MATH 337 FINAL PROJECT

ALGORITHMIC DIFFERENTIATION

using the Taylor method for high-accuracy integration of non-stiff problems

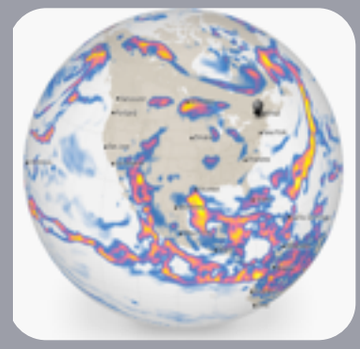
#DIFFERENTIATEEVERYTHING

ANDREW REAGAN
DEPARTMENT OF MATH
UNIVERSITY OF VERMONT

MAIN IDEAS

ALGORITHMIC DIFFERENTIATION

The basics, main theorem, example

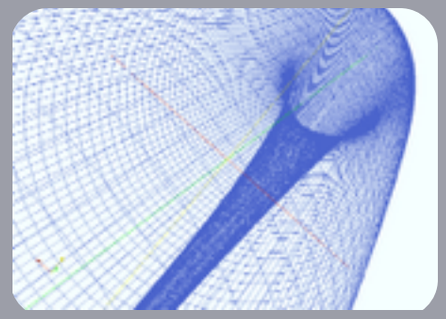


ADVANTAGES AND DISADVANTAGES

Why do we want to use this

IMPLEMENTATION DETAILS

Operator overloading and source code transformation



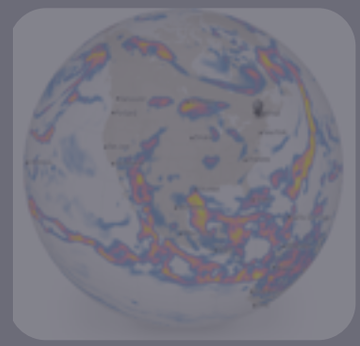
MAIN RESULTS: 3-BODY PROBLEM

Comparing a high-order Taylor method

MAIN IDEAS

ALGORITHMIC DIFFERENTIATION

The basics, main theorem, example

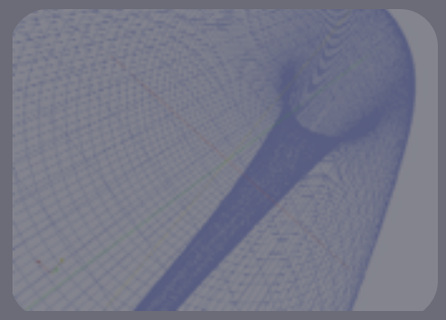


ADVANTAGES AND DISADVANTAGES

Why do we want to use this

IMPLEMENTATION DETAILS

Operator overloading and source code transformation



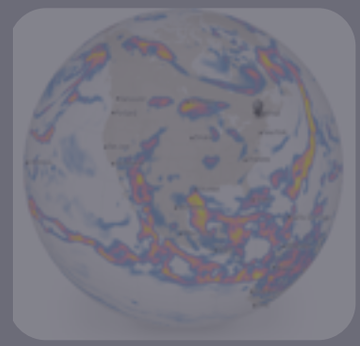
MAIN RESULTS: 3-BODY PROBLEM

Comparing a high-order Taylor method

MAIN IDEAS

ALGORITHMIC DIFFERENTIATION

The basics, main theorem, example

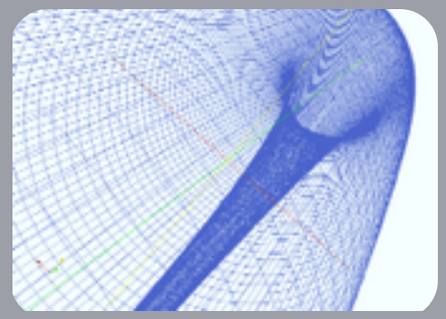


ADVANTAGES AND DISADVANTAGES

Why do we want to use this

IMPLEMENTATION DETAILS

Operator overloading and source code transformation



MAIN RESULTS: 3-BODY PROBLEM

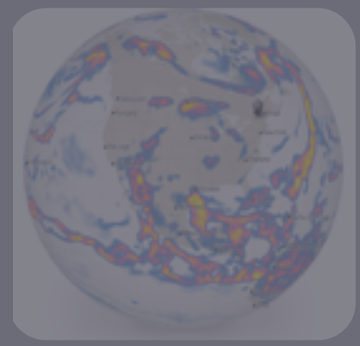
Comparing a high-order Taylor method

```
VACC happy%
VACC happy% cat tbp.in
/* ODE specification: tbp
   Two body problem, discretized into
   a set of four ODE's.  */

diff(x1, t)= x3;
diff(x2, t)= x4;
diff(x3, t)= -x1/((x1^2+x2^2)^(3/2));
diff(x4, t)= -x2/((x1^2+x2^2)^(3/2));

ecc = 0.6; /* 1-ecc, 0, 0, -sqrt((1+ecc)/(1-ecc)); */

initial_values= 0.4, 0, 0, -2;
start_time= 0.0;
stop_time = 500.0;
absolute_error_tolerance = 0.1e-16;
relative_error_tolerance = 0.1e-16;
VACC happy% cat make.sh
# make the executable
./taylor -name tbp -o tbp.c -jet -step tbp.in
./taylor -name tbp -o taylor.h -header
./taylor -name tbp -o main_tbp.c -main_only tbp.in
gcc -O3 main_tbp.c tbp.c -lm -sVACC happy%
VACC happy%
```

