

The default interactive shell is now zsh.

To update your account to use zsh, please run `chsh -s /bin/zsh`.

For more details, please visit <https://support.apple.com/kb/HT208050>.

(base) 10-19-35-194:~ ChengweiChen\$ cd desktop/3001/hw2

(base) 10-19-35-194:hw2 ChengweiChen\$ for f in nbody.py; do python -m  
cProfile -s cumulative \$f; done

-0.16908926275527172

-0.1690524049239141

-0.16901474404530115

-0.16902307738080738

-0.1690798593916716

-0.1690837851340391

-0.1690461237029509

-0.1690141632287673

-0.1690277860596755

-0.16908371256964286

-0.16908078067628346

-0.16904474158017624

-0.16901196403207439

-0.16903317301080864

-0.16908783999484456

-0.16908019793585344

-0.16904027123722912

-0.16900666759845165

-0.1690385994000913

-0.1690927820263521

-0.16907709741618646

-0.1690318157474469

-0.16900365578743826

-0.16904872400310705

-0.16909656666618936

-0.16907120739400114

-0.16902491372614678

-0.1690054028562737

-0.1690615084418881

-0.16909732952330989

-0.16906445026914277

-0.16901977601924423

-0.1690087837330612

-0.16906942996092264

-0.1690936981250834

-0.16905776550855287

-0.16901607122935539

-0.16901202092861942

-0.1690769590988439

-0.16909176966916228

-0.16905402040535616

-0.16901235909925366

-0.16901736033369455

-0.1690847459685499

-0.16909035534676262  
-0.16904838452880422  
-0.16900663034076266  
-0.16902335367423574  
-0.16909124149510837  
-0.16908618459859356  
-0.16904015517545168  
-0.16900291923555205  
-0.16903287494400335  
-0.16909558331070956  
-0.16908055117120765  
-0.16903390308620184  
-0.16900274590721814  
-0.16904459300211724  
-0.16909854774651836  
-0.16907499697399825  
-0.16902883385621698  
-0.16900287426063337  
-0.16905344993896332  
-0.16909778695827116  
-0.1690688542355601  
-0.16902288517135491  
-0.1690034111639226  
-0.16906323202819348  
-0.16909793327535813  
-0.16906372791458069  
-0.16901758963658736  
-0.16900762655227408  
-0.16907413362652127  
-0.1690966701276139  
-0.16905715253841647  
-0.16901176533650106  
-0.16901316541886924  
-0.16908223578125162  
-0.1690918842838697  
-0.1690491567289713  
-0.1690084483625472  
-0.16902057135969534  
-0.16908716660200046  
-0.16908658831414558  
-0.16904412116934314  
-0.16900740673825185  
-0.16902932050670785  
-0.16909180276278374  
-0.16908292959405574  
-0.16903991544261052  
-0.16900522540601676  
-0.16903656773659115  
-0.16909410318888132  
-0.169078466211733

```

-0.16903274720873912
-0.16900284987920383
-0.1690462807510843
-0.1690971767866576
-0.16907293588692712
-0.16902628585294033

```

326007706 function calls in 162.107 seconds

Ordered by: cumulative time

ncalls	totttime	percall	cumtime	percall	
filename:lineno(function)					
1	0.000	0.000	162.107	162.107	{built-in method
builtins.exec}					
1	0.000	0.000	162.107	162.107	nbody.py:3(<module>)
1	0.764	0.764	162.107	162.107	nbody.py:125(nbody)
2000000	34.648	0.000	161.333	0.000	nbody.py:67(advance)
20000000	42.240	0.000	114.159	0.000	nbody.py:54(update_vs)
120000000	36.292	0.000	71.919	0.000	nbody.py:47(compute_b)
120000000	35.627	0.000	35.627	0.000	nbody.py:51(compute_mag)
10000000	4.744	0.000	4.744	0.000	nbody.py:62(update_rs)
20002000	3.800	0.000	3.800	0.000	
nbody.py:44(compute_deltas)					
20002000	2.212	0.000	2.212	0.000	{method 'append' of
'list' objects}					
14001401	1.771	0.000	1.771	0.000	{method 'keys' of 'dict'
objects}					
200	0.004	0.000	0.006	0.000	
nbody.py:88(report_energy)					
100	0.003	0.000	0.003	0.000	{built-in method
builtins.print}					
2000	0.001	0.000	0.001	0.000	
nbody.py:85(compute_energy)					
1	0.000	0.000	0.000	0.000	
nbody.py:108(offset_momentum)					
1	0.000	0.000	0.000	0.000	{method 'disable' of
'_lsprof.Profiler' objects}					

```

(base) 10-19-35-194:hw2 ChengweiChen$ for f in nbody_1.py; do python
-m cProfile -s cumulative $f; done
-0.16908926275527172
-0.1690524049239141
-0.16901474404530115
-0.16902307738080738
-0.1690798593916716
-0.1690837851340391
-0.1690461237029509
-0.1690141632287673
-0.1690277860596755

```

-0.16908371256964286  
-0.16908078067628346  
-0.16904474158017624  
-0.16901196403207439  
-0.16903317301080864  
-0.16908783999484456  
-0.16908019793585344  
-0.16904027123722912  
-0.16900666759845165  
-0.1690385994000913  
-0.1690927820263521  
-0.16907709741618646  
-0.1690318157474469  
-0.16900365578743826  
-0.16904872400310705  
-0.16909656666618936  
-0.16907120739400114  
-0.16902491372614678  
-0.1690054028562737  
-0.1690615084418881  
-0.16909732952330989  
-0.16906445026914277  
-0.16901977601924423  
-0.1690087837330612  
-0.16906942996092264  
-0.1690936981250834  
-0.16905776550855287  
-0.16901607122935539  
-0.16901202092861942  
-0.1690769590988439  
-0.16909176966916228  
-0.16905402040535616  
-0.16901235909925366  
-0.16901736033369455  
-0.1690847459685499  
-0.16909035534676262  
-0.16904838452880422  
-0.16900663034076266  
-0.16902335367423574  
-0.16909124149510837  
-0.16908618459859356  
-0.16904015517545168  
-0.16900291923555205  
-0.16903287494400335  
-0.16909558331070956  
-0.16908055117120765  
-0.16903390308620184  
-0.16900274590721814  
-0.16904459300211724  
-0.16909854774651836

