stores a gsl_vector_complex_view and uses it to access original member data.

7.9.2 Constructor & Destructor Documentation

7.9.2.1 cvector_view() [1/2]

```
gsl::cvector_view::cvector_view (
            gsl_vector_complex_view gvec_view )  [inline]
```

Construct a view of a gsl::cvector through another cvector_view.

7.9.2.2 cvector_view() [2/2]

```
gsl::cvector_view::cvector_view (
            const cvector & v )  [inline]
```

Construct a view of the given gsl::cvector.

7.9.3 Member Function Documentation

7.9.3.1 get_gsl_ptr()

```
const gsl_vector_complex* gsl::cvector_view::get_gsl_ptr ( ) const  [inline]
```

Return a constant pointer to the underlying gsl_vector_complex.

7.9.3.2 operator cvector()

```
gsl::cvector_view::operator cvector ( ) const  [inline]
```

"Dereferences" a cvector_view into independent gsl::cvector object

7.9.3.3 operator=() [1/2]

```
cvector_view& gsl::cvector_view::operator= (
            const cvector & v )
```

Assignment to a cvector view from a cvector.

7.9.3.4 operator=() [2/2]

```
cvector_view& gsl::cvector_view::operator= (
            cvector_view v )
```

Assignment to a cvector view from another cvector view.

7.9.3.5 print()

```
void gsl::cvector_view::print (
            FILE * out = stdout ) const
```

Pretty-print the viewed vector to file stream.

7.9.4 Member Data Documentation

7.9.4.1 gvec_view

```
gsl_vector_complex_view gsl::cvector_view::gvec_view  [protected]
```

The documentation for this class was generated from the following file:

- /home/jspainhour/spheroidal_cpp/include/yawg/cvector.h

7.10 gsl::matrix Class Reference

A wrapper class for gsl_matrix.

`#include <matrix.h>`

Public Member Functions

- matrix ()
  Construct empty matrix.
- matrix (size_t n, size_t m)
  Construct zero matrix of size n x m.
- matrix (const gsl_matrix *gsl_mat)
  Construct new gsl::matrix from gsl_matrix.
- matrix (const vector &v)
  Construct new n x 1 gsl::matrix from gsl::vector.
- matrix (const matrix &M, size_t n, size_t m)
  Copy constructor creating n x m matrix.
- matrix (const matrix &M)
- matrix (matrix &&M)
- matrix & operator= (const matrix &M)
- matrix & operator= (matrix &&M)
- ~matrix ()
- double & operator() (size_t i, size_t j)
- void set (size_t i, size_t j, double val)
- double operator() (size_t i, size_t j) const
- double get (size_t i, size_t j) const
- size_t size () const
- size_t nrows () const
- size_t ncols () const
- gsl_matrix * get_gsl_ptr () const
  Access the pointer to the underlying gsl_matrix.
- void resize (size_t n, size_t m)
  Resize the gsl::matrix, setting elements to zero.
- void clear ()
  CLear the gsl::matrix, free underlying memory.
- matrix reshape (size_t n, size_t m) const
  Return a new n x m gsl::matrix with same elements.
- void print (FILE *out=stdout) const
  Pretty-print the matrix to file stream.
- void print_csv (FILE *out=stdout) const
  Print the matrix to file stream in CSV format.
- void load_csv (FILE *in=stdin)
  Load the matrix from a file stream in CSV format.
- matrix_view submatrix (size_t i, size_t j, size_t n, size_t m)
  Return a view to a submatrix of the matrix.
- row_view row (size_t i)
  Return a view to a row of the matrix.
- column_view column (size_t j)
  Return a view to a column of the matrix.

Protected Member Functions

- void free ()

  Private function to free allocated memory.
- void calloc (size_t n, size_t m)

  Private function to (continuously) allocate memory.

Protected Attributes

- gsl_matrix * gmat

Friends

- class cmatrix
- class matrix_view
- class row_view
- class column_view
- matrix operator* (const matrix &A, const matrix &B)

7.10.1 Detailed Description

A wrapper class for gsl_matrix.

Stores and operates on a pointer to a gsl_matrix.

7.10.2 Constructor & Destructor Documentation

7.10.2.1 matrix() [1/7]

```
gsl::matrix::matrix ( )
```

Construct empty matrix.

7.10.2.2 matrix() [2/7]

```
gsl::matrix::matrix (
            size_t n,
            size_t m )
```

Construct zero matrix of size n x m.

7.10.2.3 matrix() [3/7]

```
gsl::matrix::matrix (
            const gsl_matrix * gsl_mat )
```

Construct new gsl::matrix from gsl_matrix.

7.10.2.4 matrix() [4/7]

```
gsl::matrix::matrix (
            const vector & v )
```

Construct new n x 1 gsl::matrix from gsl::vector.

7.10.2.5 matrix() [5/7]

```
gsl::matrix::matrix (
            const matrix & M,
            size_t n,
            size_t m )
```

Copy constructor creating n x m matrix.

7.10.2.6 matrix() [6/7]

```
gsl::matrix::matrix (
            const matrix & M )
```

7.10.2.7 matrix() [7/7]

```
gsl::matrix::matrix (
            matrix && M )
```

7.10.2.8 ~matrix()

```
gsl::matrix::~matrix ( )
```

7.10.3 Member Function Documentation

7.10.3.1 calloc()

```
void gsl::matrix::calloc (
            size_t n,
            size_t m )  [protected]
```

Private function to (continuously) allocate memory.

7.10.3.2 clear()

```
void gsl::matrix::clear ( )
```

CLear the gsl::matrix, free underlying memory.

7.10.3.3 column()

```
column_view gsl::matrix::column (
            size_t j )
```

Return a view to a column of the matrix.

7.10.3.4 free()

```
void gsl::matrix::free ( )  [protected]
```

Private function to free allocated memory.

7.10.3.5 get()

```
double gsl::matrix::get (
            size_t i,
            size_t j ) const
```

7.10.3.6 get_gsl_ptr()

```
gsl_matrix* gsl::matrix::get_gsl_ptr ( ) const  [inline]
```

Access the pointer to the underlying gsl_matrix.

