Simulating spin magnons using Runge-Kutta methods

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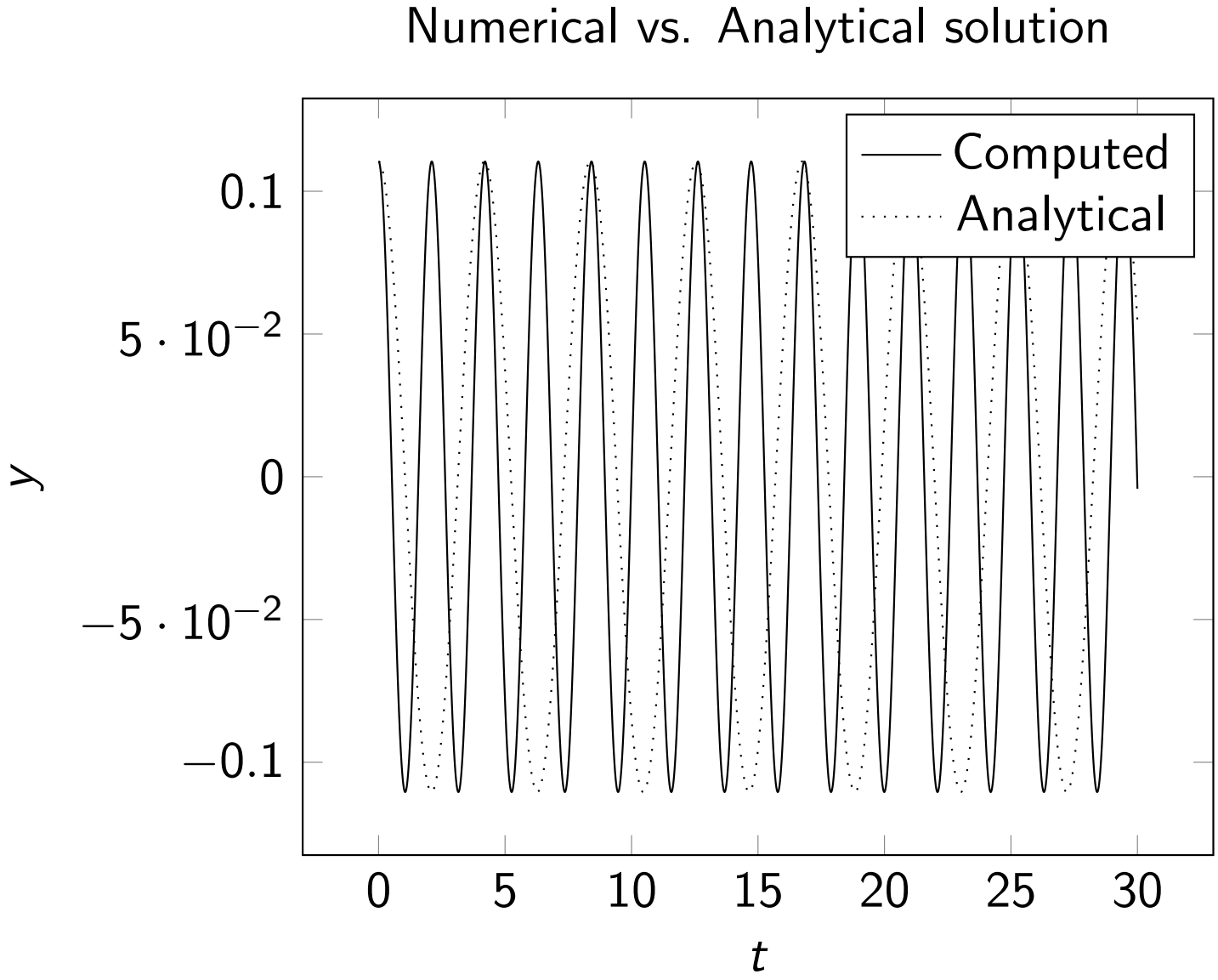