-0.16907499697399825  
-0.16902883385621698  
-0.16900287426063337  
-0.16905344993896332  
-0.16909778695827116  
-0.1690688542355601  
-0.16902288517135491  
-0.1690034111639226  
-0.16906323202819348  
-0.16909793327535813  
-0.16906372791458069  
-0.16901758963658736  
-0.16900762655227408  
-0.16907413362652127  
-0.1690966701276139  
-0.16905715253841647  
-0.16901176533650106  
-0.16901316541886924  
-0.16908223578125162  
-0.1690918842838697  
-0.1690491567289713  
-0.1690084483625472  
-0.16902057135969534  
-0.16908716660200046  
-0.16908658831414558  
-0.16904412116934314  
-0.16900740673825185  
-0.16902932050670785  
-0.16909180276278374  
-0.16908292959405574  
-0.16903991544261052  
-0.16900522540601676  
-0.16903656773659115  
-0.16909410318888132  
-0.169078466211733  
-0.16903274720873912  
-0.16900284987920383  
-0.1690462807510843  
-0.1690971767866576  
-0.16907293588692712  
-0.16902628585294033

36004011 function calls (36004005 primitive calls) in 48.533  
seconds

Ordered by: cumulative time

ncalls	tottime	percall	cumtime	percall
filename:lineno(function)				
2/1	0.000	0.000	48.533	48.533 {built-in method builtins.exec}

```

1      0.000      0.000      48.533      48.533 nbody_1.py:6(<module>)
1      0.724      0.724      48.531      48.531 nbody_1.py:116(nbody)
2000000 44.363      0.000      47.800      0.000 nbody_1.py:49(advance)
20002000 1.950      0.000      1.950      0.000 {method 'append' of
'list' objects}
14001401 1.488      0.000      1.488      0.000 {method 'keys' of 'dict'
objects}
200      0.004      0.000      0.005      0.000
nbody_1.py:79(report_energy)
100      0.003      0.000      0.003      0.000 {built-in method
builtins.print}
2/1      0.000      0.000      0.001      0.001 <frozen
importlib._bootstrap>:978(_find_and_load)
2/1      0.000      0.000      0.001      0.001 <frozen
importlib._bootstrap>:948(_find_and_load_unlocked)
2/1      0.000      0.000      0.001      0.001 <frozen
importlib._bootstrap>:663(_load_unlocked)
1      0.000      0.000      0.001      0.001 <frozen
importlib._bootstrap_external>:722(exec_module)
1      0.000      0.000      0.001      0.001 <frozen
importlib._bootstrap_external>:793(get_code)
1      0.000      0.000      0.001      0.001 <frozen
importlib._bootstrap_external>:914(get_data)
1      0.001      0.001      0.001      0.001 {method 'read' of
'_io.FileIO' objects}
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:882(_find_spec)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:1272(find_spec)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:1240(_get_spec)
3/1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:211(_call_with_frames_removed)
1      0.000      0.000      0.000      0.000 timeit.py:49(<module>)
3      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:1356(find_spec)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:523(_compile_bytecode)
1      0.000      0.000      0.000      0.000 {built-in method
marshal.loads}
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:576(module_from_spec)
5      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:74(_path_stat)
5      0.000      0.000      0.000      0.000 {built-in method
posix.stat}
4      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:1203(_path_importer_cache)
1      0.000      0.000      0.000      0.000 {built-in method
posix.getcwd}

```

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2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:147(__enter__)
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:504(_init_module_attrs)
16     0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:56(_path_join)
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:157(_get_module_lock)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:740(create_module)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:93(_path_isfile)
1      0.000      0.000      0.000      0.000 {built-in method
builtins.__build_class__}
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:84(_path_is_mode_type)
1      0.000      0.000      0.000      0.000 {built-in method
_imp.create_builtin}
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:271(cache_from_source)
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:403(cached)
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:719(find_spec)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:951(path_stats)
16     0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:58(<listcomp>)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:369(_get_cached)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:438(_classify_pyc)
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:318(__exit__)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:1351(_get_spec)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:433(spec_from_loader)
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:78(acquire)
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:58(__init__)
10     0.000      0.000      0.000      0.000 {built-in method
builtins.getattr}
3      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:51(_r_long)
34     0.000      0.000      0.000      0.000 {method 'rstrip' of
'str' objects}
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:151(__exit__)

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1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:574(spec_from_file_location)
18     0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:222(_verbose_message)
1      0.000      0.000      0.000      0.000
nbody_1.py:99(offset_momentum)
2      0.000      0.000      0.000      0.000 {built-in method
builtins.any}
18     0.000      0.000      0.000      0.000 {method 'join' of 'str'
objects}
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:103(release)
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:176(cb)
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:62(_path_split)
3      0.000      0.000      0.000      0.000 {built-in method
from_bytes}
2      0.000      0.000      0.000      0.000 {built-in method
_imp.is_builtin}
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:369(__init__)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:471(_validate_timestamp_pyc)
11     0.000      0.000      0.000      0.000 {method 'rpartition' of
'str' objects}
9      0.000      0.000      0.000      0.000 {built-in method
builtins.hasattr}
3      0.000      0.000      0.000      0.000 {built-in method
builtins.len}
8      0.000      0.000      0.000      0.000 {built-in method
_imp.acquire_lock}
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:143(__init__)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:232(_requires_builtin_wrapper)
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:311(__enter__)
8      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:321(<genexpr>)
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:416(parent)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:748(exec_module)
4      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:855(__enter__)
1      0.000      0.000      0.000      0.000 {method 'endswith' of
'str' objects}
1      0.000      0.000      0.000      0.000 {built-in method
_imp._fix_co_filename}

```



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3      0.000      0.000      0.000      0.000 {built-in method
posix.fspath}
4      0.000      0.000      0.000      0.000 {built-in method
_thread.allocate_lock}
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:35(_new_module)
3      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:36(_relax_case)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:792(find_spec)
4      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:859(__exit__)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:401(_check_name_wrapper)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:884(__init__)
1      0.000      0.000      0.000      0.000 timeit.py:82(Timer)
4      0.000      0.000      0.000      0.000 {method 'get' of 'dict'
objects}
5      0.000      0.000      0.000      0.000 {built-in method
builtins.isinstance}
1      0.000      0.000      0.000      0.000 {built-in method
_imp.is_frozen}
1      0.000      0.000      0.000      0.000 {built-in method
_imp.exec_builtin}
4      0.000      0.000      0.000      0.000 {built-in method
_thread.get_ident}
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:307(__init__)
8      0.000      0.000      0.000      0.000 {built-in method
_imp.release_lock}
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:424(has_location)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:765(is_package)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:719(create_module)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:909(get_filename)
1      0.000      0.000      0.000      0.000 {method 'disable' of
'_lsprof.Profiler' objects}