7.10.3.7 load_csv()

```
void gsl::matrix::load_csv (
            FILE * in = stdin )
```

Load the matrix from a file stream in CSV format.

7.10.3.8 ncols()

```
size_t gsl::matrix::ncols ( ) const
```

7.10.3.9 nrows()

```
size_t gsl::matrix::nrows ( ) const
```

7.10.3.10 operator()() [1/2]

```
double& gsl::matrix::operator() (
            size_t i,
            size_t j )
```

7.10.3.11 operator()() [2/2]

```
double gsl::matrix::operator() (
            size_t i,
            size_t j ) const
```

7.10.3.12 operator=() [1/2]

```
matrix& gsl::matrix::operator= (
            const matrix & M )
```

7.10.3.13 operator=() [2/2]

```
matrix& gsl::matrix::operator= (
            matrix && M )
```

7.10.3.14 print()

```
void gsl::matrix::print (
            FILE * out = stdout ) const
```

Pretty-print the matrix to file stream.

7.10.3.15 print_csv()

```
void gsl::matrix::print_csv (
            FILE * out = stdout ) const
```

Print the matrix to file stream in CSV format.

7.10.3.16 reshape()

```
matrix gsl::matrix::reshape (
            size_t n,
            size_t m ) const
```

Return a new n x m gsl::matrix with same elements.

7.10.3.17 resize()

```
void gsl::matrix::resize (
            size_t n,
            size_t m )
```

Resize the gsl::matrix, setting elements to zero.

7.10.3.18 row()

```
row_view gsl::matrix::row (
            size_t i )
```

Return a view to a row of the matrix.

7.10.3.19 set()

```
void gsl::matrix::set (
            size_t i,
            size_t j,
            double val )
```

7.10.3.20 size()

```
size_t gsl::matrix::size ( ) const
```

7.10.3.21 submatrix()

```
matrix_view gsl::matrix::submatrix (
            size_t i,
            size_t j,
            size_t n,
            size_t m )
```

Return a view to a submatrix of the matrix.

7.10.4 Friends And Related Function Documentation

7.10.4.1 cmatrix

```
friend class cmatrix  [friend]
```

7.10.4.2 column_view

```
friend class column_view  [friend]
```

7.10.4.3 matrix_view

```
friend class matrix_view  [friend]
```

7.10.4.4 operator*

```
matrix operator* (
            const matrix & A,
            const matrix & B )  [friend]
```

7.10.4.5 row_view

```
friend class row_view  [friend]
```

7.10.5 Member Data Documentation

7.10.5.1 gmat

```
gsl_matrix* gsl::matrix::gmat  [protected]
```

The documentation for this class was generated from the following file:

- /home/jspainhour/spheroidal_cpp/include/yawg/matrix.h

7.11 gsl::matrix_view Class Reference

A wrapper class for gsl_matrix_view.

`#include <matrix.h>`

Public Member Functions

- operator matrix () const
  "Dereferences" a matrix_view into independent gsl::matrix object
- matrix_view (gsl_matrix_view gmat_view)
  Construct a view of a gsl::matrix through another matrix_view.
- matrix_view (const matrix &m)
  Construct a view of the given gsl::matrix.
- matrix_view & operator= (const matrix &M)
  Assignment to a matrix view from a matrix.
- matrix_view & operator= (matrix_view Mv)
  Assignment to a matrix view from another matrix view.
- void print (FILE *out=stdout) const
  Pretty-print the viewed matrix to file stream.
- const gsl_matrix * get_gsl_ptr () const
  Return a constant pointer to the underlying gsl_matrix.

Protected Attributes

- gsl_matrix_view gmat_view

7.11.1 Detailed Description

A wrapper class for gsl_matrix_view.

Stores a gsl_matrix_view and uses it to access original member data.

7.11.2 Constructor & Destructor Documentation

7.11.2.1 matrix_view() [1/2]

```
gsl::matrix_view::matrix_view (
            gsl_matrix_view gmat_view )  [inline]
```

Construct a view of a gsl::matrix through another matrix_view.

7.11.2.2 matrix_view() [2/2]

```
gsl::matrix_view::matrix_view (
            const matrix & m )  [inline]
```

Construct a view of the given gsl::matrix.

7.11.3 Member Function Documentation

7.11.3.1 get_gsl_ptr()

```
const gsl_matrix* gsl::matrix_view::get_gsl_ptr ( ) const  [inline]
```

Return a constant pointer to the underlying gsl_matrix.

7.11.3.2 operator matrix()

```
gsl::matrix_view::operator matrix ( ) const  [inline]
```

"Dereferences" a matrix_view into independent gsl::matrix object

7.11.3.3 operator=() [1/2]

```
matrix_view& gsl::matrix_view::operator= (
            const matrix & M )
```

Assignment to a matrix view from a matrix.

7.11.3.4 operator=() [2/2]

```
matrix_view& gsl::matrix_view::operator= (
            matrix_view Mv )
```

Assignment to a matrix view from another matrix view.

7.11.3.5 print()

```
void gsl::matrix_view::print (
            FILE * out = stdout ) const
```

Pretty-print the viewed matrix to file stream.

7.11.4 Member Data Documentation

7.11.4.1 gmat_view

```
gsl_matrix_view gsl::matrix_view::gmat_view  [protected]
```

The documentation for this class was generated from the following file:

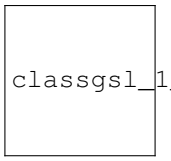
- /home/jspainhour/spheroidal_cpp/include/yawg/matrix.h

7.12 gsl::row_view Class Reference

A subclass of vector_view for stride-1 vectors.

`#include <vector.h>`

Inheritance diagram for gsl::row_view:



Public Member Functions

- row_view (gsl_vector_view gvec_view)

  Construct row_view from existing vector view, checking that stride is 1.
- row_view (const vector &v)

  Construct row_view from vector, checking that stride is 1.
- matrix_view reshape (size_t n, size_t m)

  Return a matrix view out of the elements of the row.

Additional Inherited Members

7.12.1 Detailed Description

A subclass of vector_view for stride-1 vectors.

7.12.2 Constructor & Destructor Documentation

7.12.2.1 row_view() [1/2]

```
gsl::row_view::row_view (
            gsl_vector_view gvec_view )  [inline]
```

Construct row_view from existing vector view, checking that stride is 1.