MAIN IDEAS

ALGORITHMIC DIFFERENTIATION

The basics, main theorem, example

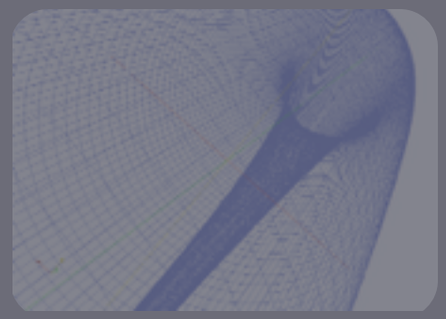


ADVANTAGES AND DISADVANTAGES

Why do we want to use this

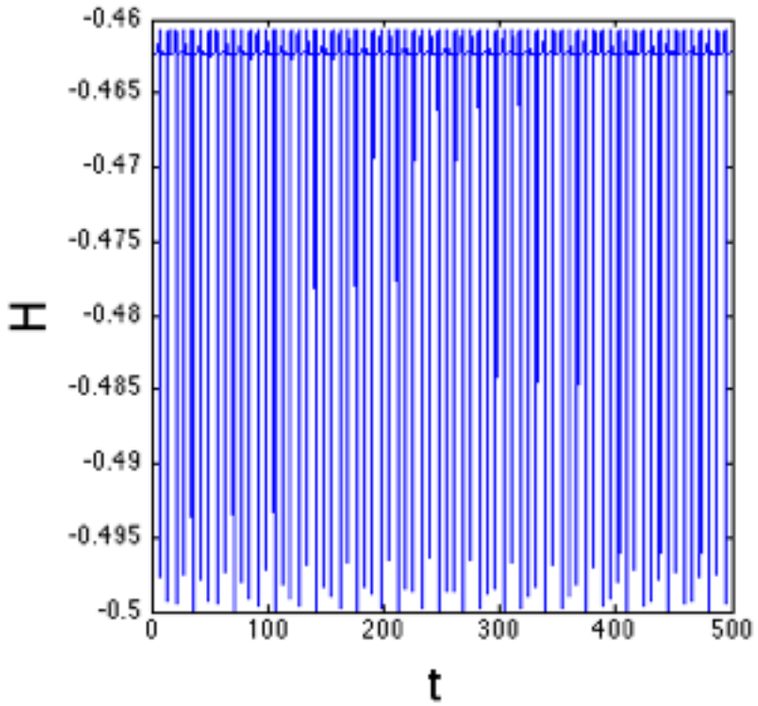
IMPLEMENTATION DETAILS

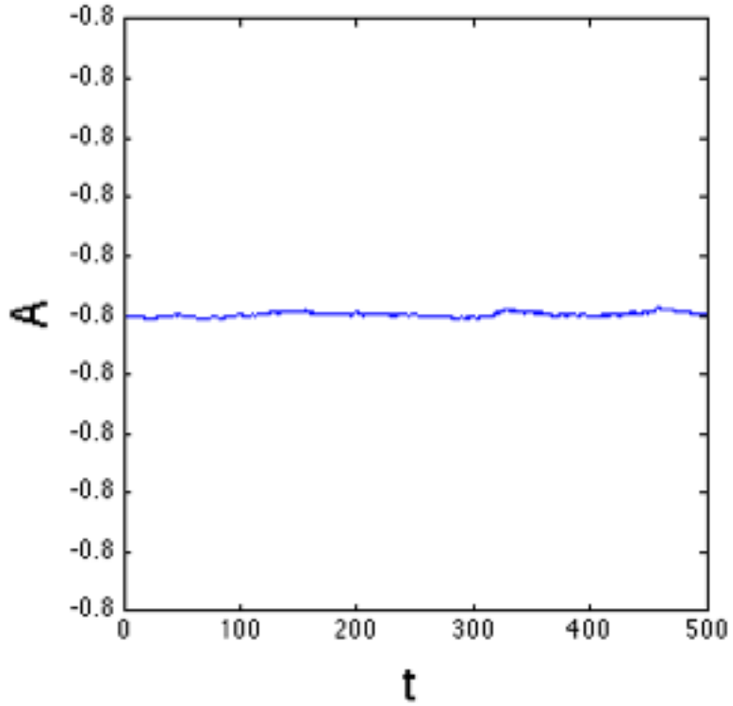
Operator overloading and source code transformation