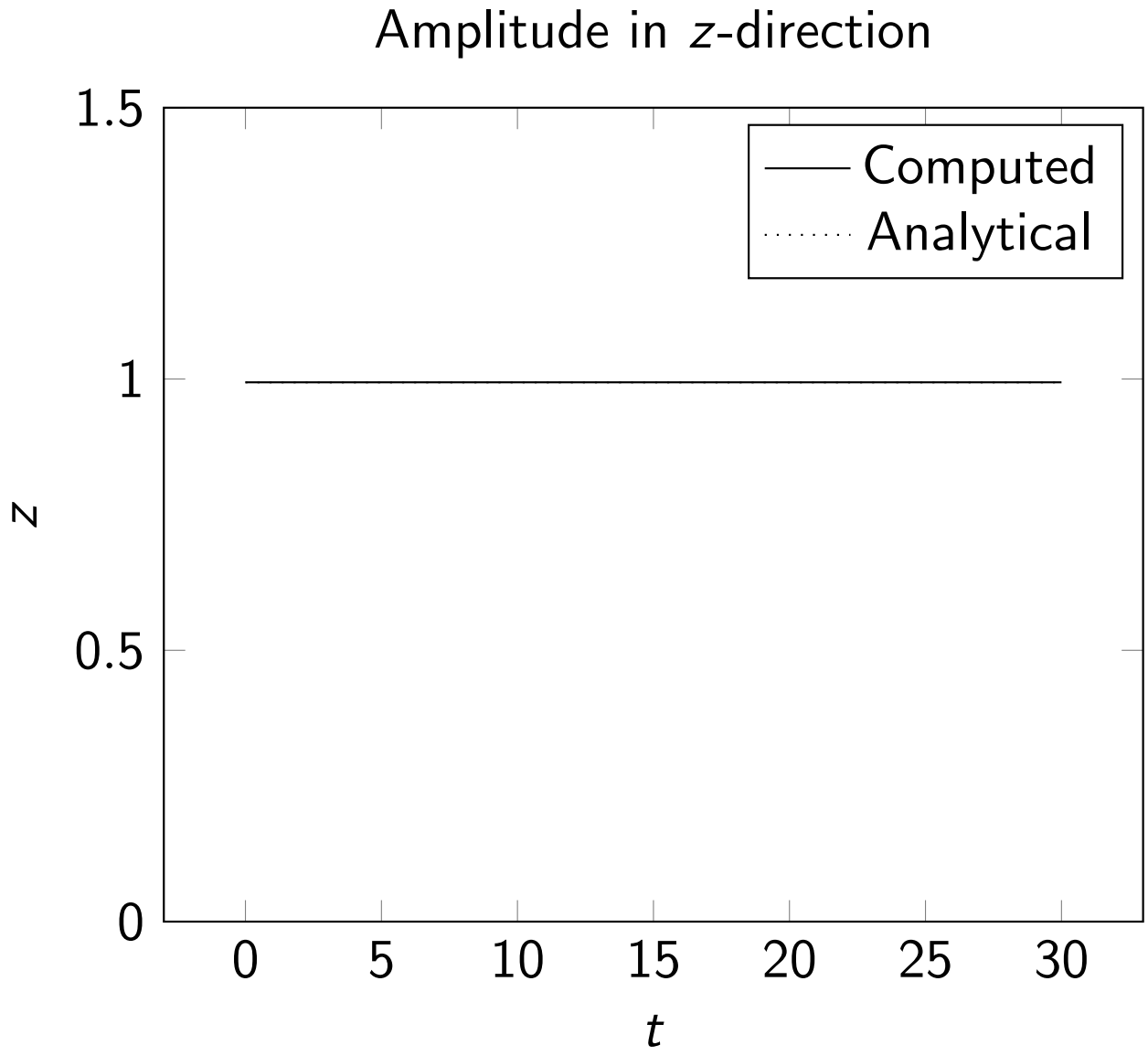
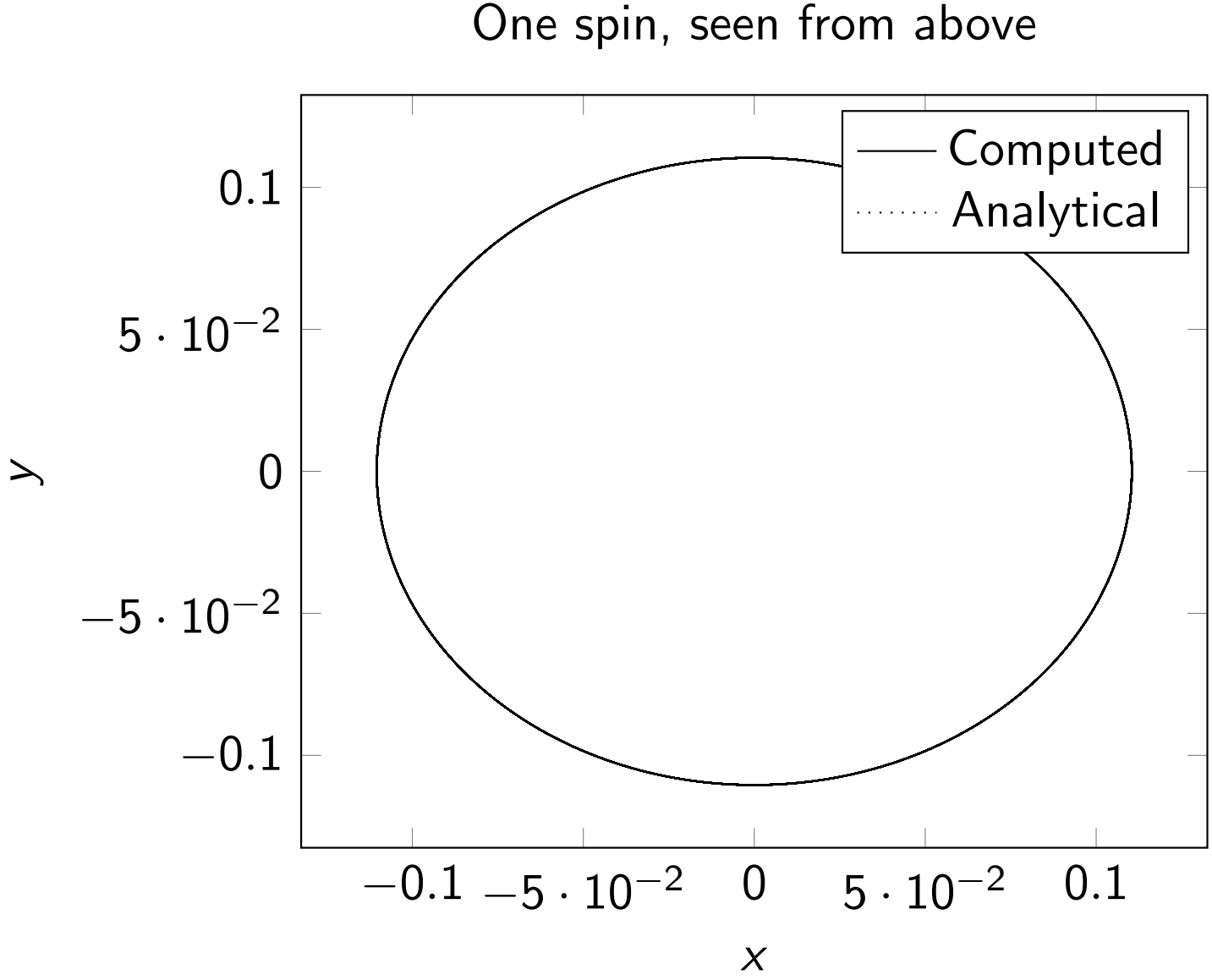
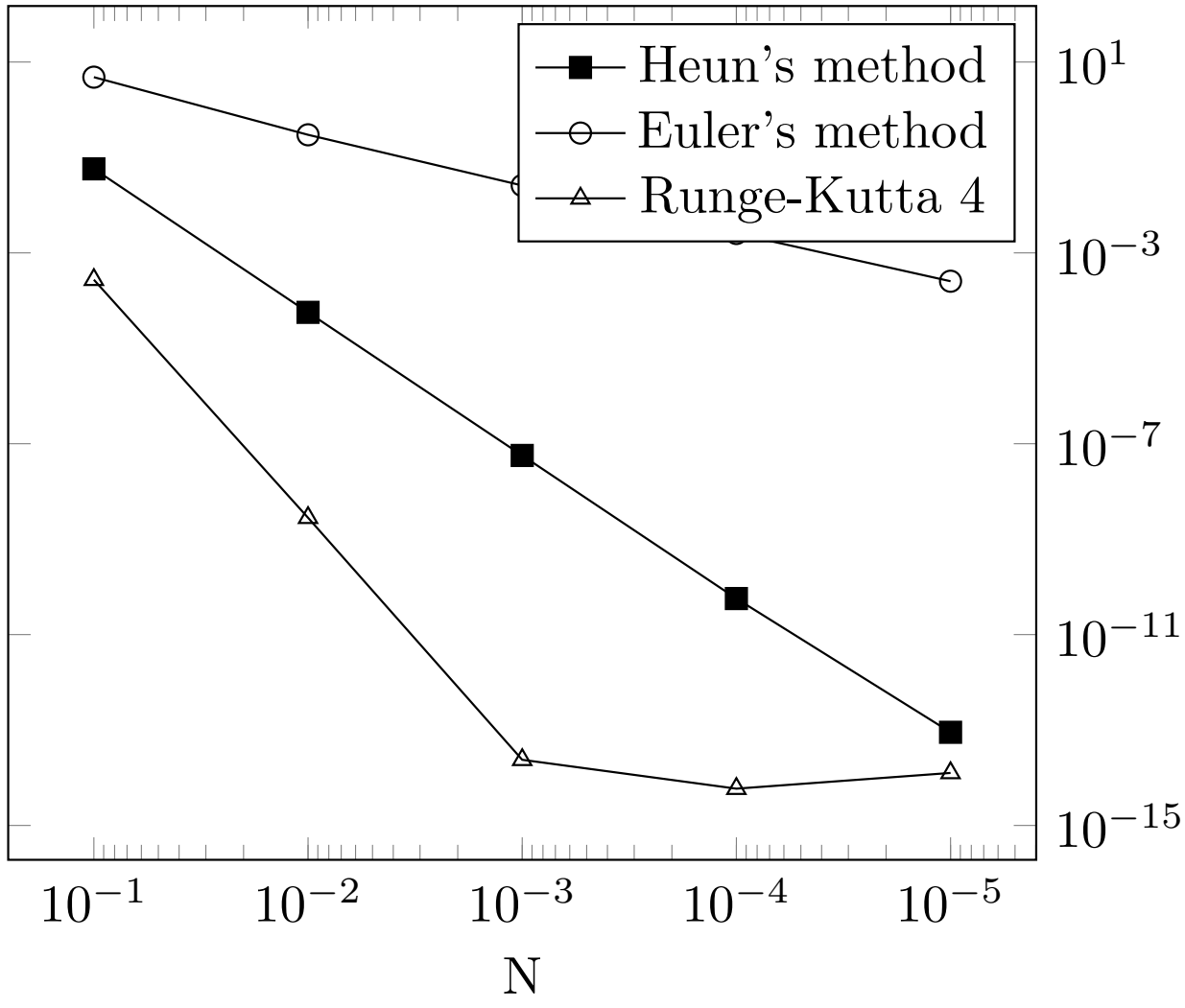
May 2, 2021

