```
travis_time:start:0715f69c
[0K$ ./test.sh
Smoke Test...
Smoke test passes
Simulator test...
[doctest] doctest version is "2.0.1"
[doctest] run with "--help" for options
===============================================================
===================
[doctest] test cases:      4 |      4 passed |      0 failed |      0 skipped
[doctest] assertions:     62 |     62 passed |      0 failed |
[doctest] Status: SUCCESS!
Simulator test passes
Generating coverage report...
File 'test-nbodySimulator.cpp'
Lines executed:100.00% of 98
Branches executed:78.30% of 1152
Taken at least once:39.15% of 1152
Calls executed:61.71% of 1298
Creating 'test-nbodySimulator.cpp.gcov'

File '/usr/include/c++/5/bits/stl_vector.h'
Lines executed:93.81% of 113
Branches executed:62.50% of 112
Taken at least once:37.50% of 112
Calls executed:64.24% of 288
Creating 'stl_vector.h.gcov'

File 'doctest.h'
Lines executed:36.71% of 1321
Branches executed:48.35% of 1694
Taken at least once:25.32% of 1694
Calls executed:34.21% of 1374
Creating 'doctest.h.gcov'

File '/usr/include/c++/5/iostream'
Lines executed:100.00% of 1
No branches
Calls executed:100.00% of 2
Creating 'iostream.gcov'
```

File '../thirdparty/boost_1_68_0/boost/multi_array/base.hpp'
Lines executed:100.00% of 2
No branches
Calls executed:100.00% of 2
Creating 'base.hpp.gcov'

File '../thirdparty/boost_1_68_0/boost/math/special_functions/lanczos.hpp'
Lines executed:100.00% of 103
Branches executed:100.00% of 30
Taken at least once:56.67% of 30
Calls executed:100.00% of 153
Creating 'lanczos.hpp.gcov'

File '../thirdparty/eigen/Eigen/src/Core/CoreEvaluators.h'
Lines executed:100.00% of 55
Branches executed:100.00% of 92
Taken at least once:50.00% of 92
Calls executed:91.86% of 344
Creating 'CoreEvaluators.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/functors/BinaryFunctors.h'
Lines executed:100.00% of 21
No branches
Calls executed:100.00% of 15
Creating 'BinaryFunctors.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/CwiseBinaryOp.h'
Lines executed:100.00% of 19
Branches executed:100.00% of 52
Taken at least once:50.00% of 52
Calls executed:92.59% of 162
Creating 'CwiseBinaryOp.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/AssignEvaluator.h'
Lines executed:98.53% of 68
Branches executed:100.00% of 134
Taken at least once:50.00% of 134
Calls executed:90.65% of 278
Creating 'AssignEvaluator.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/Matrix.h'
Lines executed:100.00% of 22
No branches

Calls executed:100.00% of 19
Creating 'Matrix.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/Transpose.h'
Lines executed:100.00% of 5
No branches
Calls executed:100.00% of 6
Creating 'Transpose.h.gcov'

File '/usr/include/c++/5/bits/stl_construct.h'
Lines executed:100.00% of 15
Branches executed:70.00% of 20
Taken at least once:40.00% of 20
Calls executed:57.14% of 42
Creating 'stl_construct.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/functors/NullaryFunctors.h'
Lines executed:100.00% of 4
No branches
Calls executed:100.00% of 1
Creating 'NullaryFunctors.h.gcov'

File '/usr/include/c++/5/bits/stl_uninitialized.h'
Lines executed:80.65% of 31
Branches executed:45.45% of 22
Taken at least once:36.36% of 22
Calls executed:50.65% of 77
Creating 'stl_uninitialized.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/MathFunctions.h'
Lines executed:100.00% of 10
No branches
Calls executed:100.00% of 3
Creating 'MathFunctions.h.gcov'

File '/usr/include/c++/5/bits/stl_algobase.h'
Lines executed:96.97% of 33
Branches executed:72.73% of 22
Taken at least once:59.09% of 22
Calls executed:70.15% of 67
Creating 'stl_algobase.h.gcov'

File '/usr/include/c++/5/bits/stl_iterator_base_types.h'

Lines executed:66.67% of 6
No branches
Calls executed:71.43% of 7
Creating 'stl_iterator_base_types.h.gcov'

