SpinDec

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Contents

Chapter 1

Class Index

1.1 Class Hierarchy

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

Chapter 2

Class Index

2.1 Class List

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

Chapter 3

Class Documentation

3.1 SpinDec::AdiabaticLabel Class Reference

Adiabatic eigenstates of a spin donor.

`#include <AdiabaticLabel.h>`

Public Member Functions

- **AdiabaticLabel** (const Sign &sign, const int quantum_number)
- const Sign & **get_sign** () const
- int **get_quantum_number** () const

Private Attributes

- Sign sign_

  Plus or minus.

- int quantum_number_

  $m = S + I$

Friends

- std::ostream & **operator**<< (std::ostream &os, AdiabaticLabel const &label)

3.1.1 Detailed Description

Adiabatic eigenstates of a spin donor. For a spin donor, the adiabatic energy eigenstates are labeled as follows:

$|\pm, m\rangle$, where $m = S + I$ is an integer, S and I are the electron and nuclear spin quantum numbers.

3.2 SpinDec::BoostEigen Class Reference

Static methods to extend Eigen functionality.

`#include <BoostEigen.h>`

Static Public Member Functions

- static double cosAngleBetween (const ThreeVector &a, const ThreeVector &b)
  Cosine of angle between real vectors.
- static double maxAbsCoeff (const ThreeVector &a)
  Maximum absolute coefficient.
- static ComplexVector exp (const ComplexVector &a)
  Element-wise exponentiation for complex vectors.
- static ComplexMatrix tensorProduct (const ComplexMatrix &A, const ComplexMatrix &B)
  Tensor product for complex matrices.
- static ComplexVector tensorProduct (const ComplexVector &a, const ComplexVector &b)
  Tensor product for complex vectors.
- static ComplexMatrix partialTrace (const ComplexMatrix &AB, const unsigned int dimension_B)
  Partial trace for complex matrices.
- static ComplexMatrix spectralDecomposition (const ComplexMatrix &eigenvectors, const ComplexVector &eigenvalues)
  Spectral decomposition of a complex matrix.
- static ComplexMatrix unitarySpectralDecomposition (const ComplexMatrix &eigenvectors, const ComplexVector &eigenvalues)
  Spectral decomposition of a unitary matrix.
- static bool isWithinDistance (const ThreeVector &r, const double distance)
  Is $|\mathbf{r}| \leq d$*?*

3.2.1 Detailed Description

Static methods to extend Eigen functionality. Note that the naming convention complies with that of Eigen, and is different from the rest of SpinDec. Eigen is for linear algebra and can be obtained for free: http://eigen.tuxfamily.org/ .

3.2.2 Member Function Documentation

3.2.2.1 double SpinDec::BoostEigen::cosAngleBetween (const ThreeVector & *a*, const ThreeVector & *b*) [static]

Cosine of angle between real vectors. $\cos\theta = \frac{\mathbf{a}\cdot\mathbf{b}}{|\mathbf{a}||\mathbf{b}|}$.

3.2.2.2 double SpinDec::BoostEigen::maxAbsCoeff (const ThreeVector & *a*) [static]

Maximum absolute coefficient. Maximum of $[|a_1|, |a_2|, |a_3|]$ for real vector $\mathbf{a} = (a_1, a_2, a_3)$.

3.2.2.3 ComplexMatrix SpinDec::BoostEigen::partialTrace (const ComplexMatrix & *AB*, const unsigned int *dimension_B*) [static]

Partial trace for complex matrices. Given $\mathbf{C} = \mathbf{A} \otimes \mathbf{B}$, and the dimension of $\mathbf{B}$, this method outputs $\mathrm{Tr}_{\mathbf{B}} \mathbf{A}$.

3.2.2.4 ComplexMatrix SpinDec::BoostEigen::spectralDecomposition (const ComplexMatrix & *eigenvectors*, const ComplexVector & *eigenvalues*) [static]

Spectral decomposition of a complex matrix. This is $\mathbf{A} = \mathbf{V}\mathbf{D}\mathbf{V}^{-1}$, where $\mathbf{D}$ is the diagonal of eigenvalues of $\mathbf{A}$ and $\mathbf{V}$ is the columnwise eigenvector matrix.

3.2.2.5 ComplexVector SpinDec::BoostEigen::tensorProduct (const ComplexVector & *a*, const ComplexVector & *b*) [static]

Tensor product for complex vectors. Evaluates $\mathbf{c} = \mathbf{a} \otimes \mathbf{b}$. For example, for 2-vectors, this is

$$\mathbf{c} = \begin{pmatrix} a_1 b_1 \\ a_1 b_2 \\ a_2 b_1 \\ a_2 b_2 \end{pmatrix}$$

3.2.2.6 ComplexMatrix SpinDec::BoostEigen::tensorProduct (const ComplexMatrix & *A*, const ComplexMatrix & *B*) [static]

Tensor product for complex matrices. Evaluates $\mathbf{C} = \mathbf{A} \otimes \mathbf{B}$. For example, for 2×2 matrices, this is

$$\mathbf{C} = \begin{pmatrix} A_{11}\mathbf{B} & A_{12}\mathbf{B} \\ A_{21}\mathbf{B} & A_{22}\mathbf{B} \end{pmatrix}$$

3.2.2.7 ComplexMatrix SpinDec::BoostEigen::unitarySpectralDecomposition (const ComplexMatrix & *eigenvectors*, const ComplexVector & *eigenvalues*) [static]

Spectral decomposition of a unitary matrix. For a unitary matrix, $\mathbf{A}^{-1} = \mathbf{V}^{\dagger}$

3.3 SpinDec::CCE Class Reference

Public Member Functions

- **CCE** (const UInt max_truncation_order, const auto_ptr< PulseExperiment > &pulse_experiment, const ClusterDatabase &cluster_database, const bool include_one_clusters)
- UInt **get_max_truncation_order** () const
- void **calculate** (const UInt order)
- void **calculate** (const UInt order, const bool no_divisions)
- void **calculate** ()
- TimeEvolution **evolution** (const UInt order) const
- const ClusterDatabase & **get_database** () const

Private Member Functions

- void **check_order** (const UInt order) const
- TimeEvolution **reducible_correlation** (const Cluster &cluster)
- TimeEvolution **true_correlation** (const Cluster &cluster)

Private Attributes

- vector< TimeEvolution > **product_correlations_by_order_**
- UInt **max_truncation_order_**
- bool **include_one_clusters_**
- auto_ptr< PulseExperiment > **pulse_experiment_**
- ClusterDatabase **cluster_database_**

3.4 SpinDec::Cluster Class Reference

Public Member Functions

- **Cluster** (const UIntArray &labels)
- void **add** (const UInt label)
- bool **operator==** (const Cluster &rhs) const
- UInt **num_spins** () const
- UInt **get_label** (const UInt index) const
- const UIntArray & **get_labels** () const
- vector< Cluster > **subsets** () const
- vector< Cluster > **proper_subsets** () const

Private Member Functions

- vector< UIntArray > **subsets** (const UIntArray &v, const UInt size) const
- vector< UIntArray > **subsets** (const UIntArray &v) const

Private Attributes

- UIntArray **labels_**

Friends

- std::ostream & **operator**<< (std::ostream &os, Cluster const &cluster)

3.5 SpinDec::ClusterDatabase Class Reference

Public Member Functions

- **ClusterDatabase** (const SpinBath &spin_bath, const UInt max_order, const double cluster_cutoff, const string &build_method)
- const ClusterDatabaseEntry & **get_entry** (const UInt order, const UInt index) const
- const Cluster & **get_cluster** (const UInt order, const UInt index) const
- void **set_time_evolution** (const Cluster &cluster, const TimeEvolution &time_evolution)
- bool **is_solved** (const Cluster &cluster) const
- UInt **get_max_order** () const
- UInt **num_clusters** (const UInt order) const
- const TimeEvolution & **get_time_evolution** (const Cluster &cluster) const
- void **print** () const