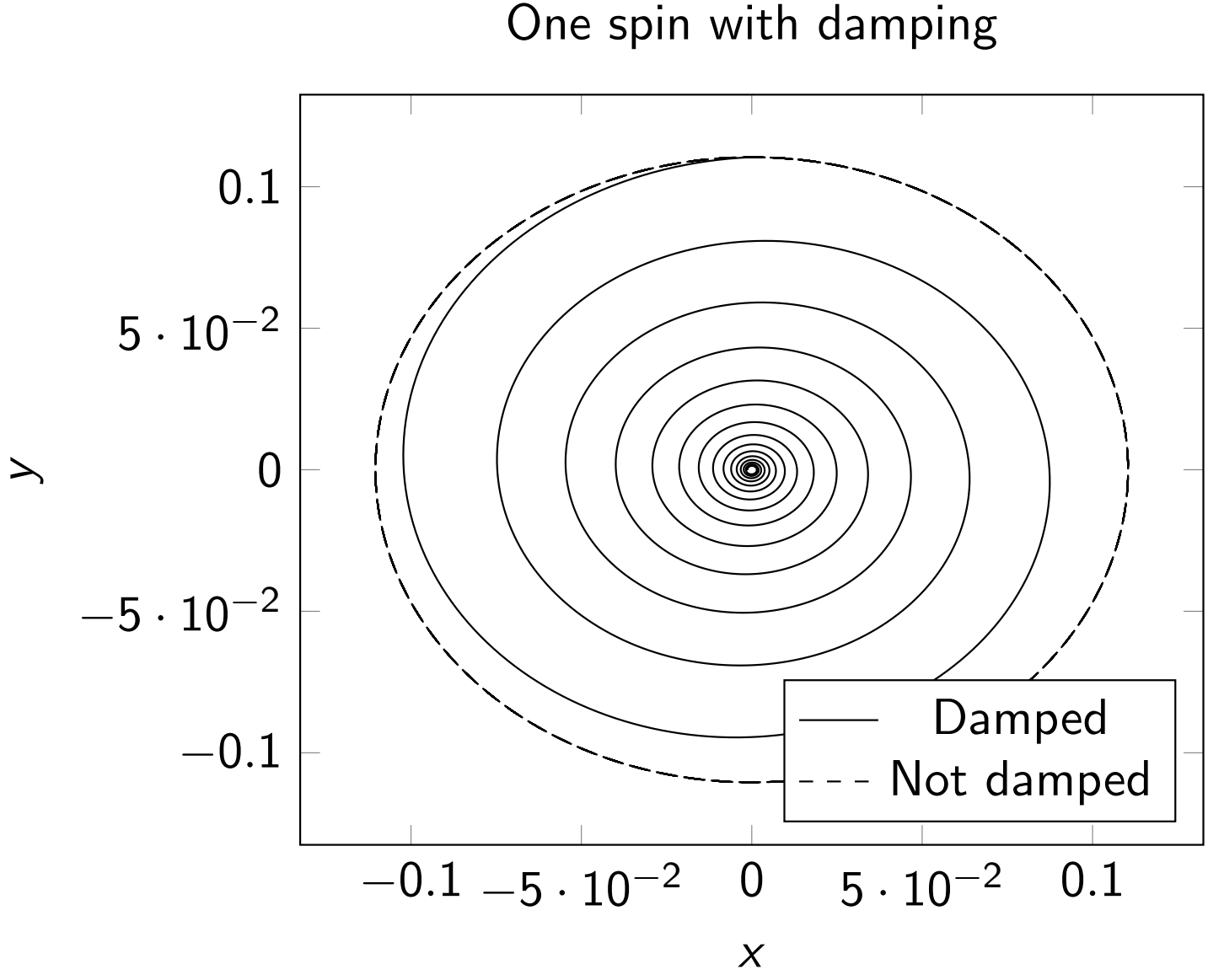
Part one: Single spin

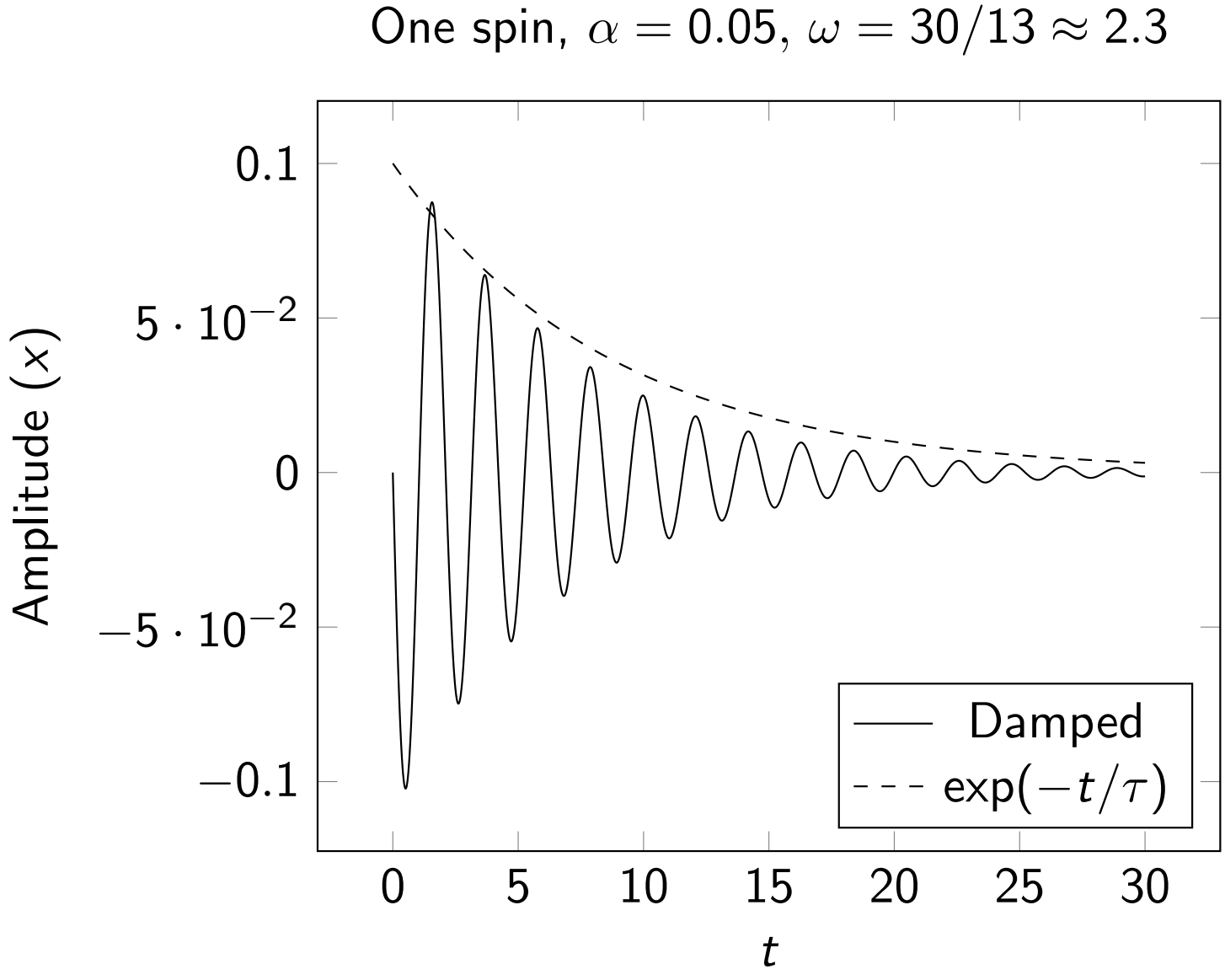

Numerical vs. Analytical solution
Computed
Analytical
0.1
$5 \cdot 10^{-2}$
0
$-5 \cdot 10^{-2}$
-0.1
y
0
5
10
15
20
25
30
t