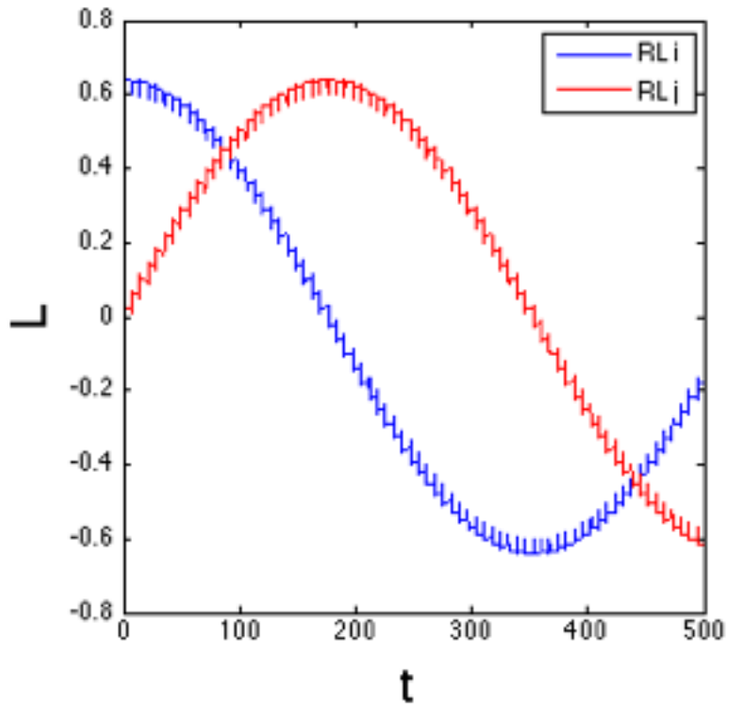


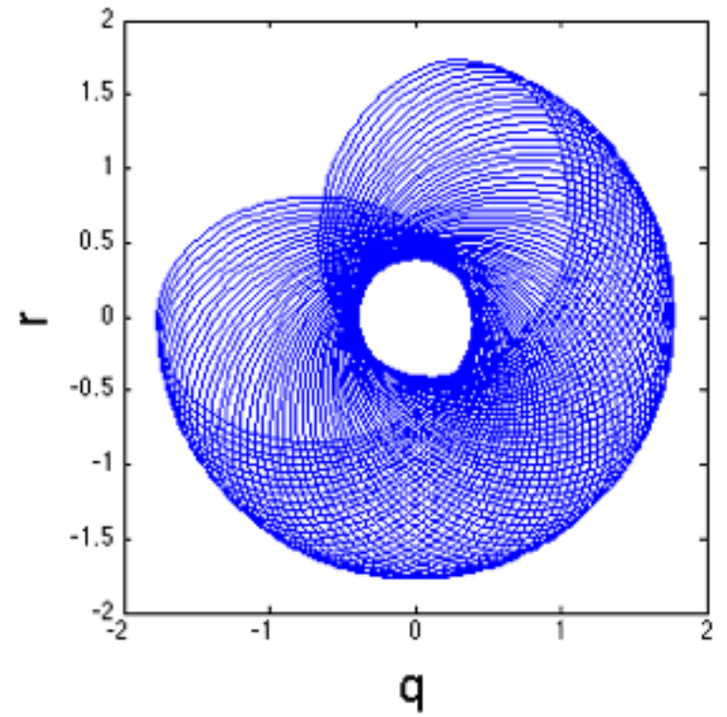
MAIN RESULTS: 3-BODY PROBLEM

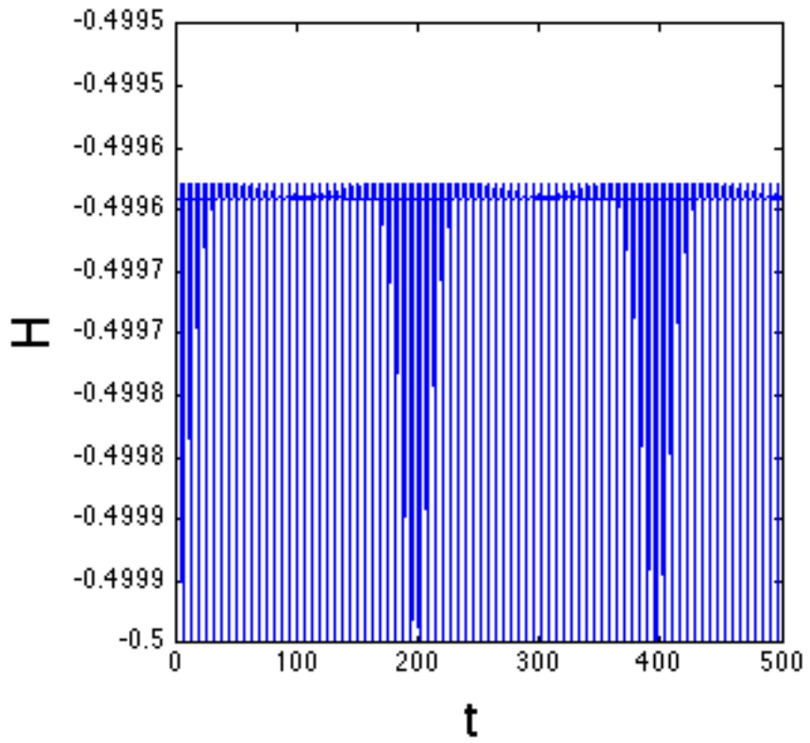
Comparing a high-order Taylor method