Private Member Functions

- void **build_pairs** ()
- void **build_ones** ()
- void **build_with_local_cutoff** ()
- void **build_with_global_cutoff** ()
- UInt **get_index** (const Cluster &cluster) const
- void **add_unsolved_entry** (const Cluster &cluster)
- bool **is_order_built** (const UInt order) const
- bool **cluster_exists** (const Cluster &cluster) const

Private Attributes

- UInt **max_order_**
- SpinBath **spin_bath_**
- database_map **database_**
- double **cluster_cutoff_**

3.6 SpinDec::ClusterDatabaseEntry Class Reference

Public Member Functions

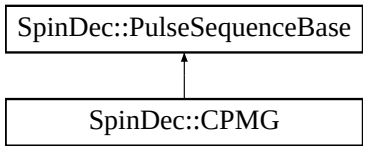
- **ClusterDatabaseEntry** (const Cluster &cluster)
- const Cluster & **get_cluster** () const
- bool **is_solved** () const
- const TimeEvolution & **get_time_evolution** () const
- void **set_time_evolution** (const TimeEvolution &time_evolution)

Private Attributes

- Cluster **cluster_**
- TimeEvolution **time_evolution_**
- bool **is_solved_**

3.7 SpinDec::CPMG Class Reference

Inheritance diagram for SpinDec::CPMG::



Public Member Functions

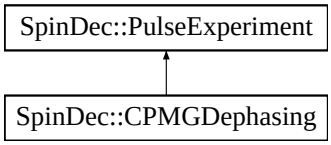
- **CPMG** (const UInt order, const EvolutionOperator &evolution_operator, const Pulse &pi_pulse)
- void **set_time** (const double time_value)
- virtual auto_ptr< PulseSequenceBase > **clone** () const

Private Attributes

- UInt **order_**
- EvolutionOperator **evolution_operator_**
- vector< bool > **is_unitary_**

3.8 SpinDec::CPMGDephasing Class Reference

Inheritance diagram for SpinDec::CPMGDephasing::



Public Member Functions

- **CPMGDephasing** (const CSDProblem &csd_problem, const TimeArray &time_array, const UInt cpmg_order, const CDouble &c0, const UInt level_label0, const CDouble &c1, const UInt level_label1)
- virtual TimeEvolution **time_evolution** (const UIntArray bath_indices)
- virtual auto_ptr< PulseExperiment > **clone** () const

Private Attributes

- UInt **cpmg_order_**
- TwoStateSuperposition **initial_system_state_**
- PiPulse **system_pi_pulse_**
- vector< pair< UInt, Pulse > > **pulses_**

3.9 SpinDec::CrystalBasis Class Reference

Public Member Functions

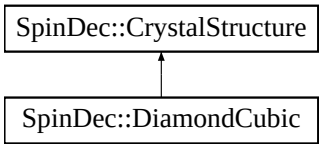
- void **add_basis_vector** (const ThreeVector &basis_vector)
- const std::vector< ThreeVector > & **get_basis_vectors** () const
- const ThreeVector & **get_basis_vector** (const UInt index) const
- UInt **num_basis_vectors** () const

Protected Attributes

- std::vector< ThreeVector > **basis_vectors_**

3.10 SpinDec::CrystalStructure Class Reference

Inheritance diagram for SpinDec::CrystalStructure::



Public Member Functions

- **CrystalStructure** (const LatticeVectors &lattice_vectors, const CrystalBasis &basis, const int min_i, const int max_i, const int min_j, const int max_j, const int min_k, const int max_k, const double min_x, const double max_x, const double min_y, const double max_y, const double min_z, const double max_z, const double fractional_abundance)
- **CrystalStructure** (const string &file_name)
- **CrystalStructure** (const vector< ThreeVector > &site_vectors)
- const std::vector< ThreeVector > & **get_site_vectors** () const
- const ThreeVector & **get_site_vector** (const UInt index) const
- UInt **num_site_vectors** () const
- double **max_site_vector_length** () const
- double **max_abs_component** () const
- double **average_site_vector_separation** () const
- void **write_site_vectors** (const string &file_name) const

Protected Member Functions

- void **fill_site_vectors** (const LatticeVectors &lattice_vectors, const CrystalBasis &basis, const int min_i, const int max_i, const int min_j, const int max_j, const int min_k, const int max_k, const double min_x, const double max_x, const double min_y, const double max_y, const double min_z, const double max_z, const double fractional_abundance)
- void **add_site_vector** (const ThreeVector &site_vector)
- void **scale_site_vectors** (const double scale_factor)
- std::vector< ThreeVector > **cartesian_basis_vectors** (const LatticeVectors &lattice_vectors, const CrystalBasis &basis) const

Protected Attributes

- std::vector< ThreeVector > **site_vectors_**

Private Member Functions

- void **read_site_vectors** (const string &file_name)

Friends

- std::ostream & **operator**<< (std::ostream &os, CrystalStructure const &crystal_structure)

3.11 SpinDec::CSDProblem Class Reference

Public Member Functions

- **CSDProblem** (const CSDProblem &csd_problem)
- CSDProblem & **operator=** (const CSDProblem &csd_problem)
- **CSDProblem** (const auto_ptr< SpinSystemBase > &central_spin_system_base, const SpinBath &spin_bath, const vector< SpinInteractionEdge > &system_bath_edges, const UniformMagneticField &field)
- **CSDProblem** (const auto_ptr< SpinSystemBase > &central_spin_system_base, const SpinBath &spin_bath, const SpinInteractionEdge &system_bath_edge, const UniformMagneticField &field)

- void **set_central_spin_state** (const SpinState &spin_state) const
- SpinSystem **get_reduced_problem** (const UIntArray bath_indices)
- const SpinBath & **get_spin_bath** () const
- auto_ptr< SpinSystemBase > **get_central_spin_system** () const

Private Member Functions

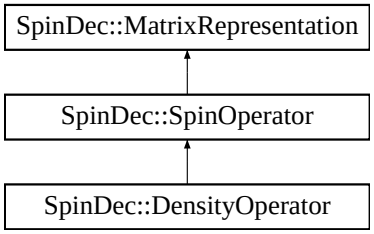
- void **init** (const auto_ptr< SpinSystemBase > &central_spin_system_base, const SpinBath &spin_bath, const vector< SpinInteractionEdge > &system_bath_edges, const UniformMagneticField &field)
- vector< SpinInteractionEdge > **make_system_bath_edges** (const UInt order, const SpinInteractionEdge &edge) const
- vector< SpinInteractionEdge > **make_system_bath_edges** (const UInt order) const
- SpinSystem **construct_reduced_problem** (const UInt order) const
- UIntArray **get_bath_vertex_labels** (const UInt order) const

Private Attributes

- auto_ptr< SpinSystemBase > **central_spin_system_**
- SpinBath **spin_bath_**
- UniformMagneticField **field_**
- vector< SpinInteractionEdge > **system_bath_edges_**
- vector< pair< UInt, SpinSystem > > **reduced_problems_**

3.12 SpinDec::DensityOperator Class Reference

Inheritance diagram for SpinDec::DensityOperator::



Public Member Functions

- **DensityOperator** (const SpinState &state, const SpinState &state0, const SpinState &state1)
- DensityOperator **reduced** () const
- CDouble **off_diagonal_reduced** () const

Private Member Functions

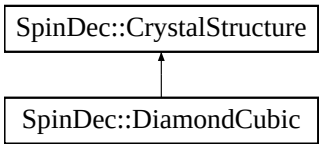
- **DensityOperator** (const ComplexMatrix &matrix, const SpinBasis &basis, const SpinState &state0, const SpinState &state1)