```

```

(base) 10-19-35-194:hw2 ChengweiChen$ for f in nbody_2.py; do python
-m cProfile -s cumulative $f; done
-0.16908926275527172
-0.1690524049239141
-0.16901474404530115
-0.16902307738080738
-0.1690798593916716

```

-0.1690837851340391  
-0.1690461237029509  
-0.1690141632287673  
-0.1690277860596755  
-0.16908371256964286  
-0.16908078067628346  
-0.16904474158017624  
-0.16901196403207439  
-0.16903317301080864  
-0.16908783999484456  
-0.16908019793585344  
-0.16904027123722912  
-0.16900666759845165  
-0.1690385994000913  
-0.1690927820263521  
-0.16907709741618646  
-0.1690318157474469  
-0.16900365578743826  
-0.16904872400310705  
-0.16909656666618936  
-0.16907120739400114  
-0.16902491372614678  
-0.1690054028562737  
-0.1690615084418881  
-0.16909732952330989  
-0.16906445026914277  
-0.16901977601924423  
-0.1690087837330612  
-0.16906942996092264  
-0.1690936981250834  
-0.16905776550855287  
-0.16901607122935539  
-0.16901202092861942  
-0.1690769590988439  
-0.16909176966916228  
-0.16905402040535616  
-0.16901235909925366  
-0.16901736033369455  
-0.1690847459685499  
-0.16909035534676262  
-0.16904838452880422  
-0.16900663034076266  
-0.16902335367423574  
-0.16909124149510837  
-0.16908618459859356  
-0.16904015517545168  
-0.16900291923555205  
-0.16903287494400335  
-0.16909558331070956  
-0.16908055117120765

-0.16903390308620184  
-0.16900274590721814  
-0.16904459300211724  
-0.16909854774651836  
-0.16907499697399825  
-0.16902883385621698  
-0.16900287426063337  
-0.16905344993896332  
-0.16909778695827116  
-0.1690688542355601  
-0.16902288517135491  
-0.1690034111639226  
-0.16906323202819348  
-0.16909793327535813  
-0.16906372791458069  
-0.16901758963658736  
-0.16900762655227408  
-0.16907413362652127  
-0.1690966701276139  
-0.16905715253841647  
-0.16901176533650106  
-0.16901316541886924  
-0.16908223578125162  
-0.1690918842838697  
-0.1690491567289713  
-0.1690084483625472  
-0.16902057135969534  
-0.16908716660200046  
-0.16908658831414558  
-0.16904412116934314  
-0.16900740673825185  
-0.16902932050670785  
-0.16909180276278374  
-0.16908292959405574  
-0.16903991544261052  
-0.16900522540601676  
-0.16903656773659115  
-0.16909410318888132  
-0.169078466211733  
-0.16903274720873912  
-0.16900284987920383  
-0.1690462807510843  
-0.1690971767866576  
-0.16907293588692712  
-0.16902628585294033

306006011 function calls (306006005 primitive calls) in  
155.945 seconds

Ordered by: cumulative time

ncalls	tottime	percall	cumtime	percall	
filename:lineno(function)					
2/1	0.000	0.000	155.945	155.945	{built-in method
builtins.exec}					
1	0.000	0.000	155.945	155.945	nbody_2.py:6(<module>)
1	0.770	0.770	155.943	155.943	nbody_2.py:130(nbody)
2000000	28.924	0.000	155.164	0.000	nbody_2.py:72(advance)
20000000	42.674	0.000	116.118	0.000	nbody_2.py:59(update_vs)
120000000	36.952	0.000	73.444	0.000	nbody_2.py:52(compute_b)
120000000	36.493	0.000	36.493	0.000	
nbody_2.py:56(compute_mag)					
10000000	4.817	0.000	4.817	0.000	nbody_2.py:67(update_rs)
20002000	3.760	0.000	3.760	0.000	
nbody_2.py:49(compute_deltas)					
14001401	1.546	0.000	1.546	0.000	{method 'keys' of 'dict'
objects}					
200	0.004	0.000	0.006	0.000	
nbody_2.py:93(report_energy)					
100	0.003	0.000	0.003	0.000	{built-in method
builtins.print}					
2/1	0.000	0.000	0.002	0.002	<frozen
importlib._bootstrap>:978(_find_and_load)					
2/1	0.000	0.000	0.002	0.002	<frozen
importlib._bootstrap>:948(_find_and_load_unlocked)					
2/1	0.000	0.000	0.001	0.001	<frozen
importlib._bootstrap>:663(_load_unlocked)					
1	0.000	0.000	0.001	0.001	<frozen
importlib._bootstrap_external>:722(exec_module)					
1	0.000	0.000	0.001	0.001	<frozen
importlib._bootstrap_external>:793(get_code)					
2000	0.001	0.000	0.001	0.000	
nbody_2.py:90(compute_energy)					
1	0.000	0.000	0.001	0.001	<frozen
importlib._bootstrap_external>:914(get_data)					
2	0.000	0.000	0.001	0.000	<frozen
importlib._bootstrap>:882(_find_spec)					
1	0.000	0.000	0.000	0.000	<frozen
importlib._bootstrap_external>:1272(find_spec)					
1	0.000	0.000	0.000	0.000	<frozen
importlib._bootstrap_external>:1240(_get_spec)					
1	0.000	0.000	0.000	0.000	{method 'read' of
'_io.FileIO' objects}					
3/1	0.000	0.000	0.000	0.000	<frozen
importlib._bootstrap>:211(_call_with_frames_removed)					
1	0.000	0.000	0.000	0.000	timeit.py:49(<module>)
3	0.000	0.000	0.000	0.000	<frozen
importlib._bootstrap_external>:1356(find_spec)					
1	0.000	0.000	0.000	0.000	<frozen
importlib._bootstrap_external>:523(_compile_bytecode)					
1	0.000	0.000	0.000	0.000	{built-in method

```

marshal.loads}
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:576(module_from_spec)
    5    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:74(_path_stat)
    5    0.000    0.000    0.000    0.000 {built-in method
posix.stat}
    4    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:1203(_path_importer_cache)
    1    0.000    0.000    0.000    0.000 {built-in method
posix.getcwd}
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:504(_init_module_attrs)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:147(__enter__)
   16    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:56(_path_join)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:740(create_module)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:157(_get_module_lock)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:93(_path_isfile)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:84(_path_is_mode_type)
    1    0.000    0.000    0.000    0.000 {built-in method
_imp.create_builtin}
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:951(path_stats)
    1    0.000    0.000    0.000    0.000 {built-in method
builtins.__build_class__}
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:271(cache_from_source)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:403(cached)
   16    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:58(<listcomp>)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:719(find_spec)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:369(_get_cached)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:1351(_get_spec)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:318(__exit__)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:438(_classify_pyc)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:433(spec_from_loader)
    2    0.000    0.000    0.000    0.000 <frozen