File '/usr/include/c++/5/bits/stl_iterator.h'
Lines executed:93.75% of 32
No branches
Calls executed:63.64% of 33
Creating 'stl_iterator.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/functors/AssignmentFunctors.h'
Lines executed:100.00% of 12
No branches
Calls executed:100.00% of 2
Creating 'AssignmentFunctors.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/GenericPacketMath.h'
Lines executed:100.00% of 2
Branches executed:100.00% of 4
Taken at least once:50.00% of 4
Calls executed:100.00% of 6
Creating 'GenericPacketMath.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/CwiseNullaryOp.h'
Lines executed:100.00% of 14
Branches executed:100.00% of 20
Taken at least once:50.00% of 20
Calls executed:91.30% of 23
Creating 'CwiseNullaryOp.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/NumTraits.h'
Lines executed:0.00% of 3
No branches
Calls executed:0.00% of 1
Creating 'NumTraits.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/ArrayWrapper.h'
Lines executed:100.00% of 6
No branches
Calls executed:100.00% of 8
Creating 'ArrayWrapper.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/DenseBase.h'
Lines executed:60.00% of 5
No branches
Calls executed:94.74% of 19
Creating 'DenseBase.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/DenseCoeffsBase.h'
Lines executed:100.00% of 4
No branches
Calls executed:100.00% of 21
Creating 'DenseCoeffsBase.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/EigenBase.h'
Lines executed:87.50% of 8
No branches
Calls executed:40.00% of 10
Creating 'EigenBase.h.gcov'

File '/usr/include/c++/5/bits/vector.tcc'
Lines executed:77.05% of 61
Branches executed:25.00% of 128
Taken at least once:14.06% of 128
Calls executed:34.69% of 196
Creating 'vector.tcc.gcov'

File '../thirdparty/boost_1_68_0/boost/range/size.hpp'
Lines executed:100.00% of 4
No branches
Calls executed:100.00% of 2
Creating 'size.hpp.gcov'

File '../thirdparty/eigen/Eigen/src/Core/functors/UnaryFunctors.h'
Lines executed:100.00% of 4
No branches
Calls executed:100.00% of 2
Creating 'UnaryFunctors.h.gcov'

File '/usr/include/c++/5/ext/new_allocator.h'
Lines executed:92.86% of 14
Branches executed:51.52% of 66
Taken at least once:25.76% of 66
Calls executed:36.11% of 108
Creating 'new_allocator.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/DenseStorage.h'
Lines executed:100.00% of 14
No branches
Calls executed:100.00% of 2
Creating 'DenseStorage.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/MatrixBase.h'
Lines executed:100.00% of 4
Branches executed:100.00% of 2
Taken at least once:50.00% of 2
Calls executed:100.00% of 20
Creating 'MatrixBase.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/util/XprHelper.h'
Lines executed:100.00% of 4
Branches executed:100.00% of 6
Taken at least once:50.00% of 6
Calls executed:0.00% of 3
Creating 'XprHelper.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/PlainObjectBase.h'
Lines executed:94.74% of 38
Branches executed:100.00% of 22
Taken at least once:50.00% of 22
Calls executed:92.75% of 69
Creating 'PlainObjectBase.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/CwiseUnaryOp.h'
Lines executed:100.00% of 7
No branches
Calls executed:100.00% of 7
Creating 'CwiseUnaryOp.h.gcov'

File '/usr/include/c++/5/bits/stl_pair.h'
Lines executed:75.00% of 16
Branches executed:100.00% of 8
Taken at least once:50.00% of 8
Calls executed:62.32% of 69
Creating 'stl_pair.h.gcov'

File '/usr/include/c++/5/tuple'
Lines executed:64.10% of 39

No branches
Calls executed:55.00% of 40
Creating 'tuple.gcov'

File '/usr/include/c++/5/bits/move.h'
Lines executed:100.00% of 11
No branches
Calls executed:100.00% of 3
Creating 'move.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/IO.h'
Lines executed:0.00% of 51
Branches executed:0.00% of 118
Taken at least once:0.00% of 118
Calls executed:0.00% of 104
Creating 'IO.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/BooleanRedux.h'
Lines executed:100.00% of 10
Branches executed:100.00% of 62
Taken at least once:66.13% of 62
Calls executed:93.88% of 49
Creating 'BooleanRedux.h.gcov'

File '/usr/include/c++/5/functional'
Lines executed:100.00% of 35
Branches executed:100.00% of 6
Taken at least once:50.00% of 6
Calls executed:100.00% of 36
Creating 'functional.gcov'