Amplitude in z-direction
1.5
1
0.5
0
z
0
5
10
15
20
25
30
t
Computed
Analytical

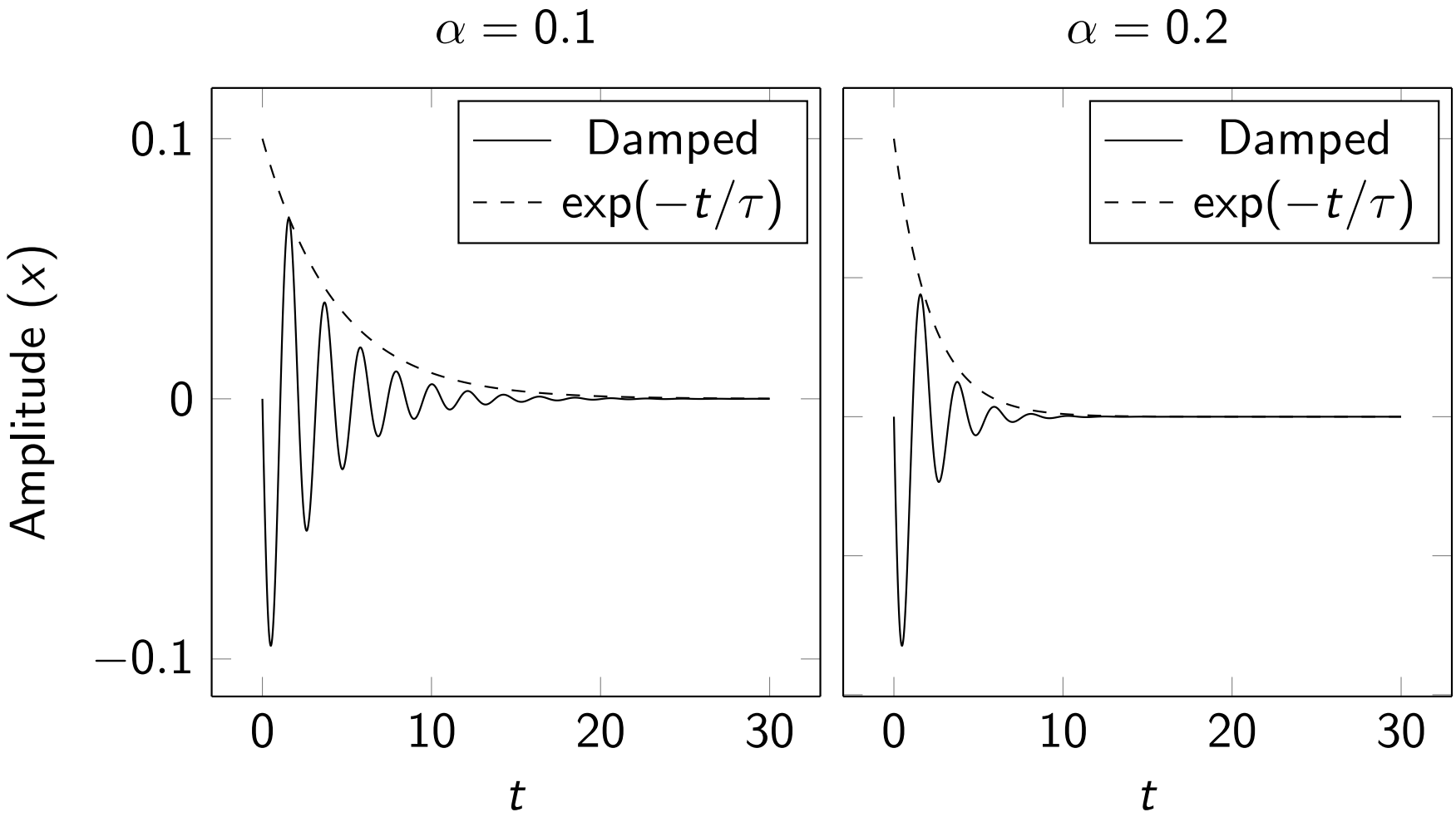

One spin, seen from above
Computed
Analytical
0.1
$5 \cdot 10^{-2}$
0
$-5 \cdot 10^{-2}$
-0.1
y
-0.1
$-5 \cdot 10^{-2}$
0
$5 \cdot 10^{-2}$
0.1
x


Heun's method
Euler's method
Runge-Kutta 4
10^{1}
10^{-3}
10^{-7}
10^{-11}
10^{-15}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
N

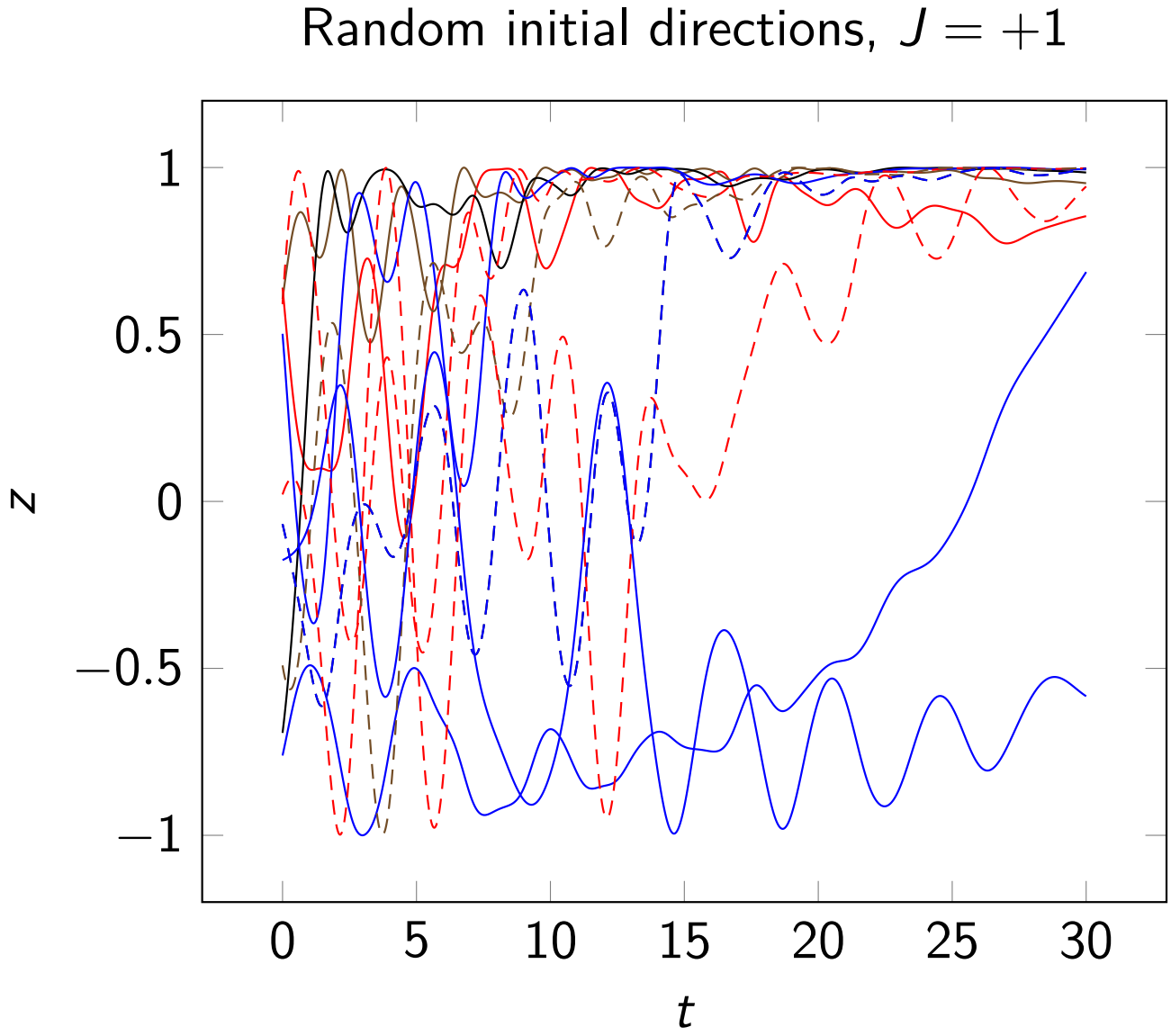

One spin with damping
0.1
$5 \cdot 10^{-2}$
0
$-5 \cdot 10^{-2}$
−0.1
y
−0.1
$-5 \cdot 10^{-2}$
0
$5 \cdot 10^{-2}$
0.1
x
Damped
Not damped