7.12.2.2 row_view() [2/2]

```
gsl::row_view::row_view (
            const vector & v )  [inline]
```

Construct row_view from vector, checking that stride is 1.

7.12.3 Member Function Documentation

7.12.3.1 reshape()

```
matrix_view gsl::row_view::reshape (
            size_t n,
            size_t m )
```

Return a matrix view out of the elements of the row.

The documentation for this class was generated from the following file:

- /home/jspainhour/spheroidal_cpp/include/yawg/vector.h

7.13 gsl::vector Class Reference

A wrapper class for gsl_vector.

`#include <vector.h>`

Public Member Functions

- vector ()
  Construct empty vector.
- vector (size_t n)
  Construct zero vector of size n.
- vector (const gsl_vector *gvec_other)
  Construct new gsl::vector from gsl_vector.
- vector (const vector &gvec_other)
- vector (vector &&gvec_other)
- vector & operator= (const vector &gvec_other)
- vector & operator= (vector &&gvec_other)
- ~vector ()
- double & operator() (size_t i)
- void set (size_t i, double val)
- double operator() (size_t i) const
- double get (size_t i) const
- size_t size () const
- gsl_vector * get_gsl_ptr () const
  Access the pointer to the underlying gsl_vector.
- void resize (size_t n)
  Resize the gsl::vector, setting elements to zero.
- void clear ()
  Clear the gsl::vector, free underlying memory.
- void print (FILE *out=stdout) const
  Pretty-print the vector to file stream.
- double norm () const
  Return the 2-norm of the vector.
- vector & operator+= (const vector &gvec_other)
- vector & operator-= (const vector &gvec_other)
- vector_view subvector (size_t offset, size_t size)
  Return a view to a subvector of the vector.
- vector_view view ()
  Return a view to the entire vector.

Protected Member Functions

- void free ()

  Private function to free allocated memory.
- void calloc (size_t n)

  Private function to (continuously) allocate memory.

Protected Attributes

- gsl_vector * gvec

Friends

- class cvector
- class vector_view
- class row_view
- class column_view
- class matrix
- vector operator* (double a, const vector &v)
- vector operator* (double a, vector &&v)
- vector operator* (const vector &v, double a)
- vector operator* (vector &&v, double a)
- cvector operator* (complex a, const vector &v)
- cvector operator* (const vector &v, complex a)
- vector operator+ (const vector &v1, const vector &v2)
- vector operator+ (vector &&v1, const vector &v2)
- vector operator+ (const vector &v1, vector &&v2)
- vector operator+ (vector &&v1, vector &&v2)
- vector operator- (const vector &v1, const vector &v2)
- vector operator- (vector &&v1, const vector &v2)
- vector operator- (const vector &v1, vector &&v2)
- vector operator- (vector &&v1, vector &&v2)
- bool operator== (const vector &v1, const vector &v2)

7.13.1 Detailed Description

A wrapper class for gsl_vector.

Stores and operates on a pointer to a gsl_vector.

7.13.2 Constructor & Destructor Documentation

7.13.2.1 vector() [1/5]

```
gsl::vector::vector ( )
```

Construct empty vector.

7.13.2.2 vector() [2/5]

```
gsl::vector::vector (
            size_t n )  [explicit]
```

Construct zero vector of size n.

7.13.2.3 vector() [3/5]

```
gsl::vector::vector (
            const gsl_vector * gvec_other )
```

Construct new gsl::vector from gsl_vector.

7.13.2.4 vector() [4/5]

```
gsl::vector::vector (
            const vector & gvec_other )
```

7.13.2.5 vector() [5/5]

```
gsl::vector::vector (
            vector && gvec_other )
```

7.13.2.6 ~vector()

```
gsl::vector::~vector ( )
```

7.13.3 Member Function Documentation

7.13.3.1 calloc()

```
void gsl::vector::calloc (
            size_t n )  [protected]
```

Private function to (continuously) allocate memory.

7.13.3.2 clear()

```
void gsl::vector::clear ( )
```

Clear the gsl::vector, free underlying memory.

7.13.3.3 free()

```
void gsl::vector::free ( )  [protected]
```

Private function to free allocated memory.

7.13.3.4 get()

```
double gsl::vector::get (
            size_t i ) const
```

7.13.3.5 get_gsl_ptr()

```
gsl_vector* gsl::vector::get_gsl_ptr ( ) const  [inline]
```

Access the pointer to the underlying gsl_vector.

7.13.3.6 norm()

```
double gsl::vector::norm ( ) const  [inline]
```

Return the 2-norm of the vector.

7.13.3.7 operator()() [1/2]

```
double& gsl::vector::operator() (
            size_t i )
```

7.13.3.8 operator()() [2/2]

```
double gsl::vector::operator() (
            size_t i ) const
```

7.13.3.9 operator+=()

```
vector& gsl::vector::operator+= (
            const vector & gvec_other )
```

7.13.3.10 operator-=()

```
vector& gsl::vector::operator-= (
            const vector & gvec_other )
```

7.13.3.11 operator=() [1/2]

```
vector& gsl::vector::operator= (
            const vector & gvec_other )
```

7.13.3.12 operator=() [2/2]

```
vector& gsl::vector::operator= (
            vector && gvec_other )
```

7.13.3.13 print()

```
void gsl::vector::print (
            FILE * out = stdout ) const
```

Pretty-print the vector to file stream.

7.13.3.14 resize()

```
void gsl::vector::resize (
            size_t n )
```

Resize the gsl::vector, setting elements to zero.

7.13.3.15 set()

```
void gsl::vector::set (
            size_t i,
            double val )
```

7.13.3.16 size()

```
size_t gsl::vector::size ( ) const
```

7.13.3.17 subvector()

```
vector_view gsl::vector::subvector (
            size_t offset,
            size_t size )
```

Return a view to a subvector of the vector.

7.13.3.18 view()

```
vector_view gsl::vector::view ( )
```

Return a view to the entire vector.