File '../thirdparty/boost_1_68_0/boost/numeric/odeint/util/resize.hpp'
Lines executed:100.00% of 9
No branches
Calls executed:100.00% of 4
Creating 'resize.hpp.gcov'

File '../thirdparty/boost_1_68_0/boost/numeric/odeint/util/same_size.hpp'
Lines executed:100.00% of 6
No branches
Calls executed:100.00% of 4
Creating 'same_size.hpp.gcov'

File '../thirdparty/eigen/Eigen/src/Core/Redux.h'
Lines executed:100.00% of 23
Branches executed:100.00% of 24
Taken at least once:50.00% of 24
Calls executed:88.46% of 26
Creating 'Redux.h.gcov'

File '../thirdparty/boost_1_68_0/boost/math/tools/detail/rational_horner1_20.hpp'
Lines executed:60.00% of 5
Branches executed:100.00% of 2
Taken at least once:50.00% of 2
No calls
Creating 'rational_horner1_20.hpp.gcov'

File '/usr/include/c++/5/bits/alloc_traits.h'
Lines executed:100.00% of 12
No branches
Calls executed:40.24% of 82
Creating 'alloc_traits.h.gcov'

File '/usr/include/c++/5/ext/aligned_buffer.h'
Lines executed:100.00% of 9
No branches
Calls executed:40.00% of 10
Creating 'aligned_buffer.h.gcov'

File '../thirdparty/eigen/Eigen/src/plugins/CommonCwiseBinaryOps.h'
Lines executed:100.00% of 4
Branches executed:100.00% of 60
Taken at least once:50.00% of 60
Calls executed:100.00% of 71
Creating 'CommonCwiseBinaryOps.h.gcov'

File '../thirdparty/boost_1_68_0/boost/math/tools/rational.hpp'
Lines executed:100.00% of 2
No branches
Calls executed:100.00% of 1
Creating 'rational.hpp.gcov'

File '../thirdparty/boost_1_68_0/boost/type_traits/integral_constant.hpp'
Lines executed:100.00% of 2
No branches
No calls

Creating 'integral_constant.hpp.gcov'

File '/usr/include/c++/5/bits/stl_tree.h'
Lines executed:64.04% of 228
Branches executed:20.99% of 324
Taken at least once:12.35% of 324
Calls executed:28.57% of 525
Creating 'stl_tree.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/ArrayBase.h'
Lines executed:100.00% of 1
No branches
Calls executed:100.00% of 4
Creating 'ArrayBase.h.gcov'

File '../thirdparty/boost_1_68_0/boost/numeric/odeint/algebra/
default_operations.hpp'
Lines executed:100.00% of 4
Branches executed:100.00% of 6
Taken at least once:50.00% of 6
Calls executed:100.00% of 4
Creating 'default_operations.hpp.gcov'

File '/usr/include/c++/5/bits/stl_function.h'
Lines executed:84.62% of 13
No branches
Calls executed:50.00% of 4
Creating 'stl_function.h.gcov'

File '../thirdparty/boost_1_68_0/boost/math/tools/big_constant.hpp'
Lines executed:100.00% of 2
No branches
No calls
Creating 'big_constant.hpp.gcov'

File '../thirdparty/boost_1_68_0/boost/numeric/odeint/algebra/detail/for_each.hpp'
Lines executed:100.00% of 4
Branches executed:100.00% of 8
Taken at least once:75.00% of 8
Calls executed:100.00% of 16
Creating 'for_each.hpp.gcov'

File '../thirdparty/boost_1_68_0/boost/numeric/odeint/util/resizer.hpp'

Lines executed:83.33% of 12
Branches executed:100.00% of 4
Taken at least once:50.00% of 4
Calls executed:100.00% of 3
Creating 'resizer.hpp.gcov'

File '/usr/include/c++/5/bits/allocator.h'
Lines executed:100.00% of 4
No branches
Calls executed:83.33% of 30
Creating 'allocator.h.gcov'

File '/usr/include/c++/5/bits/predefined_ops.h'
Lines executed:0.00% of 7
No branches
Calls executed:0.00% of 2
Creating 'predefined_ops.h.gcov'

File '../thirdparty/eigen/Eigen/src/plugins/MatrixCwiseBinaryOps.h'
Lines executed:100.00% of 2
Branches executed:100.00% of 2
Taken at least once:50.00% of 2
Calls executed:100.00% of 3
Creating 'MatrixCwiseBinaryOps.h.gcov'