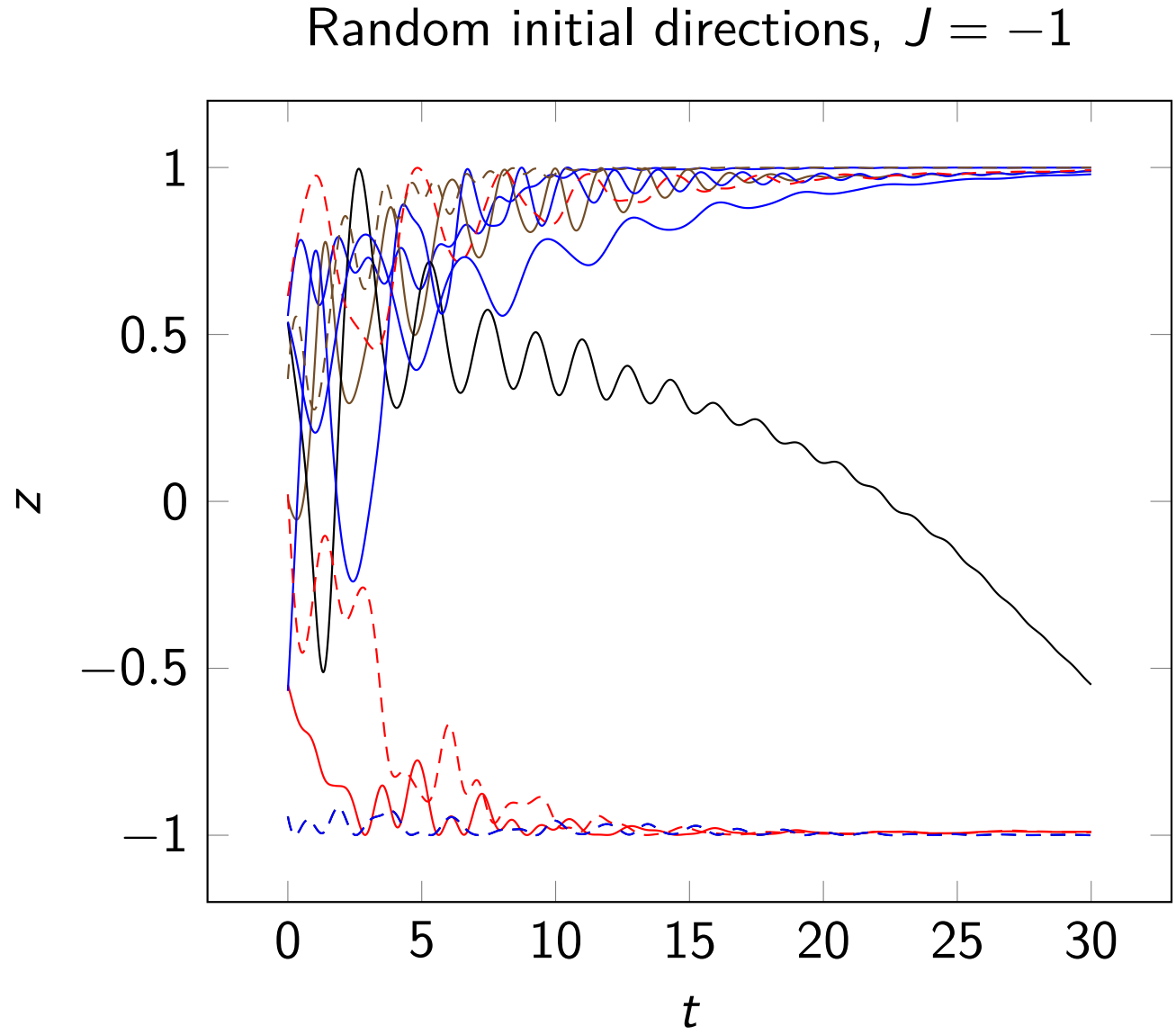

One spin, $\alpha = 0.05$, $\omega = 30/13 \approx 2.3$
Amplitude (x)
0.1
$5 \cdot 10^{-2}$
0
$-5 \cdot 10^{-2}$
-0.1
0
5
10
15
20
25
30
t
Damped
$\exp(-t/\tau)$