```

```

importlib._bootstrap>:78(acquire)
    18    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:222(_verbose_message)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:58(__init__)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:151(__exit__)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:574(spec_from_file_location)
    34    0.000    0.000    0.000    0.000 {method 'rstrip' of
'str' objects}
    10    0.000    0.000    0.000    0.000 {built-in method
builtins.getattr}
    3    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:51(_r_long)
    1    0.000    0.000    0.000    0.000
nbody_2.py:113(offset_momentum)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:103(release)
    9    0.000    0.000    0.000    0.000 {built-in method
builtins.hasattr}
    18    0.000    0.000    0.000    0.000 {method 'join' of 'str'
objects}
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:176(cb)
    2    0.000    0.000    0.000    0.000 {built-in method
builtins.any}
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:62(_path_split)
    4    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:859(__exit__)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:471(_validate_timestamp_pyc)
    2    0.000    0.000    0.000    0.000 {built-in method
_imp.is_builtin}
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:369(__init__)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:748(exec_module)
    4    0.000    0.000    0.000    0.000 {built-in method
_thread.allocate_lock}
    4    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:855(__enter__)
    11    0.000    0.000    0.000    0.000 {method 'rpartition' of
'str' objects}
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:232(_requires_builtin_wrapper)
    8    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:321(<genexpr>)
    2    0.000    0.000    0.000    0.000 <frozen

```

```

importlib._bootstrap>:416(parent)
    1    0.000    0.000    0.000    0.000 timeit.py:82(Timer)
    5    0.000    0.000    0.000    0.000 {built-in method
builtins.isinstance}
    8    0.000    0.000    0.000    0.000 {built-in method
_imp.acquire_lock}
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:35(_new_module)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:307(__init__)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:311(__enter__)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:792(find_spec)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:401(_check_name_wrapper)
    3    0.000    0.000    0.000    0.000 {built-in method
from_bytes}
    1    0.000    0.000    0.000    0.000 {method 'endswith' of
'str' objects}
    8    0.000    0.000    0.000    0.000 {built-in method
_imp.release_lock}
    1    0.000    0.000    0.000    0.000 {built-in method
_imp._fix_co_filename}
    3    0.000    0.000    0.000    0.000 {built-in method
posix.fspath}
    4    0.000    0.000    0.000    0.000 {built-in method
_thread.get_ident}
    3    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:36(_relax_case)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:143(__init__)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:884(__init__)
    4    0.000    0.000    0.000    0.000 {method 'get' of 'dict'
objects}
    3    0.000    0.000    0.000    0.000 {built-in method
builtins.len}
    1    0.000    0.000    0.000    0.000 {built-in method
_imp.exec_builtin}
    1    0.000    0.000    0.000    0.000 {built-in method
_imp.is_frozen}
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:424(has_location)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:765(is_package)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:719(create_module)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:909(get_filename)

```

```
1      0.000      0.000      0.000      0.000 {method 'disable' of
'_lsprof.Profiler' objects}
```

```
(base) 10-19-35-194:hw2 ChengweiChen$ for f in nbody_3.py; do python
-m cProfile -s cumulative $f; done
```

```
-0.16908926275527172
-0.1690524049239141
-0.16901474404530115
-0.16902307738080738
-0.1690798593916716
-0.1690837851340391
-0.1690461237029509
-0.1690141632287673
-0.1690277860596755
-0.16908371256964286
-0.16908078067628346
-0.16904474158017624
-0.16901196403207439
-0.16903317301080864
-0.16908783999484456
-0.16908019793585344
-0.16904027123722912
-0.16900666759845165
-0.1690385994000913
-0.1690927820263521
-0.16907709741618646
-0.1690318157474469
-0.16900365578743826
-0.16904872400310705
-0.16909656666618936
-0.16907120739400114
-0.16902491372614678
-0.1690054028562737
-0.1690615084418881
-0.16909732952330989
-0.16906445026914277
-0.16901977601924423
-0.1690087837330612
-0.16906942996092264
-0.1690936981250834
-0.16905776550855287
-0.16901607122935539
-0.16901202092861942
-0.1690769590988439
-0.16909176966916228
-0.16905402040535616
-0.16901235909925366
-0.16901736033369455
-0.1690847459685499
```



-0.16909035534676262  
-0.16904838452880422  
-0.16900663034076266  
-0.16902335367423574  
-0.16909124149510837  
-0.16908618459859356  
-0.16904015517545168  
-0.16900291923555205  
-0.16903287494400335  
-0.16909558331070956  
-0.16908055117120765  
-0.16903390308620184  
-0.16900274590721814  
-0.16904459300211724  
-0.16909854774651836  
-0.16907499697399825  
-0.16902883385621698  
-0.16900287426063337  
-0.16905344993896332  
-0.16909778695827116  
-0.1690688542355601  
-0.16902288517135491  
-0.1690034111639226  
-0.16906323202819348  
-0.16909793327535813  
-0.16906372791458069  
-0.16901758963658736  
-0.16900762655227408  
-0.16907413362652127  
-0.1690966701276139  
-0.16905715253841647  
-0.16901176533650106  
-0.16901316541886924  
-0.16908223578125162  
-0.1690918842838697  
-0.1690491567289713  
-0.1690084483625472  
-0.16902057135969534  
-0.16908716660200046  
-0.16908658831414558  
-0.16904412116934314  
-0.16900740673825185  
-0.16902932050670785  
-0.16909180276278374  
-0.16908292959405574  
-0.16903991544261052  
-0.16900522540601676  
-0.16903656773659115  
-0.16909410318888132  
-0.169078466211733

```

-0.16903274720873912
-0.16900284987920383
-0.1690462807510843
-0.1690971767866576
-0.16907293588692712
-0.16902628585294033