File '../thirdparty/eigen/Eigen/src/plugins/ArrayCwiseBinaryOps.h'
Lines executed:100.00% of 1
Branches executed:100.00% of 4
Taken at least once:50.00% of 4
Calls executed:100.00% of 8
Creating 'ArrayCwiseBinaryOps.h.gcov'

File '../thirdparty/boost_1_68_0/boost/numeric/odeint/algebra/range_algebra.hpp'
Lines executed:100.00% of 3
No branches
Calls executed:100.00% of 10
Creating 'range_algebra.hpp.gcov'

File '../thirdparty/boost_1_68_0/boost/range/begin.hpp'
Lines executed:100.00% of 6
No branches
Calls executed:100.00% of 4
Creating 'begin.hpp.gcov'

File '../thirdparty/boost_1_68_0/boost/range/end.hpp'
Lines executed:100.00% of 4
No branches
Calls executed:100.00% of 2
Creating 'end.hpp.gcov'

File '../thirdparty/boost_1_68_0/boost/array.hpp'
Lines executed:100.00% of 5
Branches executed:100.00% of 8
Taken at least once:75.00% of 8
Calls executed:50.00% of 4
Creating 'array.hpp.gcov'

File '../thirdparty/boost_1_68_0/boost/numeric/odeint/stepper/base/
symplectic_rkn_stepper_base.hpp'
Lines executed:100.00% of 38
Branches executed:100.00% of 28
Taken at least once:57.14% of 28
Calls executed:85.00% of 40
Creating 'symplectic_rkn_stepper_base.hpp.gcov'

File '../thirdparty/boost_1_68_0/boost/numeric/odeint/stepper/base/
algebra_stepper_base.hpp'
Lines executed:100.00% of 2
No branches
No calls
Creating 'algebra_stepper_base.hpp.gcov'

File '../thirdparty/eigen/Eigen/src/plugins/MatrixCwiseUnaryOps.h'
Lines executed:100.00% of 1
Branches executed:100.00% of 2
Taken at least once:50.00% of 2
Calls executed:100.00% of 3
Creating 'MatrixCwiseUnaryOps.h.gcov'

File '../thirdparty/boost_1_68_0/boost/multi_array/index_range.hpp'
Lines executed:100.00% of 10
No branches
Calls executed:100.00% of 4
Creating 'index_range.hpp.gcov'

File '/usr/include/c++/5/bits/stl_algo.h'

Lines executed:0.00% of 32
Branches executed:0.00% of 22
Taken at least once:0.00% of 22
Calls executed:0.00% of 20
Creating 'stl_algo.h.gcov'

File '../thirdparty/boost_1_68_0/boost/numeric/odeint/util/state_wrapper.hpp'
Lines executed:100.00% of 1
No branches
Calls executed:100.00% of 2
Creating 'state_wrapper.hpp.gcov'

File '../thirdparty/boost_1_68_0/boost/numeric/odeint/stepper/
symplectic_rkn_sb3a_mclachlan.hpp'
Lines executed:100.00% of 22
Branches executed:100.00% of 4
Taken at least once:50.00% of 4
Calls executed:100.00% of 27
Creating 'symplectic_rkn_sb3a_mclachlan.hpp.gcov'

File '../thirdparty/eigen/Eigen/src/Core/Dot.h'
Lines executed:100.00% of 4
Branches executed:100.00% of 4
Taken at least once:50.00% of 4
Calls executed:100.00% of 4
Creating 'Dot.h.gcov'

File '/usr/include/c++/5/ext/alloc_traits.h'
Lines executed:100.00% of 2
No branches
Calls executed:100.00% of 1
Creating 'alloc_traits.h.gcov'

File '../thirdparty/boost_1_68_0/boost/multi_array/extent_range.hpp'
Lines executed:100.00% of 1
No branches
Calls executed:100.00% of 1
Creating 'extent_range.hpp.gcov'

File '/usr/include/c++/5/bits/stl_map.h'
Lines executed:89.47% of 19
Branches executed:72.73% of 22
Taken at least once:36.36% of 22

Calls executed:78.95% of 19
Creating 'stl_map.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/arch/SSE/MathFunctions.h'
Lines executed:100.00% of 1
Branches executed:100.00% of 2
Taken at least once:50.00% of 2
Calls executed:100.00% of 2
Creating 'MathFunctions.h.gcov'

File '/usr/lib/gcc/x86_64-linux-gnu/5/include/emmintrin.h'
Lines executed:100.00% of 11
No branches
Calls executed:100.00% of 4
Creating 'emmintrin.h.gcov'