Private Attributes

- SpinState **state0_**
- SpinState **state1_**

3.13 SpinDec::DiamondCubic Class Reference

Inheritance diagram for SpinDec::DiamondCubic::



Public Member Functions

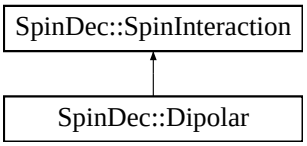
- **DiamondCubic** (const double lattice_constant, const double side_length)
- **DiamondCubic** (const double lattice_constant, const double side_length, const double fractional_-abundance)
- void **make_sphere** (const double radius)
- void **make_shell** (const double min_radius, const double max_radius)

Private Member Functions

- SimpleCubicLatticeVectors **construct_lattice_vectors** (const double lattice_constant) const
- CrystalBasis **construct_basis_vectors** () const
- int **int_range_centred_cube** (const double side_length, const double lattice_constant) const

3.14 SpinDec::Dipolar Class Reference

Inheritance diagram for SpinDec::Dipolar::

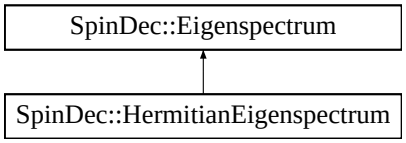


Public Member Functions

- **Dipolar** (const double strength)
- virtual void **calculate** (const SpinParameters &spin_parameters1, const SpinParameters &spin_parameters2, const ThreeVector &position1, const ThreeVector &position2, const UniformMagneticField &field)
- virtual void **fill** (ComplexMatrix *hamiltonian, const SpinParametersVector &spin_parameters_vector, const SpinBasis &basis, const UInt spin_label1, const UInt spin_label2) const
- virtual auto_ptr< SpinInteraction > **clone** () const
- virtual string **get_type** () const

3.15 SpinDec::Eigenspectrum Class Reference

Inheritance diagram for SpinDec::Eigenspectrum::



Public Member Functions

- **Eigenspectrum** (const ComplexMatrix &matrix)
- const ComplexVector & **get_eigenvalues** () const
- const ComplexMatrix & **get_eigenvectors** () const
- CDouble **get_eigenvalue** (const UInt index) const
- ComplexVector **get_eigenvector** (const UInt index) const
- virtual ComplexMatrix **spectralDecomposition** () const
- void **set_spectrum** (const ComplexMatrix &eigenvectors, const ComplexVector &eigenvalues)

Protected Member Functions

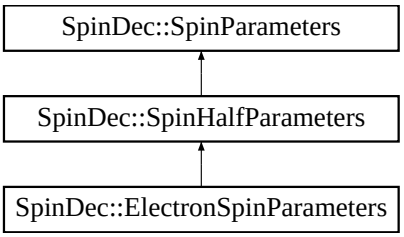
- virtual void **diagonalize** (const ComplexMatrix &matrix)

Protected Attributes

- ComplexMatrix **eigenvectors_**
- ComplexVector **eigenvalues_**

3.16 SpinDec::ElectronSpinParameters Class Reference

Inheritance diagram for SpinDec::ElectronSpinParameters::



Public Member Functions

- **ElectronSpinParameters** (const double gyromagnetic_ratio)

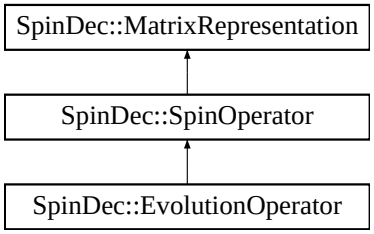
3.17 SpinDec::Errors Class Reference

Static Public Member Functions

- static void **quit** ()
- static void **quit** (const string &message)
- static void **warning** (const string &message)

3.18 SpinDec::EvolutionOperator Class Reference

Inheritance diagram for SpinDec::EvolutionOperator::



Public Member Functions

- **EvolutionOperator** (const SpinBasis &basis, const ComplexMatrix &eigenvectors, const RealVector &eigenvalues, const double time)
- void **set_time** (const double time)
- double **get_time** () const

Private Member Functions

- void **set_matrix** ()

Private Attributes

- double **time_**
- ComplexMatrix **eigenvectors_**
- RealVector **eigenvalues_**

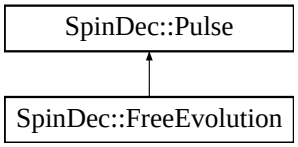
3.19 SpinDec::FileProperties Class Reference

Static Public Member Functions

- static bool **exists** (const string file_name)
- static UInt **num_lines** (const string file_name)

3.20 SpinDec::FreeEvolution Class Reference

Inheritance diagram for SpinDec::FreeEvolution::

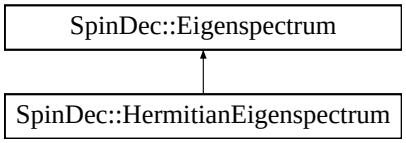


Public Member Functions

- **FreeEvolution** (const EvolutionOperator &evolution_operator)

3.21 SpinDec::HermitianEigenspectrum Class Reference

Inheritance diagram for SpinDec::HermitianEigenspectrum::



Public Member Functions

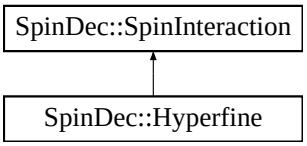
- **HermitianEigenspectrum** (const ComplexMatrix &matrix)
- virtual ComplexMatrix **spectralDecomposition** () const

Private Member Functions

- void **diagonalize_eigen** (const ComplexMatrix &matrix)
- virtual void **diagonalize** (const ComplexMatrix &matrix)

3.22 SpinDec::Hyperfine Class Reference

Inheritance diagram for SpinDec::Hyperfine::



Public Member Functions

- **Hyperfine** (const HyperfineParameters &parameters)
- **Hyperfine** (const double strength)
- virtual void **calculate** (const SpinParameters &electron_parameters, const SpinParameters &nuclear_parameters, const ThreeVector &electron_position, const ThreeVector &nuclear_position, const UniformMagneticField &field)
- virtual void **fill** (ComplexMatrix *hamiltonian, const SpinParametersVector &spin_parameters_vector, const SpinBasis &basis, const UInt spin_label1, const UInt spin_label2) const
- virtual auto_ptr< SpinInteraction > **clone** () const
- virtual string **get_type** () const

Private Member Functions

- double **envelope_function** (const UInt index, const ThreeVector &separation) const
- double **n_parameter** () const
- double **n_times_a** () const
- double **n_times_b** () const
- double **scaled_probability_density** (const ThreeVector &separation) const

Private Attributes

- HyperfineParameters **parameters_**

3.23 SpinDec::HyperfineParameters Class Reference

Public Member Functions

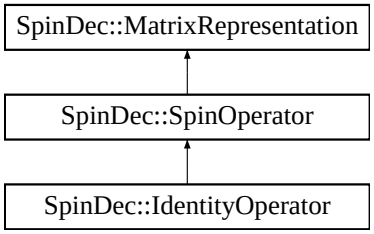
- **HyperfineParameters** (const double lattice_constant, const double lattice_parameter_a, const double lattice_parameter_b, const double electron_ionization_energy, const double charge_density, const bool ising_only, bool fermi_contact_only_)
- double **get_lattice_constant** () const
- double **get_lattice_parameter_a** () const
- double **get_lattice_parameter_b** () const
- double **get_electron_ionization_energy** () const
- double **get_charge_density** () const
- bool **is_ising_only** () const
- bool **is_fermi_contact_only** () const