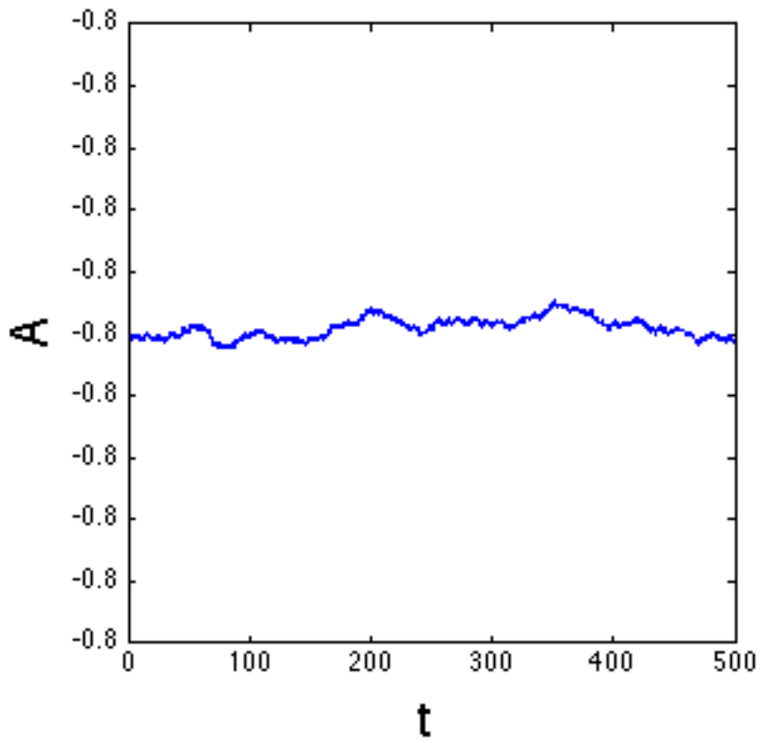

H
t
-0.46
-0.465
-0.47
-0.475
-0.48
-0.485
-0.49
-0.495
-0.5
0
100
200
300
400
500

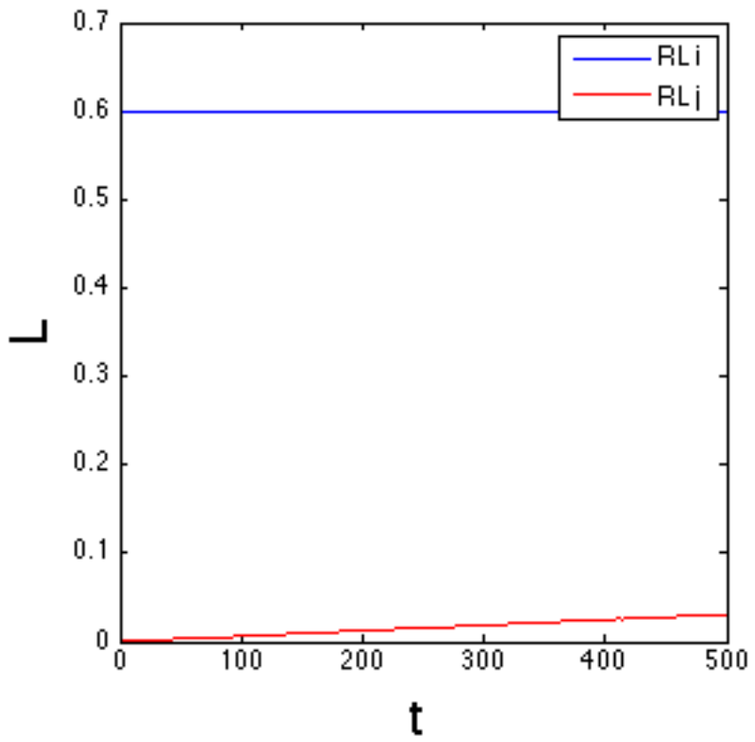