File '../thirdparty/boost_1_68_0/boost/multi_array/index_gen.hpp'
Lines executed:100.00% of 1
No branches
Calls executed:100.00% of 1
Creating 'index_gen.hpp.gcov'

File '../thirdparty/boost_1_68_0/boost/multi_array/extent_gen.hpp'
Lines executed:100.00% of 1
No branches
Calls executed:100.00% of 1
Creating 'extent_gen.hpp.gcov'

File '/usr/include/c++/5/bits/atomic_base.h'
Lines executed:100.00% of 14
No branches
Calls executed:100.00% of 2
Creating 'atomic_base.h.gcov'

File '/usr/include/c++/5/bits/stl_set.h'
Lines executed:70.59% of 17
Branches executed:10.00% of 20
Taken at least once:5.00% of 20
Calls executed:41.94% of 31
Creating 'stl_set.h.gcov'

File '/usr/include/c++/5/mutex'
Lines executed:0.00% of 12

Branches executed:0.00% of 2
Taken at least once:0.00% of 2
Calls executed:0.00% of 5
Creating 'mutex.gcov'

File '/usr/include/c++/5/iomanip'
Lines executed:33.33% of 6
No branches
No calls
Creating 'iomanip.gcov'

File '../src/nbody/NBPhysics.hpp'
Lines executed:100.00% of 45
Branches executed:100.00% of 56
Taken at least once:67.86% of 56
Calls executed:89.04% of 73
Creating 'NBPhysics.hpp.gcov'

File '../thirdparty/eigen/Eigen/src/Core/arch/SSE/PacketMath.h'
Lines executed:100.00% of 11
No branches
Calls executed:100.00% of 1
Creating 'PacketMath.h.gcov'

File '../thirdparty/eigen/Eigen/src/Core/util/Meta.h'
Lines executed:100.00% of 2
No branches
No calls
Creating 'Meta.h.gcov'

File '/usr/include/c++/5/atomic'
Lines executed:100.00% of 1
No branches
Calls executed:100.00% of 1
Creating 'atomic.gcov'

File '/usr/include/c++/5/bits/ios_base.h'
Lines executed:9.30% of 43
No branches
Calls executed:0.00% of 13
Creating 'ios_base.h.gcov'

File '/usr/include/x86_64-linux-gnu/c++/5/bits/gthr-default.h'

Lines executed:0.00% of 10
Branches executed:0.00% of 4
Taken at least once:0.00% of 4
Calls executed:0.00% of 4
Creating 'gthr-default.h.gcov'

File '/usr/include/c++/5/limits'
Lines executed:100.00% of 3
No branches
No calls
Creating 'limits.gcov'

File '/usr/include/c++/5/new'
Lines executed:66.67% of 3
No branches
No calls
Creating 'new.gcov'