7.13.4 Friends And Related Function Documentation

7.13.4.1 column_view

```
friend class column_view  [friend]
```

7.13.4.2 cvector

```
friend class cvector  [friend]
```

7.13.4.3 matrix

```
friend class matrix  [friend]
```

7.13.4.4 operator* [1/6]

```
cvector operator* (
            complex a,
            const vector & v )  [friend]
```

7.13.4.5 operator* [2/6]

```
cvector operator* (
            const vector & v,
            complex a )  [friend]
```

7.13.4.6 operator* [3/6]

```
vector operator* (
            const vector & v,
            double a )  [friend]
```

7.13.4.7 operator* [4/6]

```
vector operator* (
            double a,
            const vector & v )  [friend]
```

7.13.4.8 operator* [5/6]

```
vector operator* (
            double a,
            vector && v )  [friend]
```

7.13.4.9 operator* [6/6]

```
vector operator* (
            vector && v,
            double a )  [friend]
```

7.13.4.10 operator+ [1/4]

```
vector operator+ (
            const vector & v1,
            const vector & v2 )  [friend]
```

7.13.4.11 operator+ [2/4]

```
vector operator+ (
            const vector & v1,
            vector && v2 )  [friend]
```

7.13.4.12 operator+ [3/4]

```
vector operator+ (
            vector && v1,
            const vector & v2 )  [friend]
```

7.13.4.13 operator+ [4/4]

```
vector operator+ (
            vector && v1,
            vector && v2 )  [friend]
```

7.13.4.14 operator- [1/4]

```
vector operator- (
            const vector & v1,
            const vector & v2 )  [friend]
```

7.13.4.15 operator- [2/4]

```
vector operator- (
            const vector & v1,
            vector && v2 )  [friend]
```

7.13.4.16 operator- [3/4]

```
vector operator- (
            vector && v1,
            const vector & v2 )  [friend]
```

7.13.4.17 operator- [4/4]

```
vector operator- (
            vector && v1,
            vector && v2 )  [friend]
```

7.13.4.18 operator==

```
bool operator== (
            const vector & v1,
            const vector & v2 )  [friend]
```

7.13.4.19 row_view

```
friend class row_view  [friend]
```

7.13.4.20 vector_view

```
friend class vector_view  [friend]
```

7.13.5 Member Data Documentation

7.13.5.1 gvec

```
gsl_vector* gsl::vector::gvec  [protected]
```

The documentation for this class was generated from the following file:

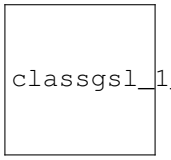
- /home/jspainhour/spheroidal_cpp/include/yawg/vector.h

7.14 gsl::vector_view Class Reference

A wrapper class for gsl_vector_view.

```
#include <vector.h>
```

Inheritance diagram for gsl::vector_view:



Public Member Functions

- operator vector () const
  "Dereferences" a vector_view into independent gsl::vector object
- vector_view (gsl_vector_view gvec_view)
  Construct a view of a gsl::vector through another vector_view.
- vector_view (const vector &v)
  Construct a view of the given gsl::vector.
- vector_view & operator= (const vector &v)
  Assignment to a vector view from a vector.
- vector_view & operator= (vector_view v)
  Assignment to a vector view from a vector view.
- void print (FILE *out=stdout) const
  Pretty-print the viewed vector to file stream.
- const gsl_vector * get_gsl_ptr () const
  Return a constant pointer to the underlying gsl_vector.

Protected Attributes

- gsl_vector_view gvec_view

7.14.1 Detailed Description

A wrapper class for gsl_vector_view.

Stores a gsl_vector_view and uses it to access original member data.

7.14.2 Constructor & Destructor Documentation

7.14.2.1 vector_view() [1/2]

```
gsl::vector_view::vector_view (
            gsl_vector_view gvec_view )  [inline]
```

Construct a view of a gsl::vector through another vector_view.

7.14.2.2 vector_view() [2/2]

```
gsl::vector_view::vector_view (
            const vector & v )  [inline]
```

Construct a view of the given gsl::vector.

7.14.3 Member Function Documentation

7.14.3.1 get_gsl_ptr()

```
const gsl_vector* gsl::vector_view::get_gsl_ptr ( ) const  [inline]
```

Return a constant pointer to the underlying gsl_vector.

7.14.3.2 operator vector()

```
gsl::vector_view::operator vector ( ) const  [inline]
```

"Dereferences" a vector_view into independent gsl::vector object

7.14.3.3 operator=() [1/2]

```
vector_view& gsl::vector_view::operator= (
            const vector & v )
```

Assignment to a vector view from a vector.

7.14.3.4 operator=() [2/2]

```
vector_view& gsl::vector_view::operator= (
            vector_view v )
```

Assignment to a vector view from a vector view.

7.14.3.5 print()

```
void gsl::vector_view::print (
            FILE * out = stdout ) const
```

Pretty-print the viewed vector to file stream.

7.14.4 Member Data Documentation

7.14.4.1 gvec_view

```
gsl_vector_view gsl::vector_view::gvec_view  [protected]
```

The documentation for this class was generated from the following file:

- /home/jspainhour/spheroidal_cpp/include/yawg/vector.h

Chapter 8

File Documentation

8.1 grid_functions.h File Reference

```
#include <yawg/matrix.h>
```

Functions

- int spharm_grid_size_ord (int p, int &nu, int &nv)

  Computes grid size of spheroidal harmonics grid given the order.
- int spharm_grid_size_tot (int ntot, int &nu, int &nv)

  Computes grid size of spheroidal harmonics grid given the total number of points.
- void gl_grid (size_t p, gsl::matrix &U, gsl::matrix &V)

  Populates the matrices `U` and `V` with a spheroidal harmonics grid of order `p`.

8.1.1 Function Documentation

8.1.1.1 gl_grid()

```
void gl_grid (
            size_t p,
            gsl::matrix & U,
            gsl::matrix & V )
```

Populates the matrices `U` and `V` with a spheroidal harmonics grid of order `p`.

8.1.1.2 spharm_grid_size_ord()

```
int spharm_grid_size_ord (
            int p,
            int & nu,
            int & nv )
```

Computes grid size of spheroidal harmonics grid given the order.