```

324008011 function calls (324008005 primitive calls) in  
160.538 seconds

Ordered by: cumulative time

ncalls	totttime	percall	cumtime	percall	
filename:lineno(function)					
2/1	0.000	0.000	160.538	160.538	{built-in method
builtins.exec}					
1	0.000	0.000	160.538	160.538	nbody_3.py:6(<module>)
1	0.783	0.783	160.536	160.536	nbody_3.py:135(nbody)
2000000	32.851	0.000	159.744	0.000	nbody_3.py:73(advance)
20000000	42.440	0.000	114.630	0.000	nbody_3.py:60(update_vs)
120000000	36.068	0.000	72.191	0.000	nbody_3.py:53(compute_b)
120000000	36.123	0.000	36.123	0.000	
nbody_3.py:57(compute_mag)					
10000000	4.746	0.000	4.746	0.000	nbody_3.py:68(update_rs)
20002000	3.771	0.000	3.771	0.000	
nbody_3.py:50(compute_deltas)					
20002000	2.265	0.000	2.265	0.000	{method 'append' of
'list' objects}					
12001401	1.482	0.000	1.482	0.000	{method 'keys' of 'dict'
objects}					
200	0.004	0.000	0.006	0.000	
nbody_3.py:95(report_energy)					
100	0.003	0.000	0.003	0.000	{built-in method
builtins.print}					
2/1	0.000	0.000	0.002	0.002	<frozen
importlib._bootstrap>:978(_find_and_load)					
2/1	0.000	0.000	0.002	0.002	<frozen
importlib._bootstrap>:948(_find_and_load_unlocked)					
2/1	0.000	0.000	0.001	0.001	<frozen
importlib._bootstrap>:663(_load_unlocked)					
1	0.000	0.000	0.001	0.001	<frozen
importlib._bootstrap_external>:722(exec_module)					
1	0.000	0.000	0.001	0.001	<frozen
importlib._bootstrap_external>:793(get_code)					
2000	0.001	0.000	0.001	0.000	
nbody_3.py:92(compute_energy)					
1	0.000	0.000	0.001	0.001	<frozen
importlib._bootstrap_external>:914(get_data)					
2	0.000	0.000	0.001	0.000	<frozen
importlib._bootstrap>:882(_find_spec)					
1	0.000	0.000	0.000	0.000	<frozen

```

importlib._bootstrap_external>:1272(find_spec)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:1240(_get_spec)
    1    0.000    0.000    0.000    0.000 {method 'read' of
'_io.FileIO' objects}
    3/1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:211(_call_with_frames_removed)
    1    0.000    0.000    0.000    0.000 timeit.py:49(<module>)
    3    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:1356(find_spec)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:523(_compile_bytecode)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:576(module_from_spec)
    1    0.000    0.000    0.000    0.000 {built-in method
marshal.loads}
    5    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:74(_path_stat)
    5    0.000    0.000    0.000    0.000 {built-in method
posix.stat}
    4    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:1203(_path_importer_cache)
    1    0.000    0.000    0.000    0.000 {built-in method
posix.getcwd}
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:504(_init_module_attrs)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:147(__enter__)
    16    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:56(_path_join)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:740(create_module)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:157(_get_module_lock)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:93(_path_isfile)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:84(_path_is_mode_type)
    1    0.000    0.000    0.000    0.000 {built-in method
_imp.create_builtin}
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:271(cache_from_source)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:951(path_stats)
    16    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:58(<listcomp>)
    1    0.000    0.000    0.000    0.000 {built-in method
builtins.__build_class__}
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:403(cached)

```

```

1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:369(_get_cached)
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:719(find_spec)
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:318(__exit__)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:1351(_get_spec)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:438(_classify_pyc)
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:78(acquire)
18     0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:222(_verbose_message)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:433(spec_from_loader)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:574(spec_from_file_location)
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:58(__init__)
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:151(__exit__)
10     0.000      0.000      0.000      0.000 {built-in method
builtins.getattr}
34     0.000      0.000      0.000      0.000 {method 'rstrip' of
'str' objects}
3      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:51(_r_long)
1      0.000      0.000      0.000      0.000
nbody_3.py:117(offset_momentum)
18     0.000      0.000      0.000      0.000 {method 'join' of 'str'
objects}
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:103(release)
2      0.000      0.000      0.000      0.000 {built-in method
builtins.any}
9      0.000      0.000      0.000      0.000 {built-in method
builtins.hasattr}
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:176(cb)
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:369(__init__)
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:62(_path_split)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:471(_validate_timestamp_pyc)
11     0.000      0.000      0.000      0.000 {method 'rpartition' of
'str' objects}
4      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:859(__exit__)

```

2	0.000	0.000	0.000	0.000	{built-in method
_imp.is_builtin}					
8	0.000	0.000	0.000	0.000	<frozen
importlib._bootstrap>:321(<genexpr>)					
2	0.000	0.000	0.000	0.000	<frozen
importlib._bootstrap>:416(parent)					
1	0.000	0.000	0.000	0.000	<frozen
importlib._bootstrap>:748(exec_module)					
4	0.000	0.000	0.000	0.000	{built-in method
_thread.allocate_lock}					
8	0.000	0.000	0.000	0.000	{built-in method
_imp.release_lock}					
1	0.000	0.000	0.000	0.000	{built-in method
_imp._fix_co_filename}					
1	0.000	0.000	0.000	0.000	<frozen
importlib._bootstrap>:35(_new_module)					
2	0.000	0.000	0.000	0.000	<frozen
importlib._bootstrap>:143(__init__)					
1	0.000	0.000	0.000	0.000	<frozen
importlib._bootstrap>:232(_requires_builtin_wrapper)					
2	0.000	0.000	0.000	0.000	<frozen
importlib._bootstrap>:311(__enter__)					
1	0.000	0.000	0.000	0.000	<frozen
importlib._bootstrap>:792(find_spec)					
4	0.000	0.000	0.000	0.000	<frozen
importlib._bootstrap>:855(__enter__)					
1	0.000	0.000	0.000	0.000	<frozen
importlib._bootstrap_external>:401(_check_name_wrapper)					
1	0.000	0.000	0.000	0.000	timeit.py:82(Timer)
3	0.000	0.000	0.000	0.000	{built-in method
from_bytes}					
5	0.000	0.000	0.000	0.000	{built-in method
builtins.isinstance}					
8	0.000	0.000	0.000	0.000	{built-in method
_imp.acquire_lock}					
4	0.000	0.000	0.000	0.000	{built-in method
_thread.get_ident}					
3	0.000	0.000	0.000	0.000	<frozen
importlib._bootstrap_external>:36(_relax_case)					
2	0.000	0.000	0.000	0.000	<frozen
importlib._bootstrap>:307(__init__)					
4	0.000	0.000	0.000	0.000	{method 'get' of 'dict'
objects}					
1	0.000	0.000	0.000	0.000	{method 'endswith' of
'str' objects}					
3	0.000	0.000	0.000	0.000	{built-in method
builtins.len}					
3	0.000	0.000	0.000	0.000	{built-in method
posix.fspath}					
2	0.000	0.000	0.000	0.000	<frozen

```

importlib._bootstrap>:424(has_location)
      1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:884(__init__)
      1      0.000      0.000      0.000      0.000 {built-in method
_imp.is_frozen}
      1      0.000      0.000      0.000      0.000 {built-in method
_imp.exec_builtin}
      1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:719(create_module)
      1      0.000      0.000      0.000      0.000 {method 'disable' of
'_lsprof.Profiler' objects}
      1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:765(is_package)
      1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:909(get_filename)