A
t
-0.8
0
100
200
300
400
500

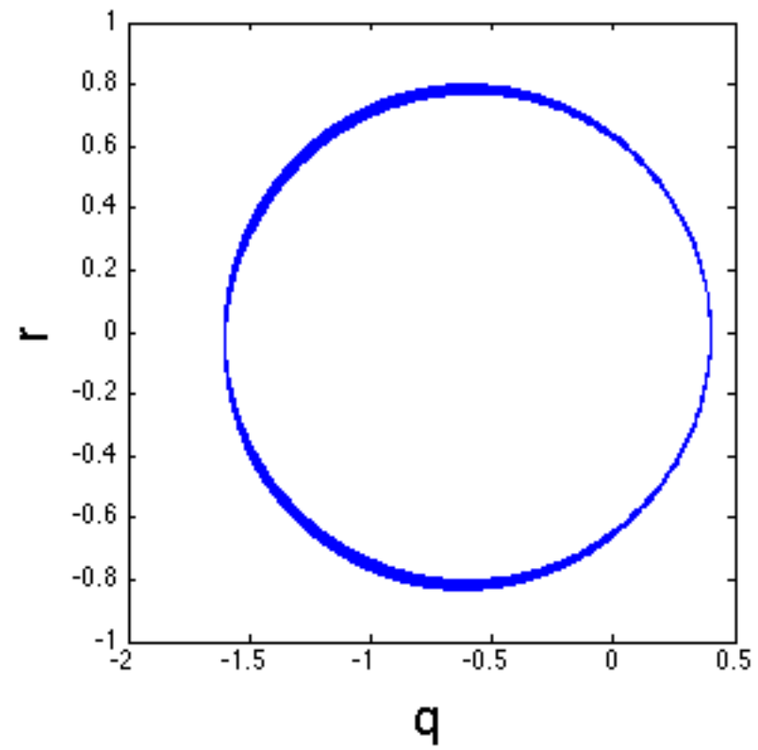

L
t
RLi
RLj
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0
100
200
300
400
500