8.1.1.3 spharm_grid_size_tot()

```
int spharm_grid_size_tot (
            int ntot,
            int & nu,
            int & nv )
```

Computes grid size of spheroidal harmonics grid given the total number of points.

8.2 legendre_otc.h File Reference

```
#include <yawg/vector.h>
#include <yawg/matrix.h>
```

Functions

- gsl::vector cont_frac (int n, int m, gsl::vector u)
- int geti (int n, int m)
- void legendre_otc (int p, gsl::vector u, gsl::matrix &P)
- void legendre_otc (int p, gsl::vector u, gsl::matrix &P, gsl::matrix &Q)
- void Dlegendre_otc (int p, gsl::vector u, gsl::matrix &P, gsl::matrix &dP)
- void Dlegendre_otc (int p, gsl::vector u, gsl::matrix &P, gsl::matrix &Q, gsl::matrix &dP, gsl::matrix &dQ)

8.2.1 Function Documentation

8.2.1.1 cont_frac()

```
gsl::vector cont_frac (
            int n,
            int m,
            gsl::vector u )
```

8.2.1.2 Dlegendre_otc() [1/2]

```
void Dlegendre_otc (
            int p,
            gsl::vector u,
            gsl::matrix & P,
            gsl::matrix & dP )
```

8.2.1.3 Dlegendre_otc() [2/2]

```
void Dlegendre_otc (
            int p,
            gsl::vector u,
            gsl::matrix & P,
            gsl::matrix & Q,
            gsl::matrix & dP,
            gsl::matrix & dQ )
```

8.2.1.4 geti()

```
int geti (
            int n,
            int m )
```

8.2.1.5 legendre_otc() [1/2]

```
void legendre_otc (
            int p,
            gsl::vector u,
            gsl::matrix & P )
```

8.2.1.6 legendre_otc() [2/2]

```
void legendre_otc (
            int p,
            gsl::vector u,
            gsl::matrix & P,
            gsl::matrix & Q )
```

8.3 spheroidal_analysis.h File Reference

```
#include <vector>
#include <gsl_wrapper/core.h>
```

Functions

- gsl::vector spheroidal_analysis (gsl::vector f)

8.3.1 Function Documentation

8.3.1.1 spheroidal_analysis()

```
gsl::vector spheroidal_analysis (
            gsl::vector f )
```

8.4 /home/jspainhour/spheroidal_cpp/include/yawg/cmatrix.h File Reference

```
#include <yawg/complex.h>
#include <gsl/gsl_matrix.h>
#include <stdio.h>
```

Classes

- class gsl::cmatrix
- class gsl::cmatrix_view

  A wrapper class for gsl_matrix_complex_view.

Namespaces

- gsl

8.5 /home/jspainhour/spheroidal_cpp/include/yawg/complex.h File Reference

```
#include <gsl/gsl_complex.h>
#include <gsl/gsl_complex_math.h>
```

Classes

- class gsl::complex

  Wrapper class for gsl_complex structs.
- class gsl::complex_ref

  Stores a refernce to a gsl::complex object.

Namespaces

- gsl
- gsl::complex_literals

Functions

- complex gsl::complex_literals::operator""_i (long double y)

  User defined literal overload for complex numbers.

8.6 /home/jspainhour/spheroidal_cpp/include/yawg/core.h File Reference

```
#include <yawg/complex.h>
#include <yawg/vector.h>
#include <yawg/cvector.h>
#include <yawg/matrix.h>
#include <yawg/cmatrix.h>
```

8.7 /home/jspainhour/spheroidal_cpp/include/yawg/cvector.h File Reference

```
#include <yawg/complex.h>
#include <gsl/gsl_vector_complex.h>
#include <gsl/gsl_blas.h>
#include <stdio.h>
```

Classes

- class gsl::cvector

  A wrapper class for gsl_vector_complex.
- class gsl::cvector_view

  A wrapper class for gsl_vector_complex_view.
- class gsl::crow_view

  A subclass of cvector_view for stride-1 vectors.
- class gsl::ccolumn_view

  A subclass of cvector_view for non-stride-1 cvectors.

Namespaces

- gsl

8.8 /home/jspainhour/spheroidal_cpp/include/yawg/fft.h File Reference

```
#include <yawg/core.h>
```

Namespaces

- gsl

Functions

- gsl::cvector gsl::fft (gsl::cvector &&x)

  Compute in-place fft of a gsl::(c)vector.
- gsl::cvector gsl::fft (const gsl::cvector &x)

  Compute fft of a gsl::(c)vector.
- gsl::cvector gsl::ifft (gsl::cvector &&x)

  Compute in-place inverse fft of a gsl::(c)vector.
- gsl::cvector gsl::ifft (const gsl::cvector &x)

  Compute inverse fft of a gsl::(c)vector.
- gsl::cmatrix gsl::fft (gsl::cmatrix &&x, int dim=1)

  Compute in-place 1D fft of each column/row of a gsl::(c)matrix.
- gsl::cmatrix gsl::fft (const gsl::cmatrix &x, int dim=1)

  Compute 1D fft of each column/row of a gsl::(c)matrix.
- gsl::cmatrix gsl::ifft (gsl::cmatrix &&x, int dim=1)

  Compute in-place 1D inverse fft of each column/row of a gsl::(c)matrix.
- gsl::cmatrix gsl::ifft (const gsl::cmatrix &x, int dim=1)

  Compute 1D inverse fft of each column/row of a gsl::(c)matrix.

8.9 /home/jspainhour/spheroidal_cpp/include/yawg/matrix.h File Reference

```
#include <gsl/gsl_matrix.h>
#include <gsl/gsl_blas.h>
#include <stdio.h>
```

Classes

- class gsl::matrix

  A wrapper class for gsl_matrix.
- class gsl::matrix_view

  A wrapper class for gsl_matrix_view.