```

```

(base) 10-19-35-194:hw2 ChengweiChen$ for f in nbody_4.py; do python
-m cProfile -s cumulative $f; done
-0.16908926275527172
-0.1690524049239141
-0.16901474404530115
-0.16902307738080738
-0.1690798593916716
-0.1690837851340391
-0.1690461237029509
-0.1690141632287673
-0.1690277860596755
-0.16908371256964286
-0.16908078067628346
-0.16904474158017624
-0.16901196403207439
-0.16903317301080864
-0.16908783999484456
-0.16908019793585344
-0.16904027123722912
-0.16900666759845165
-0.1690385994000913
-0.1690927820263521
-0.16907709741618646
-0.1690318157474469
-0.16900365578743826
-0.16904872400310705
-0.16909656666618936
-0.16907120739400114
-0.16902491372614678
-0.1690054028562737
-0.1690615084418881
-0.16909732952330989
-0.16906445026914277

```

-0.16901977601924423  
-0.1690087837330612  
-0.16906942996092264  
-0.1690936981250834  
-0.16905776550855287  
-0.16901607122935539  
-0.16901202092861942  
-0.1690769590988439  
-0.16909176966916228  
-0.16905402040535616  
-0.16901235909925366  
-0.16901736033369455  
-0.1690847459685499  
-0.16909035534676262  
-0.16904838452880422  
-0.16900663034076266  
-0.16902335367423574  
-0.16909124149510837  
-0.16908618459859356  
-0.16904015517545168  
-0.16900291923555205  
-0.16903287494400335  
-0.16909558331070956  
-0.16908055117120765  
-0.16903390308620184  
-0.16900274590721814  
-0.16904459300211724  
-0.16909854774651836  
-0.16907499697399825  
-0.16902883385621698  
-0.16900287426063337  
-0.16905344993896332  
-0.16909778695827116  
-0.1690688542355601  
-0.16902288517135491  
-0.1690034111639226  
-0.16906323202819348  
-0.16909793327535813  
-0.16906372791458069  
-0.16901758963658736  
-0.16900762655227408  
-0.16907413362652127  
-0.1690966701276139  
-0.16905715253841647  
-0.16901176533650106  
-0.16901316541886924  
-0.16908223578125162  
-0.1690918842838697  
-0.1690491567289713  
-0.1690084483625472

```

-0.16902057135969534
-0.16908716660200046
-0.16908658831414558
-0.16904412116934314
-0.16900740673825185
-0.16902932050670785
-0.16909180276278374
-0.16908292959405574
-0.16903991544261052
-0.16900522540601676
-0.16903656773659115
-0.16909410318888132
-0.169078466211733
-0.16903274720873912
-0.16900284987920383
-0.1690462807510843
-0.1690971767866576
-0.16907293588692712
-0.16902628585294033

```

294004811 function calls (294004805 primitive calls) in  
157.537 seconds

Ordered by: cumulative time

ncalls	totttime	percall	cumtime	percall	
filename:lineno(function)					
2/1	0.000	0.000	157.537	157.537	{built-in method
builtins.exec}					
1	0.000	0.000	157.537	157.537	nbody_4.py:6(<module>)
1	0.896	0.896	157.537	157.537	nbody_4.py:127(nbody)
2000000	22.701	0.000	156.632	0.000	nbody_4.py:74(advance)
20000000	45.071	0.000	124.490	0.000	nbody_4.py:60(update_vs)
120000000	39.841	0.000	79.418	0.000	nbody_4.py:53(compute_b)
120000000	39.577	0.000	39.577	0.000	
nbody_4.py:57(compute_mag)					
10000000	5.099	0.000	5.099	0.000	nbody_4.py:68(update_rs)
20002000	4.053	0.000	4.053	0.000	
nbody_4.py:50(compute_deltas)					
2000201	0.289	0.000	0.289	0.000	{method 'keys' of 'dict'
objects}					
200	0.003	0.000	0.005	0.000	
nbody_4.py:92(report_energy)					
100	0.004	0.000	0.004	0.000	{built-in method
builtins.print}					
2000	0.001	0.000	0.001	0.000	
nbody_4.py:89(compute_energy)					
2/1	0.000	0.000	0.001	0.001	<frozen
importlib._bootstrap>:978(_find_and_load)					
2/1	0.000	0.000	0.001	0.001	<frozen
importlib._bootstrap>:948(_find_and_load_unlocked)					



```

2/1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:663(_load_unlocked)
1        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:722(exec_module)
2        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:882(_find_spec)
1        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:1272(find_spec)
1        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:1240(_get_spec)
1        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:793(get_code)
3        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:1356(find_spec)
3/1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:211(_call_with_frames_removed)
1        0.000      0.000      0.000      0.000 timeit.py:49(<module>)
1        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:914(get_data)
1        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:523(_compile_bytecode)
2        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:576(module_from_spec)
5        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:74(_path_stat)
4        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:1203(_path_importer_cache)
5        0.000      0.000      0.000      0.000 {built-in method
posix.stat}
1        0.000      0.000      0.000      0.000 {built-in method
marshal.loads}
1        0.000      0.000      0.000      0.000 {built-in method
posix.getcwd}
2        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:504(_init_module_attrs)
2        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:147(__enter__)
16       0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:56(_path_join)
1        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:93(_path_isfile)
1        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:84(_path_is_mode_type)
1        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:740(create_module)
2        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:157(_get_module_lock)
1        0.000      0.000      0.000      0.000 {built-in method
_imp.create_builtin}
2        0.000      0.000      0.000      0.000 <frozen