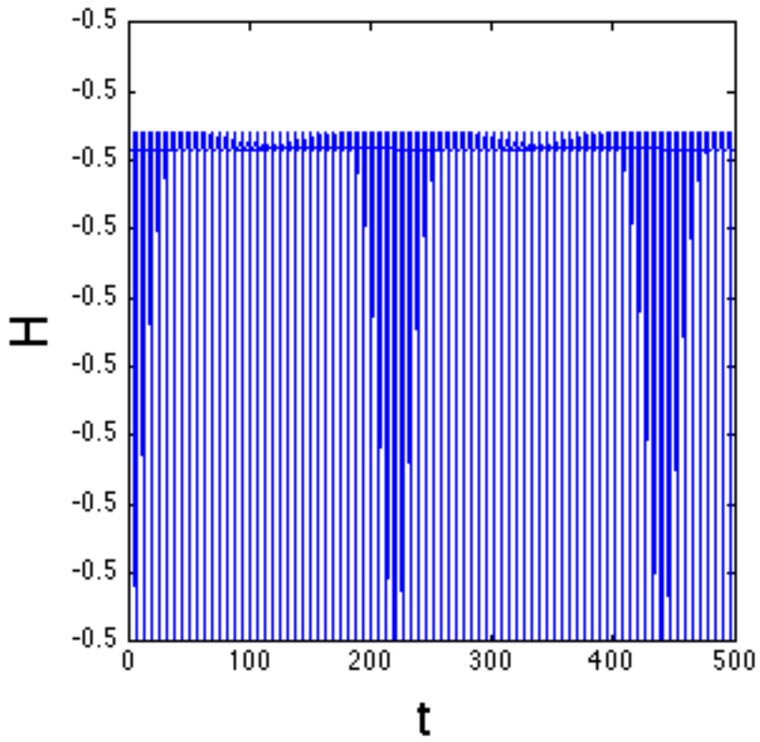

r
q
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2

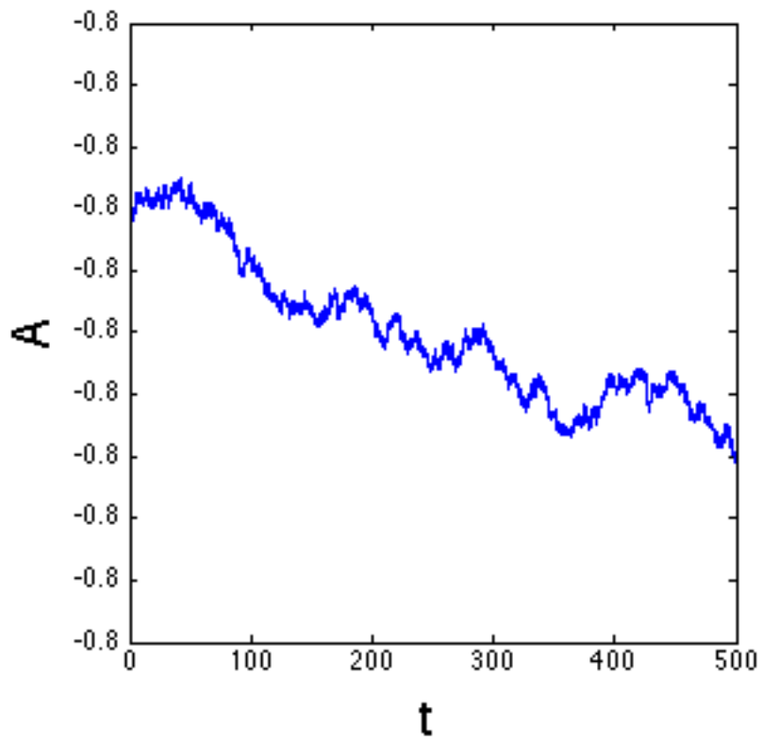

H
t
-0.4995
-0.4995
-0.4996
-0.4996
-0.4997
-0.4997
-0.4998
-0.4998
-0.4999
-0.4999
-0.5
0
100
200
300
400
500