File '/usr/include/c++/5/cmath'
Lines executed:100.00% of 4
No branches
No calls
Creating 'cmath.gcov'

```
==============================
        -:    0:Source:../src/nbody/NBPhysics.hpp
        -:    0:Graph:test-nbodySimulator.gcno
        -:    0:Data:test-nbodySimulator.gcda
        -:    0:Runs:1
        -:    0:Programs:1
        -:    1:/**
        -:    2: * Header only physics code. Currently, the system equations are
started from
        -:    3: * Boost::Numeric::odeint documentation's example, solar_system.
Physics equations
        -:    4: * will be optimized for speed in later iteration.
        -:    5: */
        -:    6:#pragma once
        -:    7:
        -:    8:#include <vector>
        -:    9:
        -:   10:#include <Eigen/Eigen>
        -:   11:
```

```
        -:   12:#include <math.h>
        -:   13:
        -:   14:#include <boost/numeric/odeint.hpp>
        -:   15:
        -:   16:typedef std::vector<Eigen::Vector3d> VectorXs;
        -:   17:
function NBodyCoordinate::NBodyCoordinate(NBodyCoordinate const&) called 2
returned 100% blocks executed 100%
function NBodyCoordinate::NBodyCoordinate(NBodyCoordinate&&) called 1
returned 100% blocks executed 100%
function NBodyCoordinate::~NBodyCoordinate() called 4 returned 100% blocks
executed 100%
        7:   18:struct NBodyCoordinate
call    0 returned 2
call    1 returned 1
call    2 returned 4
        -:   19:{
        -:   20:    NBodyCoordinate() {}
function NBodyCoordinate::NBodyCoordinate(std::vector<double,
std::allocator<double> > const&) called 1 returned 100% blocks executed 100%
        1:   21:    NBodyCoordinate(const std::vector<double> &m) : _m(m)
call    0 returned 1
        -:   22:    {
        1:   23:    }
        -:   24:
        -:   25:    /**
        -:   26:     * The system function for f(p) = -dH/dq. Computes coordinate
change from momentum
        -:   27:     * This function is modified directly from ODEINT example
solar_system.cpp
        -:   28:     *
        -:   29:     * @param p The state vector of momentum
        -:   30:     * @param dxdt The output derivative vector. Do not initialize this
vector
        -:   31:     */
function NBodyCoordinate::operator()(std::vector<Eigen::Matrix<double, 3, 1, 0, 3,
1>, std::allocator<Eigen::Matrix<double, 3, 1, 0, 3, 1> > > const&,
std::vector<Eigen::Matrix<double, 3, 1, 0, 3, 1>,
std::allocator<Eigen::Matrix<double, 3, 1, 0, 3, 1> > >&) const called 6 returned
100% blocks executed 100%
        6:   32:    void operator()(const VectorXs &p, VectorXs &dqdt) const
        -:   33:    {
        6:   34:        int N = p.size();
```

```
call    0 returned 6
      36:   35:        for (int i = 0; i < N; ++i)
branch  0 taken 30 (fallthrough)
branch  1 taken 6
       -:   36:        {
      30:   37:            dqdt[i] = p[i] / _m[i];
call    0 returned 30
call    1 returned 30
call    2 returned 30
call    3 returned 30
call    4 returned 30
branch  5 taken 30 (fallthrough)
branch  6 taken 0 (throw)
       -:   38:            // std::cout << "p[" << i << "]: " << p[i].transpose() <<
std::endl;
       -:   39:            // std::cout << "m[" << i << "]: " << _m[i] << std::endl;
       -:   40:            // std::cout << "dqdt[" << i << "]: " << dqdt[i].transpose() <<
std::endl;
       -:   41:        }
       6:   42:    }
       -:   43:
       -:   44:    const std::vector<double> &getM() const { return _m; }
       -:   45:
function NBodyCoordinate::addM(double) called 5 returned 100% blocks executed
100%
       5:   46:    void addM(double m) { _m.push_back(m); }
call    0 returned 5
       -:   47:
       -:   48:  private:
       -:   49:    std::vector<double> _m;
       -:   50:};
       -:   51:
function NBodyMomentum::NBodyMomentum(NBodyMomentum const&) called 2
returned 100% blocks executed 100%
function NBodyMomentum::NBodyMomentum(NBodyMomentum&&) called 1
returned 100% blocks executed 100%
function NBodyMomentum::~NBodyMomentum() called 4 returned 100% blocks
executed 100%
       7:   52:struct NBodyMomentum
call    0 returned 2
call    1 returned 1
call    2 returned 4
       -:   53:{
```

```
        -:   54:    NBodyMomentum(double G) : _G(G) {}
function NBodyMomentum::NBodyMomentum(double, std::vector<double,
std::allocator<double> > const&) called 1 returned 100% blocks executed 100%
        1:   55:    NBodyMomentum(double G, const std::vector<double> &m) : _G(G),
_m(m) {}
call    0 returned 1
        -:   56:
        -:   57:    /**