Varying α

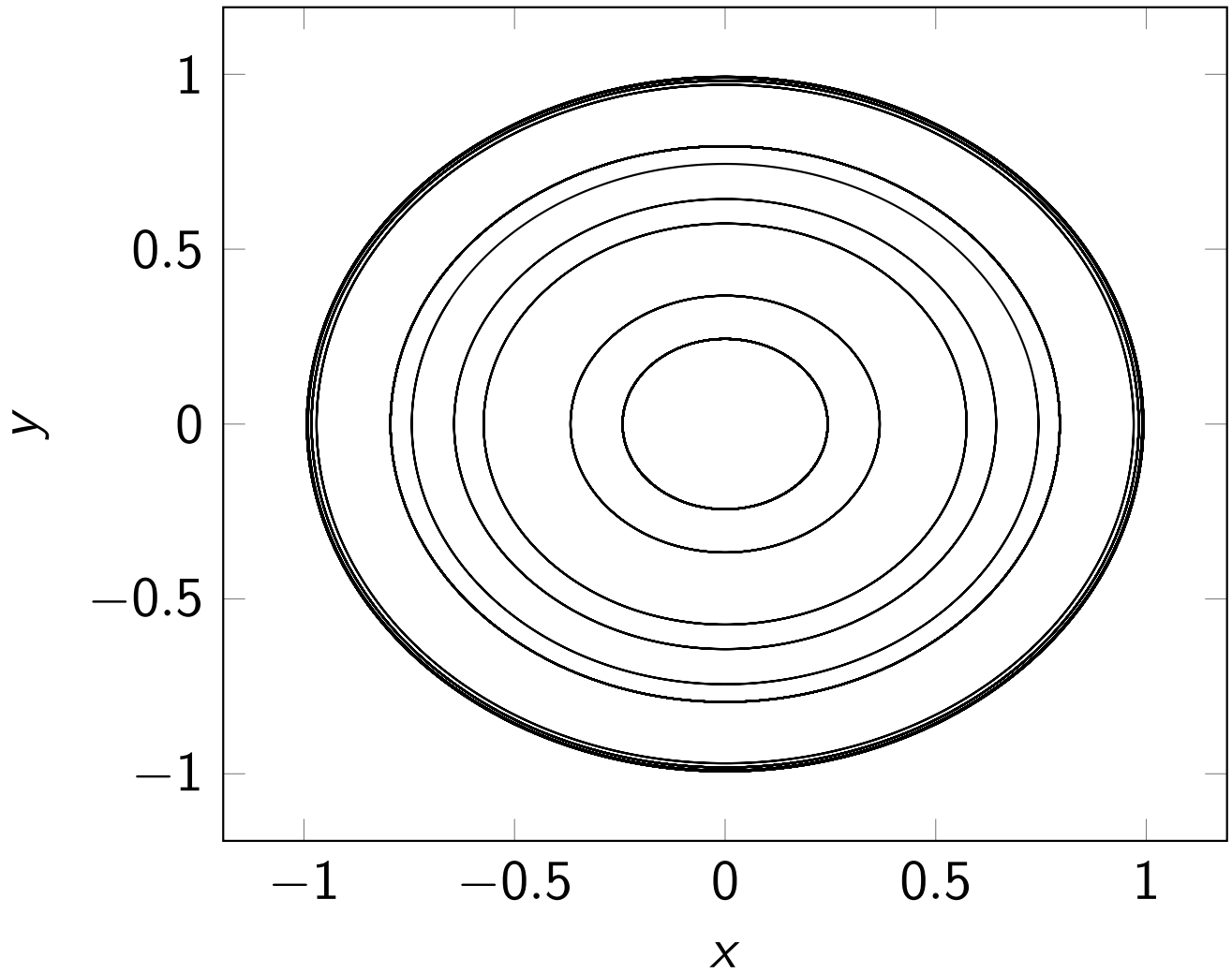


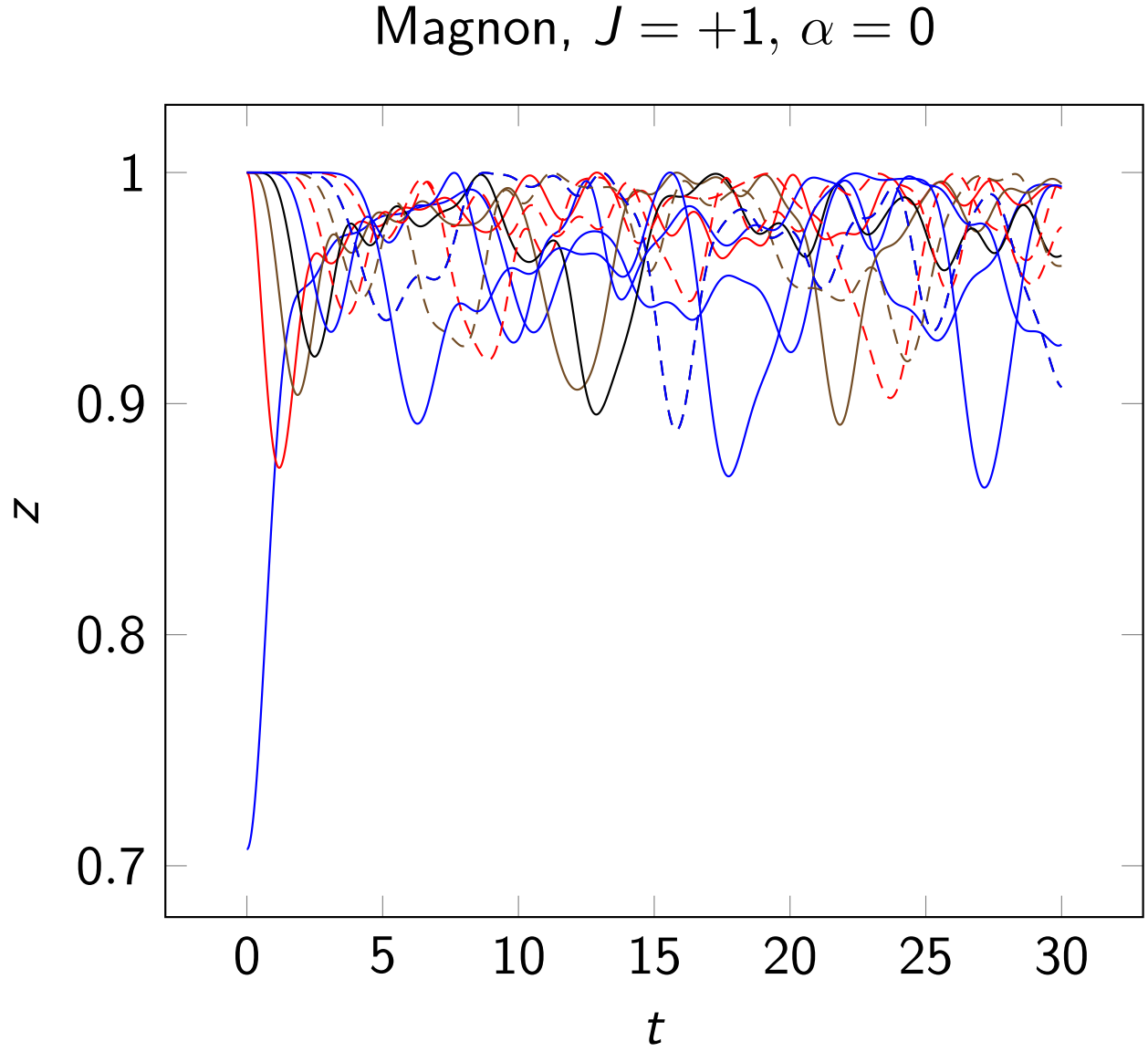
Part two: Spin chain