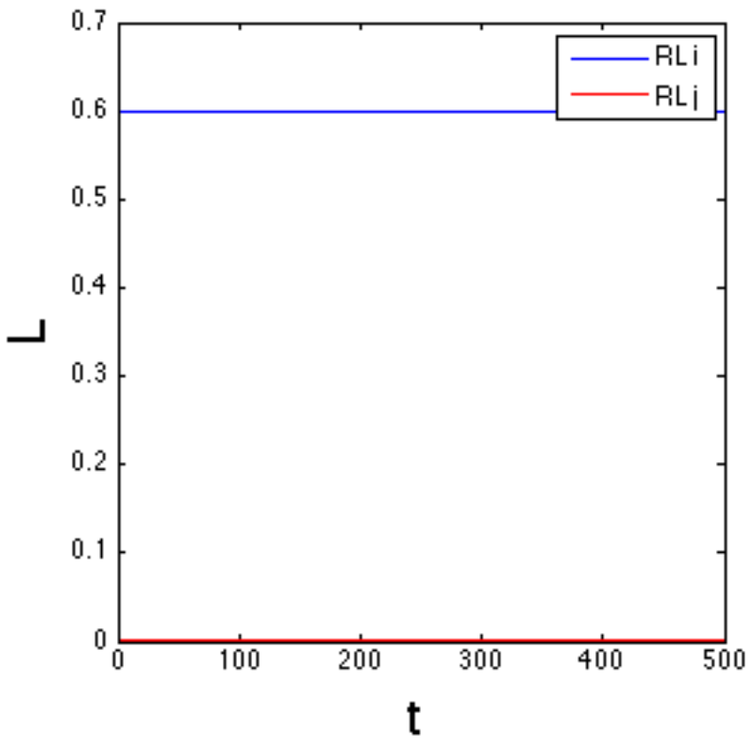

A
t
-0.8
-0.8
-0.8
-0.8
-0.8
-0.8
-0.8
-0.8
-0.8
-0.8
0
100
200
300
400
500

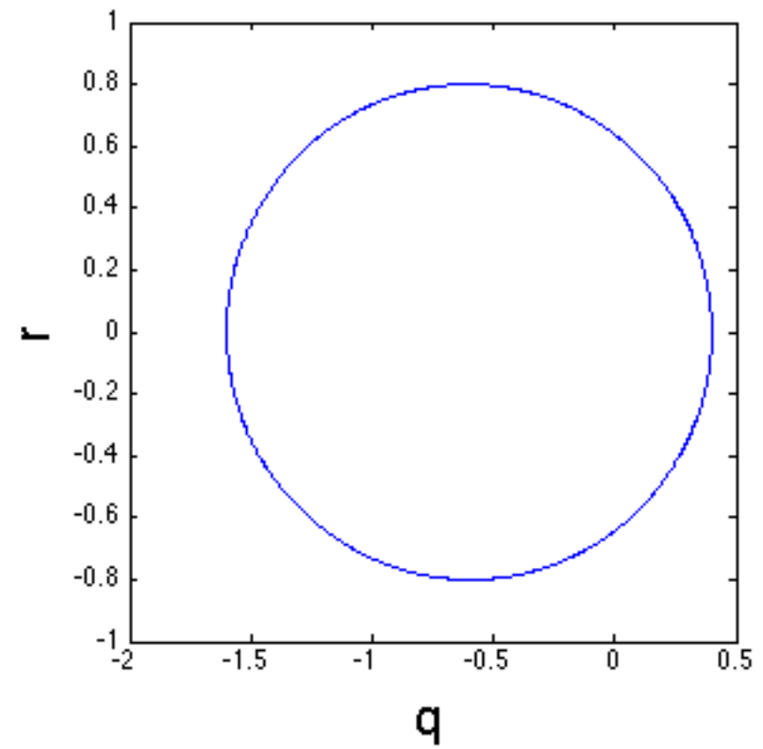

L
t
RLi
RLj
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
100
200
300
400
500