        -:   58:     * The system function for g(q) = -dH/dp. Computes momentum
change from coordinate
        -:   59:     * This function is modified directly from ODEINT example
solar_system.cpp
        -:   60:     */
function NBodyMomentum::operator()(std::vector<Eigen::Matrix<double, 3, 1, 0, 3,
1>, std::allocator<Eigen::Matrix<double, 3, 1, 0, 3, 1> > > const&,
std::vector<Eigen::Matrix<double, 3, 1, 0, 3, 1>,
std::allocator<Eigen::Matrix<double, 3, 1, 0, 3, 1> > >&) const called 6 returned
100% blocks executed 85%
        6:   61:    void operator()(const VectorXs &q, VectorXs &dpdt) const
        -:   62:    {
        6:   63:        int N = q.size();
call    0 returned 6
       36:   64:        for (int i = 0; i < N; ++i)
branch  0 taken 30 (fallthrough)
branch  1 taken 6
        -:   65:        {
       30:   66:            dpdt[i] = Eigen::Vector3d::Zero();
call    0 returned 30
call    1 returned 30
call    2 returned 30
branch  3 taken 30 (fallthrough)
branch  4 taken 0 (throw)
call    5 never executed
       90:   67:            for (int j = 0; j < i; ++j)
branch  0 taken 60 (fallthrough)
branch  1 taken 30
        -:   68:            {
       60:   69:                const auto xi = q[i];
call    0 returned 60
call    1 returned 60
branch  2 taken 60 (fallthrough)
branch  3 taken 0 (throw)
       60:   70:                const auto xj = q[j];
```

```
call    0 returned 60
call    1 returned 60
branch  2 taken 60 (fallthrough)
branch  3 taken 0 (throw)
      60:   71:              auto x = xj - xi;
call    0 returned 60
branch  1 taken 60 (fallthrough)
branch  2 taken 0 (throw)
      60:   72:              double d = x.norm();
call    0 returned 60
branch  1 taken 60 (fallthrough)
branch  2 taken 0 (throw)
      60:   73:              auto ddpdt = _G * _m[i] * _m[j] * x / d / d / d;
call    0 returned 60
call    1 returned 60
call    2 returned 60
branch  3 taken 60 (fallthrough)
branch  4 taken 0 (throw)
call    5 returned 60
branch  6 taken 60 (fallthrough)
branch  7 taken 0 (throw)
call    8 returned 60
branch  9 taken 60 (fallthrough)
branch 10 taken 0 (throw)
call   11 returned 60
branch 12 taken 60 (fallthrough)
branch 13 taken 0 (throw)
      60:   74:              dpdt[i] += ddpdt;
call    0 returned 60
call    1 returned 60
branch  2 taken 60 (fallthrough)
branch  3 taken 0 (throw)
      60:   75:              dpdt[j] -= ddpdt;
call    0 returned 60
call    1 returned 60
branch  2 taken 60 (fallthrough)
branch  3 taken 0 (throw)
       -:   76:            }
       -:   77:            // std::cout << "dpdt[" << i << "]: " << dpdt[i].transpose() <<
std::endl;
       -:   78:        }
       6:   79:    }
       -:   80:
```

```
        -:   81:    double getG() const { return _G; }
        -:   82:
        -:   83:    const std::vector<double> &getM() const { return _m; }
        -:   84:
function NBodyMomentum::addM(double) called 5 returned 100% blocks
executed 100%
        5:   85:    void addM(double m) { _m.push_back(m); }
call    0 returned 5
        -:   86:
        -:   87:  private:
        -:   88:    double _G;
        -:   89:    std::vector<double> _m;
        -:   90:};
        -:   91:
function NBodySimulator::~NBodySimulator() called 1 returned 100% blocks
executed 100%
        1:   92:class NBodySimulator
call    0 returned 1
call    1 returned 1
call    2 returned 1
        -:   93:{
        -:   94:    typedef
boost::numeric::odeint::symplectic_rkn_sb3a_mclachlan<VectorXs> integrator;
        -:   95:
        -:   96:  public:
function NBodySimulator::NBodySimulator(double) called 1 returned 100% blocks
executed 57%
        1:   97:    NBodySimulator(double G) : _system(std::make_pair(
        -:   98:                                NBodyCoordinate(std::vector<double>()),
        1:   99:                                NBodyMomentum(G, std::vector<double>())))
call    0 returned 1
branch  1 taken 1 (fallthrough)
branch  2 taken 0 (throw)
call    3 returned 1
call    4 returned 1
call    5 returned 1
branch  6 taken 1 (fallthrough)
branch  7 taken 0 (throw)
call    8 returned 1
call    9 returned 1
branch 10 taken 1 (fallthrough)
branch 11 taken 0 (throw)
call   12 returned 1
```

```
call   13 returned 1
call   14 returned 1
call   15 returned 1
call   16 returned 1
call   17 never executed
call   18 never executed
call   19 never executed
call   20 never executed
call   21 never executed
call   22 never executed
        -:  100:    {
        1:  101:    }