Namespaces

- gsl

8.10 /home/jspainhour/spheroidal_cpp/include/yawg/utils.hpp File Reference

```
#include <yawg/core.h>
#include <utility>
```

Namespaces

- gsl

Functions

- void gsl::leggauss (size_t n, gsl::vector &x, gsl::vector &w, double a=-1.0, double b=1.0)

  Store Gauss-Legendre quadrature nodes and weights.
- vector gsl::leggauss (size_t n, double a=-1.0, double b=1.0)

  Get a vector Gauss-Legendre quadrature nodes.
- gsl::vector gsl::linspace (double a, double b, size_t N=100)

  Get a gsl::vector of evenly spaced points on the interval [a, b] (inclusive)
- gsl::cvector gsl::linspace (gsl::complex a, gsl::complex b, size_t n)

  Complex version of linspace.
- gsl::vector gsl::arange (double a, double b, double step=1.0)
- void gsl::meshgrid (const gsl::vector &x, const gsl::vector &y, gsl::matrix &X, gsl::matrix &Y)

  Store 2D grid coordinates based on 1D input gsl::vectors.
- void gsl::meshgrid (const gsl::cvector &x, const gsl::cvector &y, gsl::cmatrix &X, gsl::cmatrix &Y)
- gsl::matrix gsl::eye (size_t n)

  Return the nxn identity matrix.
- template<typename Lambda >
  gsl::vector gsl::arrayfun (Lambda &&func, const gsl::vector &x)

  Apply lambda function to each element of a gsl::vector, akin to MATLAB arrayfun.
- template<typename Lambda >
  gsl::vector gsl::arrayfun (Lambda &&func, gsl::vector &&x)

  Move version of arrayfun for vectors.
- template<typename Lambda >
  gsl::cvector gsl::arrayfun (Lambda &&func, const gsl::cvector &x)

  Copy version of arrayfun for complex vectors.
- template<typename Lambda >
  gsl::cvector gsl::arrayfun (Lambda &&func, gsl::cvector &&x)

  Move version of arrayfun for complex vectors.
- template<typename Lambda >
  gsl::matrix gsl::arrayfun (Lambda &&func, const gsl::matrix &x)

  Apply lambda function to each element of a gsl::matrix, akin to MATLAB arrayfun.
- template<typename Lambda >
  gsl::matrix gsl::arrayfun (Lambda &&func, gsl::matrix &&x)

  Move version of arrayfun.

- template<typename Lambda >
  gsl::cmatrix gsl::arrayfun (Lambda &&func, const gsl::cmatrix &x)

  Copy version of arrayfun for complex matrices.
- template<typename Lambda >
  gsl::cmatrix gsl::arrayfun (Lambda &&func, gsl::cmatrix &&x)

  Move version of arrayfun for complex matrices.

8.11 /home/jspainhour/spheroidal_cpp/include/yawg/vector.h File Reference

```
#include <gsl/gsl_vector.h>
#include <gsl/gsl_blas.h>
#include <stdio.h>
```

Classes

- class gsl::vector

  A wrapper class for gsl_vector.
- class gsl::vector_view

  A wrapper class for gsl_vector_view.
- class gsl::row_view

  A subclass of vector_view for stride-1 vectors.
- class gsl::column_view

  A subclass of vector_view for non-stride-1 vectors.

Namespaces

- gsl

8.12 /home/jspainhour/spheroidal_cpp/README.md File Reference

8.13 /home/jspainhour/spheroidal_cpp/tests/yawg/test_fft.cpp File Reference

```
#include <yawg/core.h>
#include <yawg/utils.hpp>
#include <yawg/fft.h>
#include <catch2/catch_test_macros.hpp>
#include <catch2/matchers/catch_matchers_floating_point.hpp>
```

Macros

- #define CATCH_CONFIG_MAIN

Functions

- TEST_CASE ("gsl::fft", "[gsl::fft]")
- TEST_CASE ("gsl::fft with non-power-of-2 input size", "[gsl::fft]")
- TEST_CASE ("gsl::fft on 3x4 matrix", "[gsl::fft]")
- TEST_CASE ("gsl::ifft on 3x4 matrix", "[gsl::ifft]")

8.13.1 Macro Definition Documentation

8.13.1.1 CATCH_CONFIG_MAIN

```
#define CATCH_CONFIG_MAIN
```

8.13.2 Function Documentation

8.13.2.1 TEST_CASE() [1/4]

```
TEST_CASE (
            "gsl::fft on 3x4 matrix" ,
            "" [gsl::fft] )
```

8.13.2.2 TEST_CASE() [2/4]

```
TEST_CASE (
            "gsl::fft with non-power-of-2 input size" ,
            "" [gsl::fft] )
```

8.13.2.3 TEST_CASE() [3/4]

```
TEST_CASE (
            "gsl::fft" ,
            "" [gsl::fft] )
```

8.13.2.4 TEST_CASE() [4/4]

```
TEST_CASE (
            "gsl::ifft on 3x4 matrix" ,
            "" [gsl::ifft] )
```

8.14 /home/jspainhour/spheroidal_cpp/tests/yawg/test_utils.cpp File Reference

```
#include <yawg/core.h>
#include <yawg/utils.hpp>
#include <catch2/catch_test_macros.hpp>
#include <catch2/matchers/catch_matchers_floating_point.hpp>
#include <gsl/gsl_math.h>
#include <cmath>
```

Macros

- #define CATCH_CONFIG_MAIN

Functions

- TEST_CASE ("linspace", "[linspace]")
- TEST_CASE ("arange", "[arange]")
- TEST_CASE ("leggauss", "[leggauss]")
- TEST_CASE ("leggauss return", "[leggauss]")
- TEST_CASE ("meshgrid", "[meshgrid]")
- TEST_CASE ("eye", "[eye]")
- TEST_CASE ("arrayfun vector", "[arrayfun]")
- TEST_CASE ("arrayfun matrix", "[arrayfun]")