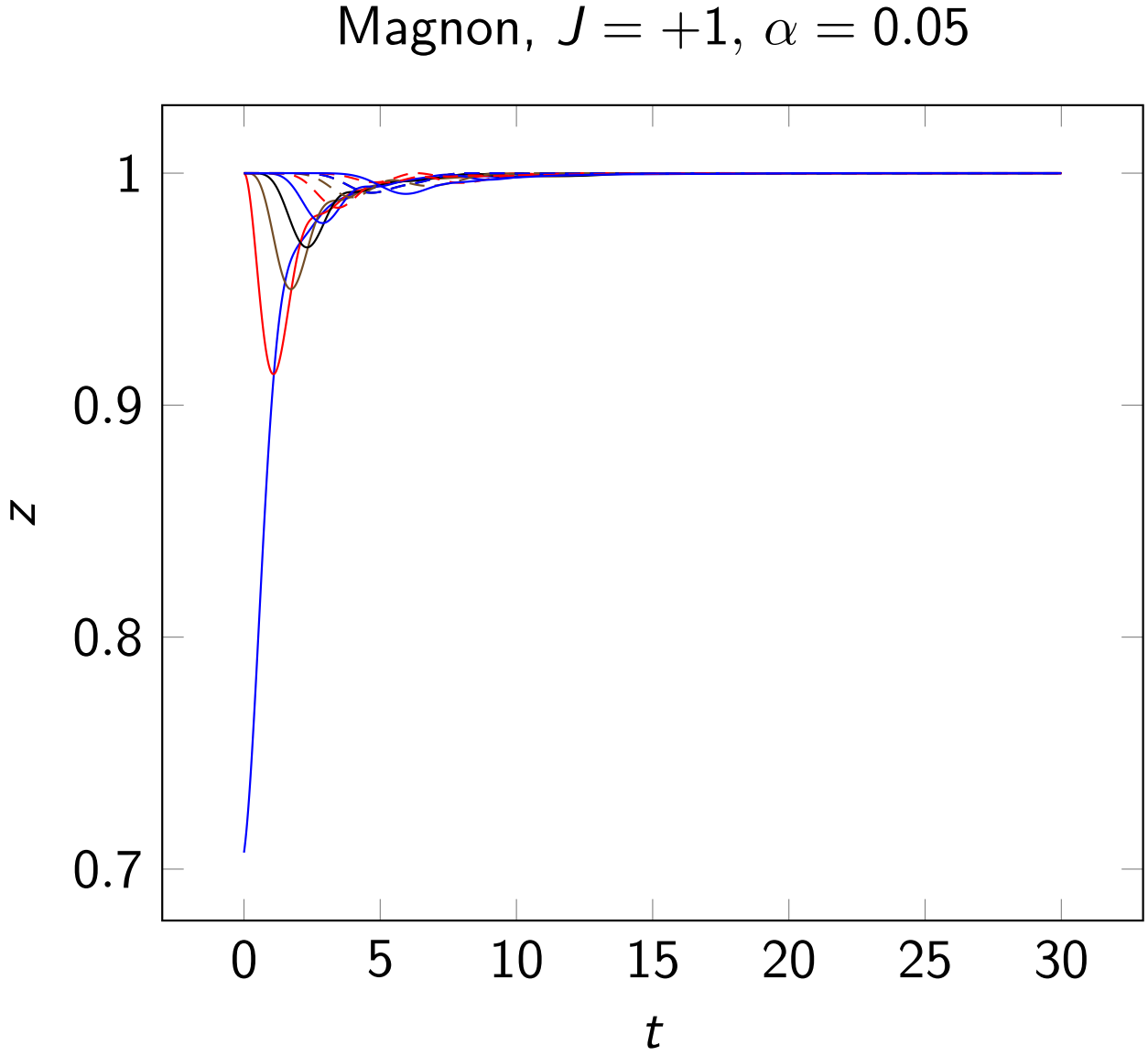

Random initial directions, $J = +1$
1
0.5
0
−0.5
−1
z
0
5
10
15
20
25
30
t