Private Attributes

- double **lattice_constant_**
- double **lattice_parameter_a_**
- double **lattice_parameter_b_**
- double **electron_ionization_energy_**
- double **charge_density_**
- bool **ising_only_**
- bool **fermi_contact_only_**

3.24 SpinDec::IdentityOperator Class Reference

Inheritance diagram for SpinDec::IdentityOperator::

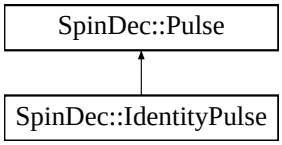


Public Member Functions

- **IdentityOperator** (const SpinBasis &basis)

3.25 SpinDec::IdentityPulse Class Reference

Inheritance diagram for SpinDec::IdentityPulse::

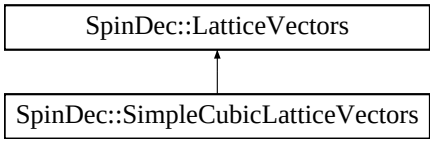


Public Member Functions

- **IdentityPulse** (const SpinBasis &basis)

3.26 SpinDec::LatticeVectors Class Reference

Inheritance diagram for SpinDec::LatticeVectors::



Public Member Functions

- **LatticeVectors** (const ThreeVector &a1, const ThreeVector &a2, const ThreeVector &a3)
- const ThreeVector & **get_a1** () const
- const ThreeVector & **get_a2** () const
- const ThreeVector & **get_a3** () const

Protected Member Functions

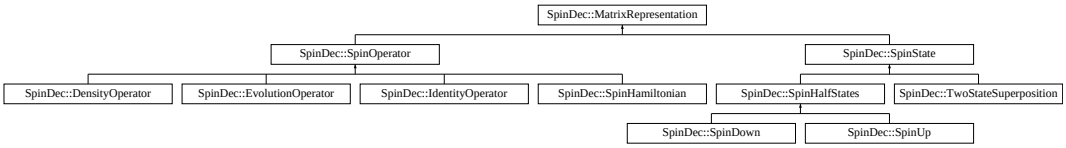
- bool **linearly_independent** () const
- void **set_lattice_vectors** (const ThreeVector &a1, const ThreeVector &a2, const ThreeVector &a3)

Protected Attributes

- ThreeVector **a1_**
- ThreeVector **a2_**
- ThreeVector **a3_**

3.27 SpinDec::MatrixRepresentation Class Reference

Inheritance diagram for SpinDec::MatrixRepresentation::



Public Member Functions

- UInt **get_dimension** () const
- const SpinBasis & **get_basis** () const
- bool **is_basis_equal** (const auto_ptr< MatrixRepresentation > &to_check) const
- virtual void **set_zero** ()=0
- virtual auto_ptr< MatrixRepresentation > **clone** () const =0

Protected Member Functions

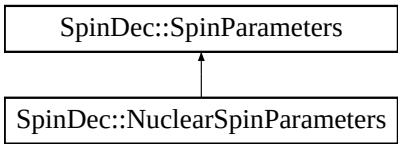
- **MatrixRepresentation** (const SpinBasis &basis)
- virtual void **quit_if_dimension_mismatch** () const =0
- void **quit_if_basis_mismatch** (const auto_ptr< MatrixRepresentation > &to_check) const

Protected Attributes

- UInt **dimension_**
- SpinBasis **basis_**

3.28 SpinDec::NuclearSpinParameters Class Reference

Inheritance diagram for SpinDec::NuclearSpinParameters::

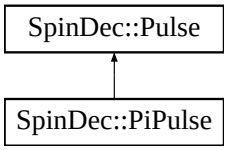


Public Member Functions

- **NuclearSpinParameters** (const double quantum_number, const double gyromagnetic_ratio)

3.29 SpinDec::PiPulse Class Reference

Inheritance diagram for SpinDec::PiPulse::

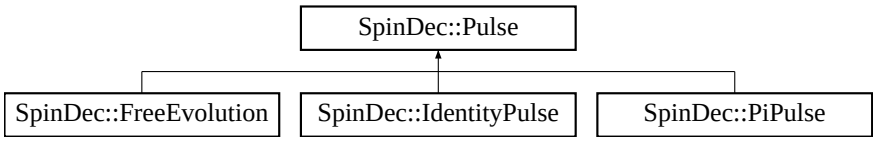


Public Member Functions

- **PiPulse** (const SpinState &state0, const SpinState &state1)
- **PiPulse** (const SpinState &state0, const SpinState &state1, const vector< SpinState > &states2_-plus)

3.30 SpinDec::Pulse Class Reference

Inheritance diagram for SpinDec::Pulse::



Public Member Functions

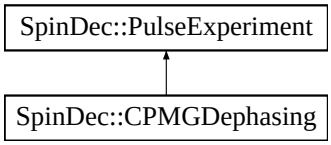
- **Pulse** (const double duration, const SpinOperator &pulse_operator)
- const SpinOperator & **get_pulse_operator** () const
- double **get_duration** () const
- Pulse **operator*** (const Pulse &pulse) const
- Pulse **operator^** (const Pulse &pulse) const

Protected Attributes

- double **duration_**
- SpinOperator **pulse_operator_**

3.31 SpinDec::PulseExperiment Class Reference

Inheritance diagram for SpinDec::PulseExperiment::



Public Member Functions

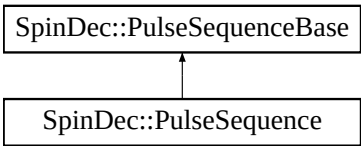
- **PulseExperiment** (const CSDProblem &csd_problem, const TimeArray &time_array)
- virtual TimeEvolution **time_evolution** (const UIntArray bath_indices)=0
- virtual auto_ptr< PulseExperiment > **clone** () const =0
- const TimeArray & **get_time_array** () const
- const CSDProblem & **get_csd_problem** () const

Protected Attributes

- CSDProblem **csd_problem_**
- TimeArray **time_array_**

3.32 SpinDec::PulseSequence Class Reference

Inheritance diagram for SpinDec::PulseSequence::

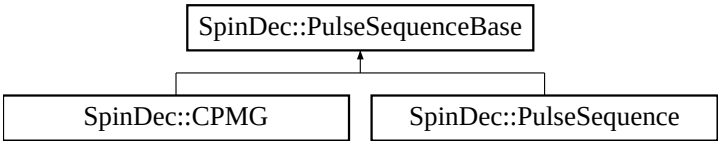


Public Member Functions

- void **clear** ()
- void **add_pulse** (const Pulse &pulse)
- virtual auto_ptr< PulseSequenceBase > **clone** () const

3.33 SpinDec::PulseSequenceBase Class Reference

Inheritance diagram for SpinDec::PulseSequenceBase::



Public Member Functions

- SpinState **final_state** (const SpinState &initial_state) const
- double **get_duration** () const
- UInt **num_pulses** () const
- virtual auto_ptr< PulseSequenceBase > **clone** () const =0

Protected Attributes

- vector< Pulse > **pulses_**
- double **duration_**

3.34 SpinDec::RandomNumberGenerator Class Reference

Static Public Member Functions

- static int **uniform_c_rand** (const int min, const int max)
- static void **seed_uniform_c_rand** (const int seed)
- static void **clock_seed_uniform_c_rand** ()
- static double **normal_c_rand** (const double mean, const double stdev)

3.35 SpinDec::ReducedProblem Class Reference

Public Member Functions

- **ReducedProblem** (const UInt order, const auto_ptr< SpinSystemBase > &spin_system_base)
- **ReducedProblem** (const ReducedProblem &rhs)
- ReducedProblem & **operator=** (const ReducedProblem &rhs)
- UInt **get_order** () const
- auto_ptr< SpinSystemBase > **get_spin_system** () const