8.14.1 Macro Definition Documentation

8.14.1.1 CATCH_CONFIG_MAIN

```
#define CATCH_CONFIG_MAIN
```

8.14.2 Function Documentation

8.14.2.1 TEST_CASE() [1/8]

```
TEST_CASE (
            "arange" ,
            "" [arange] )
```

8.14.2.2 TEST_CASE() [2/8]

```
TEST_CASE (
            "arrayfun matrix" ,
            "" [arrayfun] )
```

8.14.2.3 TEST_CASE() [3/8]

```
TEST_CASE (
            "arrayfun vector" ,
            "" [arrayfun] )
```

8.14.2.4 TEST_CASE() [4/8]

```
TEST_CASE (
            "eye" ,
            "" [eye] )
```

8.14.2.5 TEST_CASE() [5/8]

```
TEST_CASE (
            "leggauss return" ,
            "" [leggauss] )
```

8.14.2.6 TEST_CASE() [6/8]

```
TEST_CASE (
            "leggauss" ,
            "" [leggauss] )
```

8.14.2.7 TEST_CASE() [7/8]

```
TEST_CASE (
            "linspace" ,
            "" [linspace] )
```

8.14.2.8 TEST_CASE() [8/8]

```
TEST_CASE (
            "meshgrid" ,
            "" [meshgrid] )
```

8.15 /home/jspainhour/spheroidal_cpp/tests/yawg/test_wrapper.cpp File Reference

```
#include <yawg/core.h>
#include <catch2/catch_test_macros.hpp>
```

Macros

- #define CATCH_CONFIG_MAIN

Functions

- TEST_CASE ("gsl::vector constructors", "[gsl::vector]")
- TEST_CASE ("gsl::complex constructors", "[gsl::complex]")
- TEST_CASE ("gsl::cvector constructors", "[gsl::cvector]")
- TEST_CASE ("gsl::vector -> gsl::cvector conversion", "[gsl::vector][gsl::cvector]")
- TEST_CASE ("gsl::matrix -> gsl::cmatrix conversion", "[gsl::matrix][gsl::cmatrix]")
- TEST_CASE ("gsl::vector assignment operators", "[gsl::vector]")
- TEST_CASE ("gsl::cvector assignment operators", "[gsl::cvector]")
- TEST_CASE ("gsl::vector resize", "[gsl::vector]")
- TEST_CASE ("gsl::cvector resize", "[gsl::cvector]")
- TEST_CASE ("gsl::vector element access", "[gsl::vector]")
- TEST_CASE ("gsl::cvector element access", "[gsl::cvector]")
- TEST_CASE ("gsl::vector print", "[gsl::vector][gsl::cector][gsl::matrix][gsl::cmatrix]")
- TEST_CASE ("gsl::matrix constructors", "[gsl::matrix]")
- TEST_CASE ("gsl::cmatrix constructors", "[gsl::cmatrix]")
- TEST_CASE ("gsl::matrix assignment", "[gsl::matrix]")
- TEST_CASE ("gsl::cmatrix assignment operators", "[gsl::cmatrix]")
- TEST_CASE ("gsl::matrix element access", "[gsl::matrix]")
- TEST_CASE ("gsl::cmatrix element access", "[gsl::cmatrix]")
- TEST_CASE ("gsl::matrix resize", "[gsl::matrix]")
- TEST_CASE ("gsl::cmatrix resize", "[gsl::cmatrix]")

8.15.1 Macro Definition Documentation

8.15.1.1 CATCH_CONFIG_MAIN

```
#define CATCH_CONFIG_MAIN
```

8.15.2 Function Documentation

8.15.2.1 TEST_CASE() [1/20]

```
TEST_CASE (
            "gsl::cmatrix assignment operators" ,
            "" [gsl::cmatrix] )
```

8.15.2.2 TEST_CASE() [2/20]

```
TEST_CASE (
            "gsl::cmatrix constructors" ,
            "" [gsl::cmatrix] )
```

8.15.2.3 TEST_CASE() [3/20]

```
TEST_CASE (
            "gsl::cmatrix element access" ,
            "" [gsl::cmatrix] )
```

8.15.2.4 TEST_CASE() [4/20]

```
TEST_CASE (
            "gsl::cmatrix resize" ,
            "" [gsl::cmatrix] )
```

8.15.2.5 TEST_CASE() [5/20]

```
TEST_CASE (
            "gsl::complex constructors" ,
            "" [gsl::complex] )
```

8.15.2.6 TEST_CASE() [6/20]

```
TEST_CASE (
            "gsl::cvector assignment operators" ,
            "" [gsl::cvector] )
```

8.15.2.7 TEST_CASE() [7/20]

```
TEST_CASE (
            "gsl::cvector constructors" ,
            "" [gsl::cvector] )
```

8.15.2.8 TEST_CASE() [8/20]

```
TEST_CASE (
            "gsl::cvector element access" ,
            "" [gsl::cvector] )
```

8.15.2.9 TEST_CASE() [9/20]

```
TEST_CASE (
            "gsl::cvector resize" ,
            "" [gsl::cvector] )
```

8.15.2.10 TEST_CASE() [10/20]

```
TEST_CASE (
            "gsl::matrix -> gsl::cmatrix conversion" ,
            "" [gsl::matrix][gsl::cmatrix] )
```

8.15.2.11 TEST_CASE() [11/20]

```
TEST_CASE (
            "gsl::matrix assignment" ,
            "" [gsl::matrix] )
```

8.15.2.12 TEST_CASE() [12/20]

```
TEST_CASE (
            "gsl::matrix constructors" ,
            "" [gsl::matrix] )
```

8.15.2.13 TEST_CASE() [13/20]

```
TEST_CASE (
            "gsl::matrix element access" ,
            "" [gsl::matrix] )
```

8.15.2.14 TEST_CASE() [14/20]

```
TEST_CASE (
            "gsl::matrix resize" ,
            "" [gsl::matrix] )
```

8.15.2.15 TEST_CASE() [15/20]

```
TEST_CASE (
            "gsl::vector -> gsl::cvector conversion" ,
            "" [gsl::vector][gsl::cvector] )
```

8.15.2.16 TEST_CASE() [16/20]

```
TEST_CASE (
            "gsl::vector assignment operators" ,
            "" [gsl::vector] )
```

8.15.2.17 TEST_CASE() [17/20]

```
TEST_CASE (
            "gsl::vector constructors" ,
            "" [gsl::vector] )
```

8.15.2.18 TEST_CASE() [18/20]

```
TEST_CASE (
            "gsl::vector element access" ,
            "" [gsl::vector] )
```

8.15.2.19 TEST_CASE() [19/20]

```
TEST_CASE (
            "gsl::vector print" ,
            "" [gsl::vector][gsl::cector][gsl::matrix][gsl::cmatrix] )
```