```

```

importlib._bootstrap_external>:271(cache_from_source)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:403(cached)
    16    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:58(<listcomp>)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:951(path_stats)
    1    0.000    0.000    0.000    0.000 {built-in method
builtins.__build_class__}
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:369(_get_cached)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:719(find_spec)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:1351(_get_spec)
    1    0.000    0.000    0.000    0.000 {method 'read' of
'_io.FileIO' objects}
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:318(__exit__)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:433(spec_from_loader)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:58(__init__)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:78(acquire)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:574(spec_from_file_location)
    10    0.000    0.000    0.000    0.000 {built-in method
builtins.getattr}
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:151(__exit__)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:438(_classify_pyc)
    9    0.000    0.000    0.000    0.000 {built-in method
builtins.hasattr}
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:103(release)
    1    0.000    0.000    0.000    0.000
nbody_4.py:110(offset_momentum)
    18    0.000    0.000    0.000    0.000 {method 'join' of 'str'
objects}
    2    0.000    0.000    0.000    0.000 {built-in method
builtins.any}
    18    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:222(_verbose_message)
    3    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:51(_r_long)
    34    0.000    0.000    0.000    0.000 {method 'rstrip' of
'str' objects}
    2    0.000    0.000    0.000    0.000 <frozen

```

```

importlib._bootstrap>:176(cb)
    11    0.000    0.000    0.000    0.000 {method 'rpartition' of
'str' objects}
    2    0.000    0.000    0.000    0.000 {built-in method
_imp.is_builtin}
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:62(_path_split)
    4    0.000    0.000    0.000    0.000 {method 'get' of 'dict'
objects}
    5    0.000    0.000    0.000    0.000 {built-in method
builtins.isinstance}
    4    0.000    0.000    0.000    0.000 {built-in method
_thread.allocate_lock}
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:232(_requires_builtin_wrapper)
    8    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:321(<genexpr>)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:369(__init__)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:748(exec_module)
    4    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:855(__enter__)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:471(_validate_timestamp_pyc)
    8    0.000    0.000    0.000    0.000 {built-in method
_imp.release_lock}
    1    0.000    0.000    0.000    0.000 {built-in method
_imp._fix_co_filename}
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:35(_new_module)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:143(__init__)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:307(__init__)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:311(__enter__)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:416(parent)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:792(find_spec)
    4    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:859(__exit__)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:401(_check_name_wrapper)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:884(__init__)
    1    0.000    0.000    0.000    0.000 timeit.py:82(Timer)
    3    0.000    0.000    0.000    0.000 {built-in method
from_bytes}

```

```

1      0.000      0.000      0.000      0.000 {method 'endswith' of
'str' objects}
3      0.000      0.000      0.000      0.000 {built-in method
builtins.len}
8      0.000      0.000      0.000      0.000 {built-in method
_imp.acquire_lock}
3      0.000      0.000      0.000      0.000 {built-in method
posix.fspath}
3      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:36(_relax_case)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:765(is_package)
1      0.000      0.000      0.000      0.000 {method 'disable' of
'_lsprof.Profiler' objects}
1      0.000      0.000      0.000      0.000 {built-in method
_imp.is_frozen}
1      0.000      0.000      0.000      0.000 {built-in method
_imp.exec_builtin}
4      0.000      0.000      0.000      0.000 {built-in method
_thread.get_ident}
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:424(has_location)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:719(create_module)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:909(get_filename)

```

```

(base) 10-19-35-194:hw2 ChengweiChen$ for f in nbody_opt.py; do python
-m cProfile -s cumulative $f; done
-0.16908926275527172
-0.1690524049239141
-0.16901474404530115
-0.16902307738080738
-0.1690798593916716
-0.1690837851340391
-0.1690461237029509
-0.1690141632287673
-0.1690277860596755
-0.16908371256964286
-0.16908078067628346
-0.16904474158017624
-0.16901196403207439
-0.16903317301080864
-0.16908783999484456
-0.16908019793585344
-0.16904027123722912
-0.16900666759845165
-0.1690385994000913
-0.1690927820263521

```

-0.16907709741618646  
-0.1690318157474469  
-0.16900365578743826  
-0.16904872400310705  
-0.16909656666618936  
-0.16907120739400114  
-0.16902491372614678  
-0.1690054028562737  
-0.1690615084418881  
-0.16909732952330989  
-0.16906445026914277  
-0.16901977601924423  
-0.1690087837330612  
-0.16906942996092264  
-0.1690936981250834  
-0.16905776550855287  
-0.16901607122935539  
-0.16901202092861942  
-0.1690769590988439  
-0.16909176966916228  
-0.16905402040535616  
-0.16901235909925366  
-0.16901736033369455  
-0.1690847459685499  
-0.16909035534676262  
-0.16904838452880422  
-0.16900663034076266  
-0.16902335367423574  
-0.16909124149510837  
-0.16908618459859356  
-0.16904015517545168  
-0.16900291923555205  
-0.16903287494400335  
-0.16909558331070956  
-0.16908055117120765  
-0.16903390308620184  
-0.16900274590721814  
-0.16904459300211724  
-0.16909854774651836  
-0.16907499697399825  
-0.16902883385621698  
-0.16900287426063337  
-0.16905344993896332  
-0.16909778695827116  
-0.1690688542355601  
-0.16902288517135491  
-0.1690034111639226  
-0.16906323202819348  
-0.16909793327535813  
-0.16906372791458069

```

-0.16901758963658736
-0.16900762655227408
-0.16907413362652127
-0.1690966701276139
-0.16905715253841647
-0.16901176533650106
-0.16901316541886924
-0.16908223578125162
-0.1690918842838697
-0.1690491567289713
-0.1690084483625472
-0.16902057135969534
-0.16908716660200046
-0.16908658831414558
-0.16904412116934314
-0.16900740673825185
-0.16902932050670785
-0.16909180276278374
-0.16908292959405574
-0.16903991544261052
-0.16900522540601676
-0.16903656773659115
-0.16909410318888132
-0.169078466211733
-0.16903274720873912
-0.16900284987920383
-0.1690462807510843
-0.1690971767866576
-0.16907293588692712
-0.16902628585294033