Private Attributes

- UInt **order_**
- auto_ptr< SpinSystemBase > **spin_system_base_**

3.36 SpinDec::Sign Class Reference

Public Member Functions

- int **as_int** () const
- bool **isPlus** () const
- bool **isMinus** () const
- bool **operator==** (const Sign &rhs) const

Static Public Attributes

- static const Sign **Plus**
- static const Sign **Minus**

Private Member Functions

- **Sign** (const int value)

Private Attributes

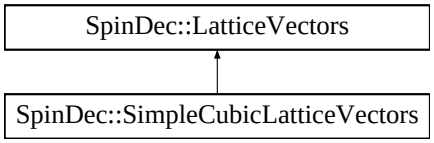
- int **value_**

Friends

- std::ostream & **operator**<< (std::ostream &os, Sign const &sign)

3.37 SpinDec::SimpleCubicLatticeVectors Class Reference

Inheritance diagram for SpinDec::SimpleCubicLatticeVectors::



Public Member Functions

- **SimpleCubicLatticeVectors** (const double lattice_constant)

3.38 SpinDec::SpinBasis Class Reference

Public Member Functions

- **SpinBasis** (const SpinParametersVector &spin_parameters_vector)
- **SpinBasis** (const SpinParameters &spin_parameters)
- **SpinBasis** (const Eigen::ArrayXXd &basis_as_array)
- const Eigen::ArrayXXd & **get_basis_as_array** () const
- UInt **num_basis_states** () const
- UInt **num_spins** () const
- double **get_element** (const UInt index, const UInt slot) const
- SpinBasis **operator+** (const SpinBasis &to_append) const
- SpinBasis **operator^** (const SpinBasis &to_combine) const
- bool **operator==** (const SpinBasis to_compare) const
- bool **is_equal** (const SpinBasis &basis) const

Private Member Functions

- Eigen::ArrayXXd **build** (const SpinParametersVector &spin_parameters_vector)
- Eigen::ArrayXXd **build** (const SpinParameters &spin_parameters)

Private Attributes

- Eigen::ArrayXXd **basis_as_array_**

Friends

- std::ostream & **operator<<** (std::ostream &os, SpinBasis const &basis)

3.39 SpinDec::SpinBath Class Reference

Public Member Functions

- **SpinBath** (const CrystalStructure &crystal_structure, const auto_ptr< SpinSystemBase > &spin_system_base, const vector< SpinInteractionEdge > &intrabath_edges)
- **SpinBath** (const CrystalStructure &crystal_structure, const auto_ptr< SpinSystemBase > &spin_system_base, const SpinInteractionEdge &intrabath_edge)
- **SpinBath** (const SpinBath &spin_bath)
- SpinBath & **operator=** (const SpinBath &spin_bath)
- const SpinState & **get_bath_state** (const UInt index) const
- UInt **num_bath_states** () const
- SpinState **get_bath_product_state** (const UIntArray &indices) const
- const CrystalStructure & **get_crystal_structure** () const
- const vector< SpinInteractionEdge > & **get_intrabath_edges** () const
- auto_ptr< SpinSystemBase > **get_spin_system** () const
- SpinInteractionGraph **reduced_problem_graph** (const UInt order) const
- ThreeVector **get_position** (const UInt vertex_label, const UInt bath_index) const
- void **set_bath_state** (const UInt index, const UInt level)

Private Member Functions

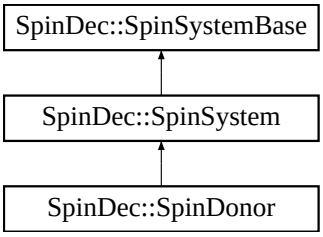
- void **init** (const CrystalStructure &crystal_structure, const auto_ptr< SpinSystemBase > &spin_system_base, const vector< SpinInteractionEdge > &intrabath_edges)
- vector< SpinInteractionEdge > **make_intrabath_edges** (const UInt order, const SpinInteractionEdge &intrabath_edge) const
- vector< SpinInteractionEdge > **make_intrabath_edges** (const UInt order) const

Private Attributes

- vector< SpinState > **bath_states_**
- CrystalStructure **crystal_structure_**
- auto_ptr< SpinSystemBase > **spin_system_base_**
- vector< SpinInteractionEdge > **intrabath_edges_**

3.40 SpinDec::SpinDonor Class Reference

Inheritance diagram for SpinDec::SpinDonor::



Public Member Functions

- **SpinDonor** (const double field_strength, const double nuclear_quantum_number, const double electron_gyromagnetic_ratio, const double nuclear_gyromagnetic_ratio, const double hyperfine_strength, const unsigned int lower_level_label, const unsigned int upper_level_label, const ThreeVector &electron_position, const ThreeVector &nuclear_position, const bool complete_basis)
- const ElectronSpinParameters & **get_electron_parameters** () const
- const NuclearSpinParameters & **get_nuclear_parameters** () const
- const Hyperfine & **get_hyperfine** () const
- int **max_quantum_number** () const
- virtual UInt **dimension** () const
- UInt **total_multiplicity** () const
- virtual SpinState **eigenstate** (const UInt level_label)
- virtual double **energy** (const UInt level_label)
- double **polarization** (const UInt level_label) const
- const SpinInteractionVertex & **electron_vertex** () const
- const SpinInteractionVertex & **nuclear_vertex** () const
- const UIntArray **get_orthogonal_level_labels** () const
- SpinState **get_lower_level** ()
- SpinState **get_upper_level** ()
- vector< SpinState > **get_orthogonal_levels** ()
- virtual PiPulse **pi_pulse** (const UInt level_label1, const UInt level_label2)
- virtual auto_ptr< SpinSystemBase > **clone** () const

Private Member Functions

- void **sort_level_labels** ()
- UInt **level_label_index** (const UInt level_label) const
- virtual void **check_level_label** (const UInt level_label) const
- void **calc_adiabatic_level_labels** ()
- double **delta** () const
- double **omega** () const
- double **scaled_omega** () const
- double **D** (const int quantum_number) const
- double **O** (const int quantum_number) const
- double **R** (const int quantum_number) const
- double **energy** (const AdiabaticLabel &adiabatic_level_label) const

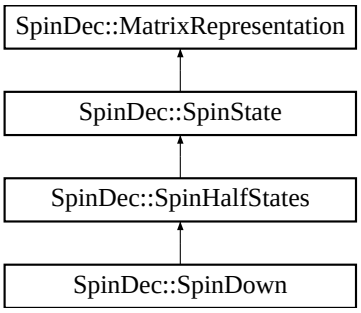
- UInt **adiabatic_label_to_int_label** (const AdiabaticLabel &adiabatic_level_label) const
- AdiabaticLabel **int_label_to_adiabatic_label** (const UInt level_label) const
- AdiabaticLabel **orthogonal_adiabatic_level_label** (AdiabaticLabel adiabatic_level_label) const
- double **cos_theta** (const int quantum_number) const
- double **sin_theta** (const int quantum_number) const
- double **a** (const int quantum_number) const
- double **b** (const int quantum_number) const
- double **polarization** (const AdiabaticLabel &adiabatic_level_label) const
- SpinBasis **build_basis** (const AdiabaticLabel &adiabatic_level_label) const
- SpinBasis **build_basis** (const std::vector< AdiabaticLabel > &adiabatic_level_labels) const
- SpinBasis **build_basis** (const UIntArray &level_labels) const
- SpinBasis **build_truncated_basis** () const
- void **set_transition** (const UInt lower_level_label, const UInt upper_level_label)
- void **set_orthogonal_level_labels** (const UInt lower_level_label, const UInt upper_level_label)
- UIntArray **get_orthogonal_level_labels** (const UInt lower_level_label, const UInt upper_level_label) const
- UInt **orthogonal_level_label** (const UInt level_label) const
- void **init** (const double field_strength, const double nuclear_quantum_number, const double electron_gyromagnetic_ratio, const double nuclear_gyromagnetic_ratio, const double hyperfine_strength, const unsigned int lower_level_label, const unsigned int upper_level_label, const ThreeVector &electron_position, const ThreeVector &nuclear_position, const bool complete_basis)