8.15.2.20 TEST_CASE() [20/20]

```
TEST_CASE (
            "gsl::vector resize" ,
            "" [gsl::vector] )
```

8.16 /home/jspainhour/spheroidal_cpp/tests/yawg/test_wrapper_↩ math.cpp File Reference

```
#include <yawg/core.h>
#include <yawg/utils.hpp>
#include <catch2/catch_test_macros.hpp>
#include <catch2/matchers/catch_matchers_floating_point.hpp>
#include <cmath>
```

Macros

- #define CATCH_CONFIG_MAIN

Functions

- TEST_CASE ("gsl::complex methods", "[gsl::complex]")
- TEST_CASE ("gsl::complex assignment operators", "[gsl::complex]")
- TEST_CASE ("gsl::complex operators", "[gsl::complex]")
- TEST_CASE ("gsl::vector addition", "[gsl::vector]")

  Use Catch2 to test addition of gsl::vectors.
- TEST_CASE ("gsl::vector and gsl::cvector addition", "[gsl::vector][gsl::cvector]")

  Use Catch2 to test addition of gsl::vectors and gsl::cvectors.
- TEST_CASE ("gsl::vector and gsl::cvector scalar multiplication", "[gsl::vector][gsl::cvector]")

  Use Catch2 to test scalar multiplication of gsl::vectors and gsl::cvectors.

8.16.1 Macro Definition Documentation

8.16.1.1 CATCH_CONFIG_MAIN

```
#define CATCH_CONFIG_MAIN
```

8.16.2 Function Documentation

8.16.2.1 TEST_CASE() [1/6]

```
TEST_CASE (
            "gsl::complex assignment operators" ,
            "" [gsl::complex] )
```

8.16.2.2 TEST_CASE() [2/6]

```
TEST_CASE (
            "gsl::complex methods" ,
            "" [gsl::complex] )
```

8.16.2.3 TEST_CASE() [3/6]

```
TEST_CASE (
            "gsl::complex operators" ,
            "" [gsl::complex] )
```

8.16.2.4 TEST_CASE() [4/6]

```
TEST_CASE (
            "gsl::vector addition" ,
            "" [gsl::vector] )
```

Use Catch2 to test addition of gsl::vectors.

8.16.2.5 TEST_CASE() [5/6]

```
TEST_CASE (
            "gsl::vector and gsl::cvector addition" ,
            "" [gsl::vector][gsl::cvector] )
```

Use Catch2 to test addition of gsl::vectors and gsl::cvectors.

8.16.2.6 TEST_CASE() [6/6]

```
TEST_CASE (
            "gsl::vector and gsl::cvector scalar multiplication" ,
            "" [gsl::vector][gsl::cvector] )
```

Use Catch2 to test scalar multiplication of gsl::vectors and gsl::cvectors.

8.17 /home/jspainhour/spheroidal_cpp/tests/yawg/test_wrapper_↩ view.cpp File Reference

```
#include <yawg/core.h>
#include <catch2/catch_test_macros.hpp>
```

Macros

- #define CATCH_CONFIG_MAIN

Functions

- TEST_CASE ("gsl::vector view methods", "[gsl::vector_view]")
- TEST_CASE ("gsl::cvector view methods", "[gsl::cvector_view]")
- TEST_CASE ("gsl::matrix view methods", "[gsl::matrix_view]")
- TEST_CASE ("gsl::cmatrix view methods", "[gsl::cmatrix_view]")
- TEST_CASE ("gsl::matrix column and row view methods", "[gsl::matrix][gsl::row_view][gsl::column_view]")
- TEST_CASE ("gsl::cmatrix column and row view methods", "[gsl::cmatrix][gsl::crow_view][gsl::ccolumn_view]")
- TEST_CASE ("gsl::vector view edge cases", "[gsl::vector][gsl::vector_view]")
- TEST_CASE ("gsl::cvector view edge cases", "[gsl::cvector][gsl::cvector_view]")
- TEST_CASE ("gsl::matrix view edge cases", "[gsl::matrix][gsl::matrix_view]")
- TEST_CASE ("gsl::cmatrix view edge cases", "[gsl::cmatrix][gsl::cmatrix_view]")

8.17.1 Macro Definition Documentation

8.17.1.1 CATCH_CONFIG_MAIN

```
#define CATCH_CONFIG_MAIN
```

8.17.2 Function Documentation

8.17.2.1 TEST_CASE() [1/10]

```
TEST_CASE (
            "gsl::cmatrix column and row view methods" ,
            "" [gsl::cmatrix][gsl::crow_view][gsl::ccolumn_view] )
```

8.17.2.2 TEST_CASE() [2/10]

```
TEST_CASE (
            "gsl::cmatrix view edge cases" ,
            "" [gsl::cmatrix][gsl::cmatrix_view] )
```

8.17.2.3 TEST_CASE() [3/10]

```
TEST_CASE (
            "gsl::cmatrix view methods" ,
            "" [gsl::cmatrix_view] )
```

8.17.2.4 TEST_CASE() [4/10]

```
TEST_CASE (
            "gsl::cvector view edge cases" ,
            "" [gsl::cvector][gsl::cvector_view] )
```

8.17.2.5 TEST_CASE() [5/10]

```
TEST_CASE (
            "gsl::cvector view methods" ,
            "" [gsl::cvector_view] )
```

8.17.2.6 TEST_CASE() [6/10]

```
TEST_CASE (
            "gsl::matrix column and row view methods" ,
            "" [gsl::matrix][gsl::row_view][gsl::column_view] )
```

8.17.2.7 TEST_CASE() [7/10]

```
TEST_CASE (
            "gsl::matrix view edge cases" ,
            "" [gsl::matrix][gsl::matrix_view] )
```

8.17.2.8 TEST_CASE() [8/10]

```
TEST_CASE (
            "gsl::matrix view methods" ,
            "" [gsl::matrix_view] )
```

8.17.2.9 TEST_CASE() [9/10]

```
TEST_CASE (
            "gsl::vector view edge cases" ,
            "" [gsl::vector][gsl::vector_view] )
```

8.17.2.10 TEST_CASE() [10/10]

```
TEST_CASE (
            "gsl::vector view methods" ,
            "" [gsl::vector_view] )
```