        -:  102:
function NBodySimulator::do_step(double, double) called 1 returned 100% blocks
executed 83%
        1:  103:    void do_step(double t, double dt)
        -:  104:    {
        1:  105:        _rkn.do_step(_system, _qp, t, dt);
call    0 returned 1
call    1 returned 1
branch  2 taken 1 (fallthrough)
branch  3 taken 0 (throw)
call    4 returned 1
call    5 never executed
        1:  106:    }
        -:  107:
function NBodySimulator::addPoint(Eigen::Matrix<double, 3, 1, 0, 3, 1>,
Eigen::Matrix<double, 3, 1, 0, 3, 1>, double) called 5 returned 100% blocks
executed 89%
        5:  108:    void addPoint(Eigen::Vector3d q, Eigen::Vector3d v, double m)
        -:  109:    {
        -:  110:        // Add coordinate
        5:  111:        _qp.first.push_back(q);
call    0 returned 5
        -:  112:        // Add momentum
        5:  113:        _qp.second.push_back(v * m);
call    0 returned 5
call    1 returned 5
branch  2 taken 5 (fallthrough)
branch  3 taken 0 (throw)
call    4 returned 5
branch  5 taken 5 (fallthrough)
branch  6 taken 0 (throw)
```

```
        -:  114:        // Add mass
        5:  115:        _system.first.addM(m);
call    0 returned 5
        5:  116:        _system.second.addM(m);
call    0 returned 5
        5:  117:    }
        -:  118:
function NBodySimulator::getQs() const called 1 returned 100% blocks executed
100%
        1:  119:    const VectorXs &getQs() const
        -:  120:    {
        1:  121:        return _qp.first;
        -:  122:    }
function NBodySimulator::getPs() const called 1 returned 100% blocks executed
100%
        1:  123:    const VectorXs &getPs() const
        -:  124:    {
        1:  125:        return _qp.second;
        -:  126:    }
        -:  127:
        -:  128:    VectorXs getVs() const
        -:  129:    {
        -:  130:        const std::vector<double> ms = _system.first.getM();
        -:  131:        VectorXs vs = _qp.second;
        -:  132:        for (int i=0;i<ms.size(); ++i)
        -:  133:        {
        -:  134:            vs[i] /= ms[i];
        -:  135:        }
        -:  136:        return vs;
        -:  137:    }
        -:  138:
        -:  139:    Eigen::Vector3d getV(int index) const
        -:  140:    {
        -:  141:        assert(index >= 0 && index < _qp.second.size());
        -:  142:        Eigen::Vector3d p = _qp.second[index];
        -:  143:        assert(_system.first.getM()[index] == _system.second.getM()
[index]);
        -:  144:        return p / _system.first.getM()[index];
        -:  145:    }
        -:  146:
        -:  147:    double getM(int index) const
        -:  148:    {
        -:  149:        assert(index >= 0 && index < _qp.second.size());
```

```
        -:  150:        assert(_system.first.getM()[index] == _system.second.getM()
[index]);
        -:  151:        return _system.first.getM()[index];
        -:  152:    }
        -:  153:
        -:  154:  private:
        -:  155:    integrator _rkn;
        -:  156:    std::pair<VectorXs, VectorXs> _qp;
        -:  157:    std::pair<NBodyCoordinate, NBodyMomentum> _system;
        -:  158:};
        -:  159:
function massIsValid(double) called 10 returned 100% blocks executed 100%
       10:  160:inline bool massIsValid(double m) { return !std::isnan(m) &&
std::isfinite(m) && m > 0.0; }
call    0 returned 10
branch  1 taken 9 (fallthrough)
branch  2 taken 1
call    3 returned 9
branch  4 taken 7 (fallthrough)
branch  5 taken 2
branch  6 taken 3 (fallthrough)
branch  7 taken 4
        -:  161:
function velocityIsValid(Eigen::Matrix<double, 3, 1, 0, 3, 1> const&) called 23
returned 100% blocks executed 100%
       23:  162:inline bool velocityIsValid(const Eigen::Vector3d& v) { return !
v.hasNaN() && v.allFinite();}
call    0 returned 23
branch  1 taken 20 (fallthrough)
branch  2 taken 3
call    3 returned 20
branch  4 taken 14 (fallthrough)
branch  5 taken 6
        -:  163:
function coordinateIsValid(Eigen::Matrix<double, 3, 1, 0, 3, 1> const&) called 23
returned 100% blocks executed 100%
       23:  164:inline bool coordinateIsValid(const Eigen::Vector3d& v) { return !
v.hasNaN() && v.allFinite();}
call    0 returned 23
branch  1 taken 20 (fallthrough)
branch  2 taken 3
call    3 returned 20
branch  4 taken 14 (fallthrough)
```

```
branch  5 taken 6
Coverage report done
travis_time:end:
0715f69c:start=1543435933025032417,finish=1543435947287634923,duration
=14262602506
[0K[32;1mThe command "./test.sh" exited with 0.[0m
```