Private Attributes

- bool **complete_basis_**
- ElectronSpinParameters **electron_parameters_**
- NuclearSpinParameters **nuclear_parameters_**
- Hyperfine **hyperfine_**
- UInt **transition_level_labels_** [2]
- UIntArray **orthogonal_level_labels_**
- UIntArray **sorted_level_labels_**
- std::vector< AdiabaticLabel > **adiabatic_level_labels_**

3.41 SpinDec::SpinDown Class Reference

Inheritance diagram for SpinDec::SpinDown::



Public Member Functions

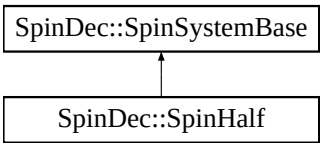
- **SpinDown** (const SpinHalfParameters &spin_half_parameters)

Private Member Functions

- virtual void **init** (const double gyromagnetic_ratio)

3.42 SpinDec::SpinHalf Class Reference

Inheritance diagram for SpinDec::SpinHalf::



Public Member Functions

- **SpinHalf** (const double gyromagnetic_ratio, const double field_strength, const ThreeVector &position)
- virtual UInt **dimension** () const
- virtual auto_ptr< SpinSystemBase > **clone** () const

Private Member Functions

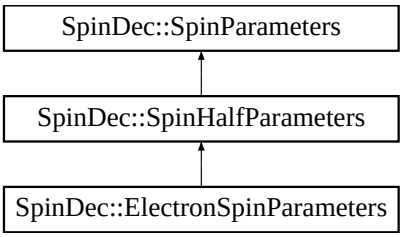
- virtual void **solve_once** ()
- virtual void **check_level_label** (const UInt level_label) const

Private Attributes

- double **gyromagnetic_ratio_**

3.43 SpinDec::SpinHalfParameters Class Reference

Inheritance diagram for SpinDec::SpinHalfParameters::

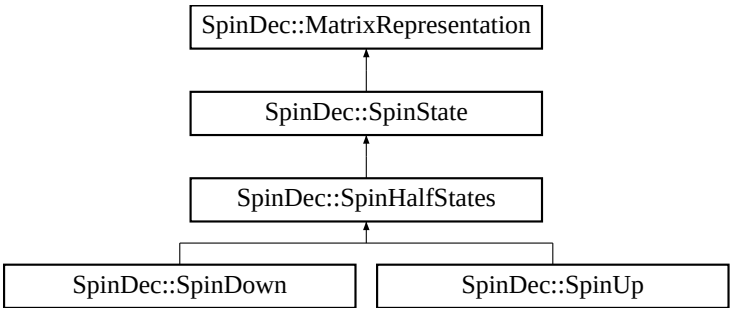


Public Member Functions

- **SpinHalfParameters** (const double gyromagnetic_ratio)

3.44 SpinDec::SpinHalfStates Class Reference

Inheritance diagram for SpinDec::SpinHalfStates::

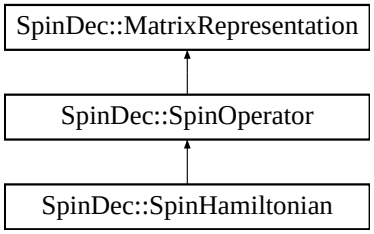


Protected Member Functions

- virtual void **init** (const double gyromagnetic_ratio)=0
- virtual void **set_state_vector** (const ComplexVector &state_vector)
- virtual void **set_element** (const UInt index, const CDouble &element)
- virtual void **set_element** (const UInt index, const double element)

3.45 SpinDec::SpinHamiltonian Class Reference

Inheritance diagram for SpinDec::SpinHamiltonian::



Public Member Functions

- **SpinHamiltonian** (const SpinInteractionGraph &graph, const UniformMagneticField &field)
- UniformMagneticField **get_field** () const
- const SpinInteractionGraph & **get_graph** () const
- void **update_positions** (const UIntArray &vertex_labels, const vector< ThreeVector > &positions)

Private Member Functions

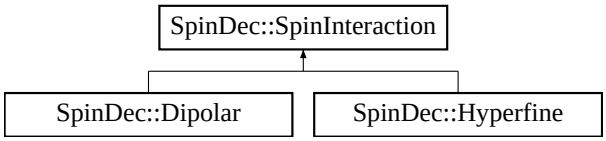
- void **fill_zeeman** ()
- void **fill_interactions** ()
- void **init_terms** ()
- void **sum_zeeman_terms** ()
- void **sum_interaction_terms** ()
- void **fill_zeeman** (const UInt vertex_label)
- void **fill_interaction** (const UInt edge_index)

Private Attributes

- UniformMagneticField **field_**
- SpinInteractionGraph **graph_**
- vector< ComplexMatrix > **zeeman_terms_**
- vector< ComplexMatrix > **interaction_terms_**
- ComplexMatrix **zeeman_hamiltonian_**
- ComplexMatrix **interaction_hamiltonian_**

3.46 SpinDec::SpinInteraction Class Reference

Inheritance diagram for SpinDec::SpinInteraction::



Public Member Functions

- virtual void **calculate** (const SpinParameters &spin_parameters1, const SpinParameters &spin_parameters2, const ThreeVector &position1, const ThreeVector &position2, const UniformMagneticField &field)=0
- double **get_strength** () const
- bool **strength_preset** () const
- virtual void **fill** (ComplexMatrix *hamiltonian, const SpinParametersVector &spins, const SpinBasis &basis, const UInt spin_label1, const UInt spin_label2) const =0
- virtual auto_ptr< SpinInteraction > **clone** () const =0
- virtual string **get_type** () const =0

Protected Member Functions

- **SpinInteraction** (const double strength)
- void **fill_ising_flipflop** (ComplexMatrix *hamiltonian, const SpinParametersVector &spin_parameters_vector, const SpinBasis &basis, const UInt spin_label1, const UInt spin_label2, const bool ising_only, const CDouble &flipflop_form) const
- void **warn_if_preset_then_calculated** () const

Protected Attributes

- double **strength_**
- bool **strength_preset_**

3.47 SpinDec::SpinInteractionEdge Class Reference

Public Member Functions

- **SpinInteractionEdge** (const SpinInteractionEdge &other)
- **SpinInteractionEdge** (const UInt label1, const UInt label2, const auto_ptr< SpinInteraction > &interaction)
- UInt **get_label1** () const
- UInt **get_label2** () const
- auto_ptr< SpinInteraction > **get_interaction** () const
- SpinInteractionEdge & **operator=** (const SpinInteractionEdge &other)