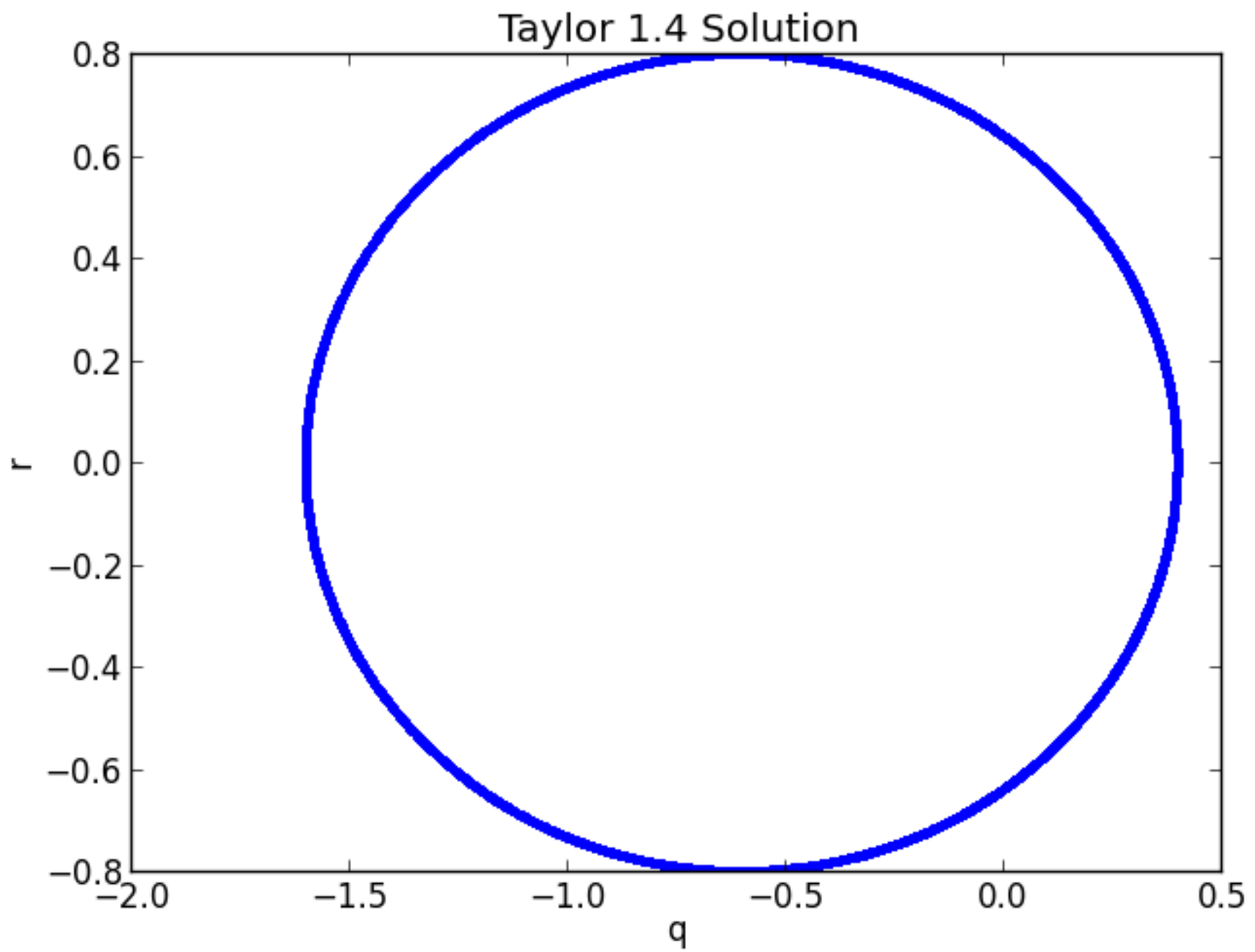

r
q
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-2
-1.5
-1
-0.5
0
0.5


H
t
-0.5
0
100
200
300
400
500


A
t
-0.8
0
100
200
300
400
500


L
t
RLi
RLj
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0
100
200
300
400
500


r
q
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
-2
-1.5
-1
-0.5
0
0.5


Taylor 1.4 Solution
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
r
−2.0
−1.5
−1.0
−0.5
0.0
0.5
q

THANK YOU