```

2000911 function calls (2000905 primitive calls) in 30.799 seconds

Ordered by: cumulative time

	ncalls	tottime	percall	cumtime	percall	
filename:lineno(function)						
2/1	0.000	0.000	30.799	30.799		{built-in method
builtins.exec}						
1	0.000	0.000	30.799	30.799		nbody_opt.py:6(<module>)
1	0.001	0.001	30.798	30.798		nbody_opt.py:75(nbody)
100	30.588	0.306	30.791	0.308		nbody_opt.py:11(advance)
2000201	0.203	0.000	0.203	0.000		{method 'keys' of 'dict'
objects}						
100	0.003	0.000	0.003	0.000		{built-in method
builtins.print}						
200	0.003	0.000	0.003	0.000		
nbody_opt.py:40(report_energy)						
2/1	0.000	0.000	0.001	0.001		<frozen
importlib._bootstrap>:978(_find_and_load)						

```

2/1      0.000      0.000      0.001      0.001 <frozen
importlib._bootstrap>:948(_find_and_load_unlocked)
2/1      0.000      0.000      0.001      0.001 <frozen
importlib._bootstrap>:663(_load_unlocked)
1        0.000      0.000      0.001      0.001 <frozen
importlib._bootstrap_external>:722(exec_module)
1        0.000      0.000      0.001      0.001 <frozen
importlib._bootstrap_external>:793(get_code)
1        0.000      0.000      0.001      0.001 <frozen
importlib._bootstrap_external>:914(get_data)
1        0.000      0.000      0.000      0.000 {method 'read' of
'_io.FileIO' objects}
2        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:882(_find_spec)
1        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:1272(find_spec)
1        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:1240(_get_spec)
3/1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:211(_call_with_frames_removed)
1        0.000      0.000      0.000      0.000 timeit.py:49(<module>)
3        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:1356(find_spec)
1        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:523(_compile_bytecode)
1        0.000      0.000      0.000      0.000 {built-in method
marshal.loads}
2        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:576(module_from_spec)
5        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:74(_path_stat)
5        0.000      0.000      0.000      0.000 {built-in method
posix.stat}
4        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:1203(_path_importer_cache)
1        0.000      0.000      0.000      0.000 {built-in method
posix.getcwd}
2        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:504(_init_module_attrs)
1        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:740(create_module)
2        0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:147(__enter__)
1        0.000      0.000      0.000      0.000 {built-in method
_imp.create_builtin}
16       0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:56(_path_join)
1        0.000      0.000      0.000      0.000 {built-in method
builtins.__build_class__}
1        0.000      0.000      0.000      0.000 <frozen

```

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importlib._bootstrap_external>:93(_path_isfile)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:157(_get_module_lock)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:84(_path_is_mode_type)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:403(cached)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:271(cache_from_source)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:438(_classify_pyc)
   16    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:58(<listcomp>)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:719(find_spec)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:951(path_stats)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:369(_get_cached)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:318(__exit__)
    3    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:51(_r_long)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:433(spec_from_loader)
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:1351(_get_spec)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:78(acquire)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:151(__exit__)
   18    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:222(_verbose_message)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:58(__init__)
    1    0.000    0.000    0.000    0.000
nbody_opt.py:59(offset_momentum)
   10    0.000    0.000    0.000    0.000 {built-in method
builtins.getattr}
    9    0.000    0.000    0.000    0.000 {built-in method
builtins.hasattr}
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:574(spec_from_file_location)
    2    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:103(release)
    2    0.000    0.000    0.000    0.000 {built-in method
builtins.any}
    1    0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:471(_validate_timestamp_pyc)
   18    0.000    0.000    0.000    0.000 {method 'join' of 'str'

```



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objects}
    34    0.000    0.000    0.000    0.000 {method 'rstrip' of
'str' objects}
    2     0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:176(cb)
    3     0.000    0.000    0.000    0.000 {built-in method
from_bytes}
    2     0.000    0.000    0.000    0.000 {built-in method
_imp.is_builtin}
    1     0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:748(exec_module)
    2     0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:62(_path_split)
    4     0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:855(__enter__)
    4     0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:859(__exit__)
   11     0.000    0.000    0.000    0.000 {method 'rpartition' of
'str' objects}
    8     0.000    0.000    0.000    0.000 {built-in method
_imp.acquire_lock}
    3     0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap_external>:36(_relax_case)
    1     0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:232(_requires_builtin_wrapper)
    2     0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:311(__enter__)
    2     0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:369(__init__)
    2     0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:416(parent)
    1     0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:792(find_spec)
    1     0.000    0.000    0.000    0.000 timeit.py:82(Timer)
    4     0.000    0.000    0.000    0.000 {method 'get' of 'dict'
objects}
    5     0.000    0.000    0.000    0.000 {built-in method
builtins.isinstance}
    8     0.000    0.000    0.000    0.000 {built-in method
_imp.release_lock}
    1     0.000    0.000    0.000    0.000 {built-in method
_imp._fix_co_filename}
    4     0.000    0.000    0.000    0.000 {built-in method
_thread.allocate_lock}
    4     0.000    0.000    0.000    0.000 {built-in method
_thread.get_ident}
    1     0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:35(_new_module)
    2     0.000    0.000    0.000    0.000 <frozen
importlib._bootstrap>:143(__init__)

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2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:307(__init__)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:401(_check_name_wrapper)
1      0.000      0.000      0.000      0.000 {method 'endswith' of
'str' objects}
3      0.000      0.000      0.000      0.000 {built-in method
builtins.len}
1      0.000      0.000      0.000      0.000 {built-in method
_imp.exec_builtin}
2      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:424(has_location)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:884(__init__)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:909(get_filename)
1      0.000      0.000      0.000      0.000 {built-in method
_imp.is_frozen}
3      0.000      0.000      0.000      0.000 {built-in method
posix.fspath}
8      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:321(<genexpr>)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap>:765(is_package)
1      0.000      0.000      0.000      0.000 <frozen
importlib._bootstrap_external>:719(create_module)
1      0.000      0.000      0.000      0.000 {method 'disable' of
'_lsprof.Profiler' objects}

```