Private Attributes

- pair< UInt, UInt > **labels_**
- auto_ptr< SpinInteraction > **interaction_**

3.48 SpinDec::SpinInteractionGraph Class Reference

Public Member Functions

- void **set_basis** (const SpinBasis &basis)
- void **add_vertex** (const SpinParameters &spin_parameters, const ThreeVector &position)
- void **add_vertex** (const SpinParameters &spin_parameters, const SpinBasis &basis, const ThreeVector &position)
- void **add_vertex_appending_basis** (const SpinParameters &spin_parameters, const ThreeVector &position)
- void **add_vertex_appending_basis** (const SpinParameters &spin_parameters, const SpinBasis &basis, const ThreeVector &position)
- void **add_edge** (unsigned int label1, unsigned int label2, const auto_ptr< SpinInteraction > &interaction)
- void **add_edges** (const vector< SpinInteractionEdge > &edges)
- unsigned int **num_vertices** () const
- unsigned int **num_edges** () const
- void **clear** ()
- const SpinBasis & **get_basis** () const
- const SpinParameters & **get_spin_parameters** (const unsigned int label) const
- const ThreeVector & **get_position** (const unsigned int label) const
- auto_ptr< SpinInteraction > **get_interaction** (const unsigned int index) const
- void **set_interaction** (const unsigned int index, const auto_ptr< SpinInteraction > &interaction)
- SpinParametersVector **spin_parameters_vector** () const
- const SpinInteractionVertex & **get_vertex** (const unsigned int label) const
- const SpinInteractionEdge & **get_edge** (const unsigned int index) const
- void **join_in_place** (const SpinInteractionGraph &to_join)
- void **join_in_place** (const SpinInteractionGraph &to_join, const std::vector< SpinInteractionEdge > &edges)
- SpinInteractionGraph **join** (const SpinInteractionGraph &to_join) const
- SpinInteractionGraph **join** (const SpinInteractionGraph &to_join, const std::vector< SpinInteractionEdge > &edges) const
- void **set_position** (const UInt label, const ThreeVector &position)
- const SpinInteractionVertex & **get_vertex1** (const UInt index) const
- const SpinInteractionVertex & **get_vertex2** (const UInt index) const
- void **set_positions** (const UIntArray &vertex_labels, const vector< ThreeVector > &positions)

Private Member Functions

- void **quit_if_vertex_label_out_of_bounds** (const unsigned int label) const
- void **quit_if_edge_index_out_of_bounds** (const unsigned int index) const
- void **set_vertex** (const unsigned int label, const SpinInteractionVertex &vertex)
- void **set_edge** (const unsigned int index, const SpinInteractionEdge &edge)

Private Attributes

- vector< SpinInteractionVertex > **vertices_**
- vector< SpinInteractionEdge > **edges_**
- SpinBasis **basis_**

3.49 SpinDec::SpinInteractionVertex Class Reference

Public Member Functions

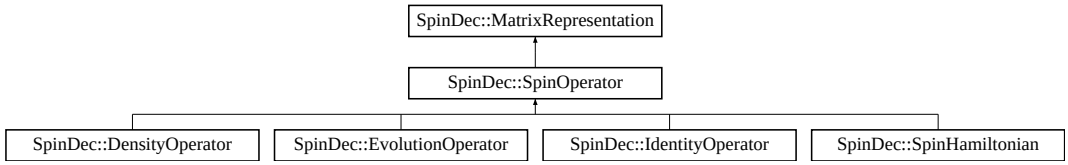
- **SpinInteractionVertex** (const UInt label, const SpinParameters &spin_parameters, const ThreeVector &position)
- **SpinInteractionVertex** (const UInt label, const SpinParameters &spin_parameters, const SpinBasis &basis, const ThreeVector &position)
- UInt **get_label** () const
- const SpinParameters & **get_spin_parameters** () const
- const SpinBasis & **get_basis** () const
- const ThreeVector & **get_position** () const
- void **set_position** (const ThreeVector &position)

Private Attributes

- UInt **label_**
- SpinParameters **spin_parameters_**
- SpinBasis **basis_**
- ThreeVector **position_**

3.50 SpinDec::SpinOperator Class Reference

Inheritance diagram for SpinDec::SpinOperator::



Public Member Functions

- **SpinOperator** (const ComplexMatrix &matrix, const SpinBasis &basis)
- **SpinOperator** (const SpinBasis &basis)
- const ComplexMatrix & **get_matrix** () const
- void **set_matrix** (const ComplexMatrix &matrix)
- const CDouble & **get_element** (const UInt i, const UInt j) const
- void **set_element** (const UInt i, const UInt j, const CDouble &element)
- void **set_element** (const UInt i, const UInt j, const double element)
- void **add_to_element** (const UInt i, const UInt j, const CDouble &to_add)
- SpinOperator **operator**$^\wedge$ (const SpinOperator &rhs) const
- SpinState **operator**$*$ (const SpinState &operand) const
- SpinOperator **operator+** (const SpinOperator &rhs) const
- SpinOperator **operator-** (const SpinOperator &rhs) const
- virtual void **set_zero** ()
- virtual auto_ptr< MatrixRepresentation > **clone** () const

Protected Member Functions

- virtual void **quit_if_dimension_mismatch** () const

Protected Attributes

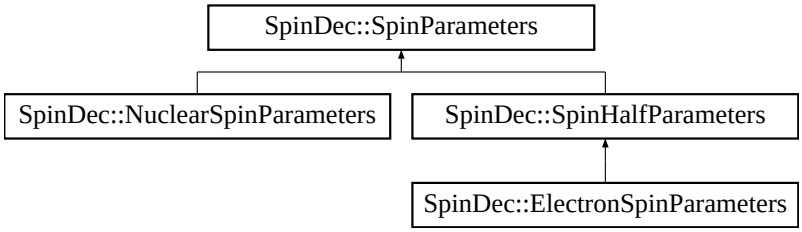
- ComplexMatrix **matrix_**

Friends

- std::ostream & **operator**<< (std::ostream &os, SpinOperator const &spin_operator)

3.51 SpinDec::SpinParameters Class Reference

Inheritance diagram for SpinDec::SpinParameters::



Public Member Functions

- **SpinParameters** (const double quantum_number, const double gyromagnetic_ratio)
- double **get_quantum_number** () const
- double **get_gyromagnetic_ratio** () const
- UInt **get_multiplicity** () const

Protected Member Functions

- UInt **multiplicity** (const double quantum_number) const

Protected Attributes

- double **quantum_number_**
- double **gyromagnetic_ratio_**
- UInt **multiplicity_**

Friends

- std::ostream & **operator**<< (std::ostream &os, SpinParameters const &spin_parameters)

3.52 SpinDec::SpinParametersVector Class Reference

Public Member Functions

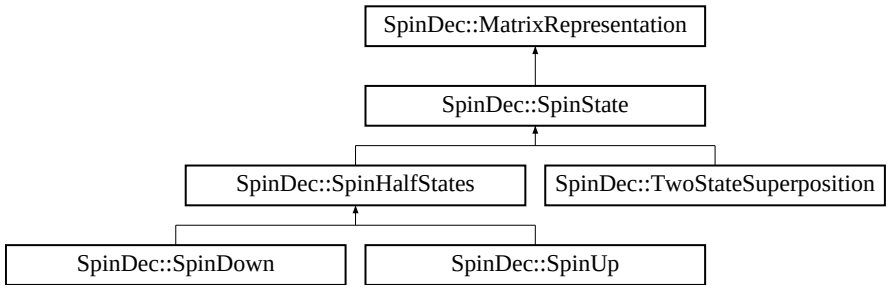
- **SpinParametersVector** (const SpinParameters &spin_parameters)
- SpinParameters & **operator[ ]** (const UInt index)
- const SpinParameters & **operator[ ]** (const UInt index) const
- void **push_back** (const SpinParameters &spin_parameters)
- UInt **size** () const
- void **clear** ()
- UInt **multiplicity** () const

Private Attributes

- std::vector< SpinParameters > **spin_parameters_vector_**

3.53 SpinDec::SpinState Class Reference

Inheritance diagram for SpinDec::SpinState::



Public Member Functions

- **SpinState** (const ComplexVector &state_vector, const SpinBasis &basis)
- **SpinState** (const SpinBasis &basis)
- const ComplexVector & **get_state_vector** () const
- virtual void **set_state_vector** (const ComplexVector &state_vector)
- const CDouble & **get_element** (const UInt index) const
- virtual void **set_element** (const UInt index, const CDouble &element)
- virtual void **set_element** (const UInt index, const double element)
- SpinState **operator^** (const SpinState &rhs) const
- CDouble **operator*** (const SpinState &rhs) const
- SpinOperator **operator%** (const SpinState &rhs) const
- SpinState **operator+** (const SpinState &rhs) const
- SpinState **operator-** (const SpinState &rhs) const
- SpinState **operator*** (const CDouble &c) const
- void **time_evolve** (const ComplexMatrix &unitary_evolution_matrix)
- virtual void **set_zero** ()
- void **normalize** ()
- SpinState **normalized** () const
- virtual auto_ptr< MatrixRepresentation > **clone** () const

Protected Member Functions

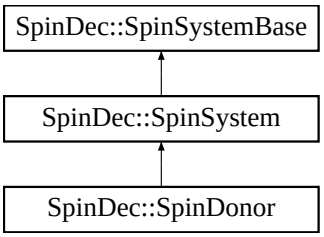
- virtual void **quit_if_dimension_mismatch** () const

Protected Attributes

- ComplexVector **state_vector_**

3.54 SpinDec::SpinSystem Class Reference

Inheritance diagram for SpinDec::SpinSystem::



Public Member Functions

- **SpinSystem** (const SpinHamiltonian &hamiltonian)
- virtual UInt **dimension** () const
- virtual auto_ptr< SpinSystemBase > **clone** () const

Protected Member Functions

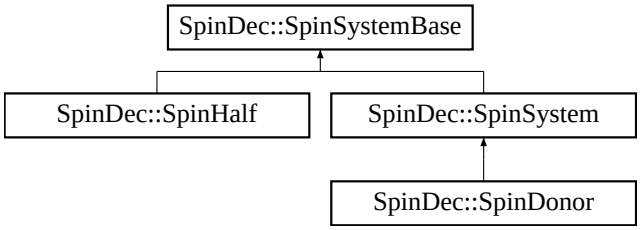
- virtual void **solve_once** ()
- virtual void **check_level_label** (const UInt level_label) const

Protected Attributes

- HermitianEigenspectrum **eigenspectrum_**

3.55 SpinDec::SpinSystemBase Class Reference

Inheritance diagram for SpinDec::SpinSystemBase::



Public Member Functions

- **SpinSystemBase** (const SpinHamiltonian &hamiltonian)
- const SpinHamiltonian & **get_hamiltonian** () const
- virtual SpinState **eigenstate** (const UInt level_label)
- virtual double **energy** (const UInt level_label)
- void **set_state** (const SpinState &state)
- void **set_state** (const UInt level_label)
- void **set_state** (const CDouble &c0, const UInt level_label0, const CDouble &c1, const UInt level_label1)
- const SpinState & **get_state** () const
- EvolutionOperator **evolution_operator** (const double time)
- virtual UInt **dimension** () const =0
- const ComplexMatrix & **get_eigenvector_matrix** ()
- const RealVector & **get_eigenvalue_vector** ()
- virtual PiPulse **pi_pulse** (const UInt level_label1, const UInt level_label2)
- void **print** (const char option)
- virtual auto_ptr< SpinSystemBase > **clone** () const =0
- void **update_positions** (const UIntArray &vertex_labels, const vector< ThreeVector > &positions)

Protected Member Functions

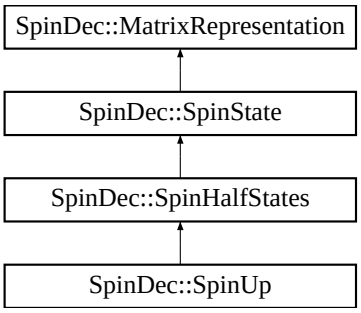
- virtual void **solve_once** ()=0
- virtual void **check_level_label** (const UInt level_label) const =0

Protected Attributes

- SpinHamiltonian **hamiltonian_**
- RealVector **energies_**
- ComplexMatrix **eigenstates_**
- SpinState **state_**
- bool **is_solved_**
- bool **is_state_set_**

3.56 SpinDec::SpinUp Class Reference

Inheritance diagram for SpinDec::SpinUp::



Public Member Functions

- **SpinUp** (const SpinHalfParameters &spin_half_parameters)

Private Member Functions

- virtual void **init** (const double gyromagnetic_ratio)

3.57 SpinDec::StringOptions Class Reference

Public Member Functions

- **StringOptions** (const string &options)
- bool **found_option** (const char option) const
- bool **is_empty** () const

Private Attributes

- string **options_**

3.58 SpinDec::TimeArray Class Reference

Public Member Functions

- **TimeArray** (const double initial_time, const double final_time, const UInt num_steps)
- **TimeArray** (const double single_time)
- bool **operator==** (const TimeArray &time_array) const
- void **logarithmic_time** ()
- double **get_time** (const UInt index) const
- const DoubleArray & **get_time_vector** () const
- UInt **num_steps** () const
- UInt **get_dimension** () const
- void **scale_time** (const double scalar)

Private Member Functions

- void **clear** ()
- void **initialize** (const double initial_time, const double final_time, const UInt num_steps)

Private Attributes

- DoubleArray **time_vector_**
- UInt **dimension_**

Friends

- std::ostream & **operator**<< (std::ostream &os, TimeArray const &time_array)

3.59 SpinDec::TimeEvolution Class Reference

Public Member Functions

- **TimeEvolution** (const TimeArray &time_array, const CDoubleArray &evolution)
- **TimeEvolution** (const TimeArray &time_array)
- const CDouble & **evolution** (const UInt index) const
- void **set_evolution_zeros** ()
- void **set_evolution_ones** ()
- const CDoubleArray & **get_evolution** () const
- const TimeArray & **get_time_array** () const
- UInt **dimension** () const
- TimeEvolution **operator+** (const TimeEvolution &to_add) const
- TimeEvolution **operator*** (const TimeEvolution &to_multiply) const
- TimeEvolution **operator/** (const TimeEvolution &to_divide) const
- void **print** () const
- void **print_real** () const
- void **print_imag** () const
- void **print_abs** () const
- void **print** (const string &file_name) const
- void **print_real** (const string &file_name) const
- void **print_imag** (const string &file_name) const
- void **print_abs** (const string &file_name) const
- void **scale_time** (const double scalar)
- void **finite_zeros** ()
- bool **has_greater_than_one** () const

Private Member Functions

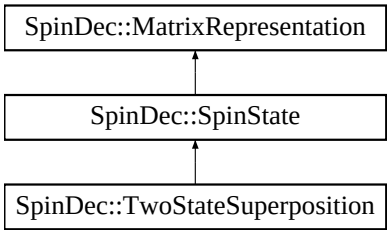
- void **print** (const char option) const
- void **print** (const string &file_name, const char option) const

Private Attributes

- TimeArray **time_array_**
- CDoubleArray **evolution_**

3.60 SpinDec::TwoStateSuperposition Class Reference

Inheritance diagram for SpinDec::TwoStateSuperposition::



Public Member Functions

- **TwoStateSuperposition** (const CDouble &c0, const SpinState &state0, const CDouble &c1, const SpinState &state1)
- const SpinState & **get_state0** () const
- const SpinState & **get_state1** () const
- const CDouble & **get_c0** () const
- const CDouble & **get_c1** () const

Private Attributes

- SpinState **state0_**
- SpinState **state1_**
- CDouble **c0_**
- CDouble **c1_**

3.61 SpinDec::UniformMagneticField Class Reference

Public Member Functions

- **UniformMagneticField** (const double magnitude)
- **UniformMagneticField** (const double magnitude, const ThreeVector &direction)
- double **get_magnitude** () const
- ThreeVector **get_direction** () const
- void **set_magnitude** (const double magnitude)
- void **set_direction** (const ThreeVector &direction)

Private Attributes

- double **magnitude_**
- ThreeVector **direction_**