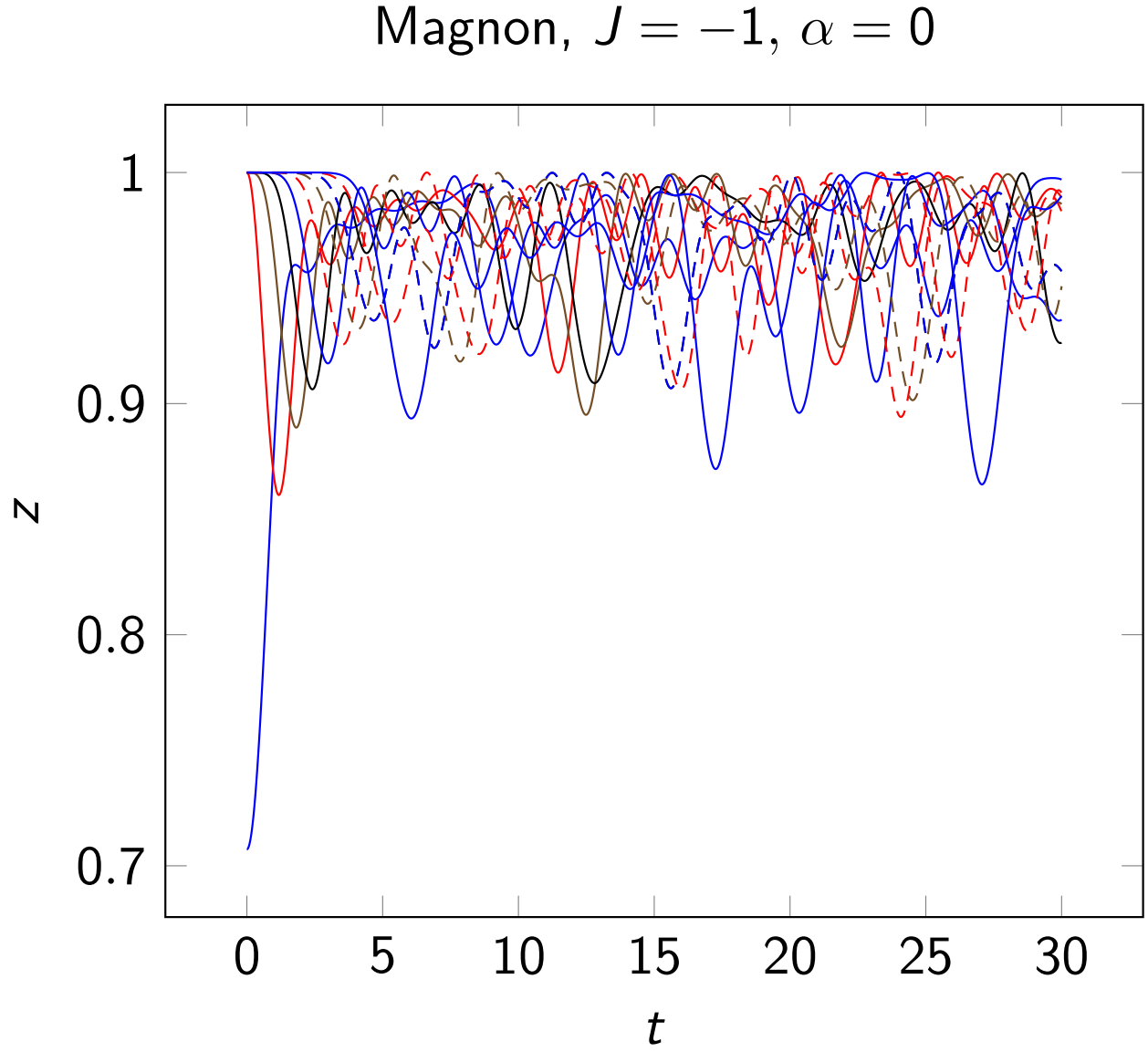

Random initial directions, $J = -1$
1
0.5
0
−0.5
−1
z
0
5
10
15
20
25
30
t

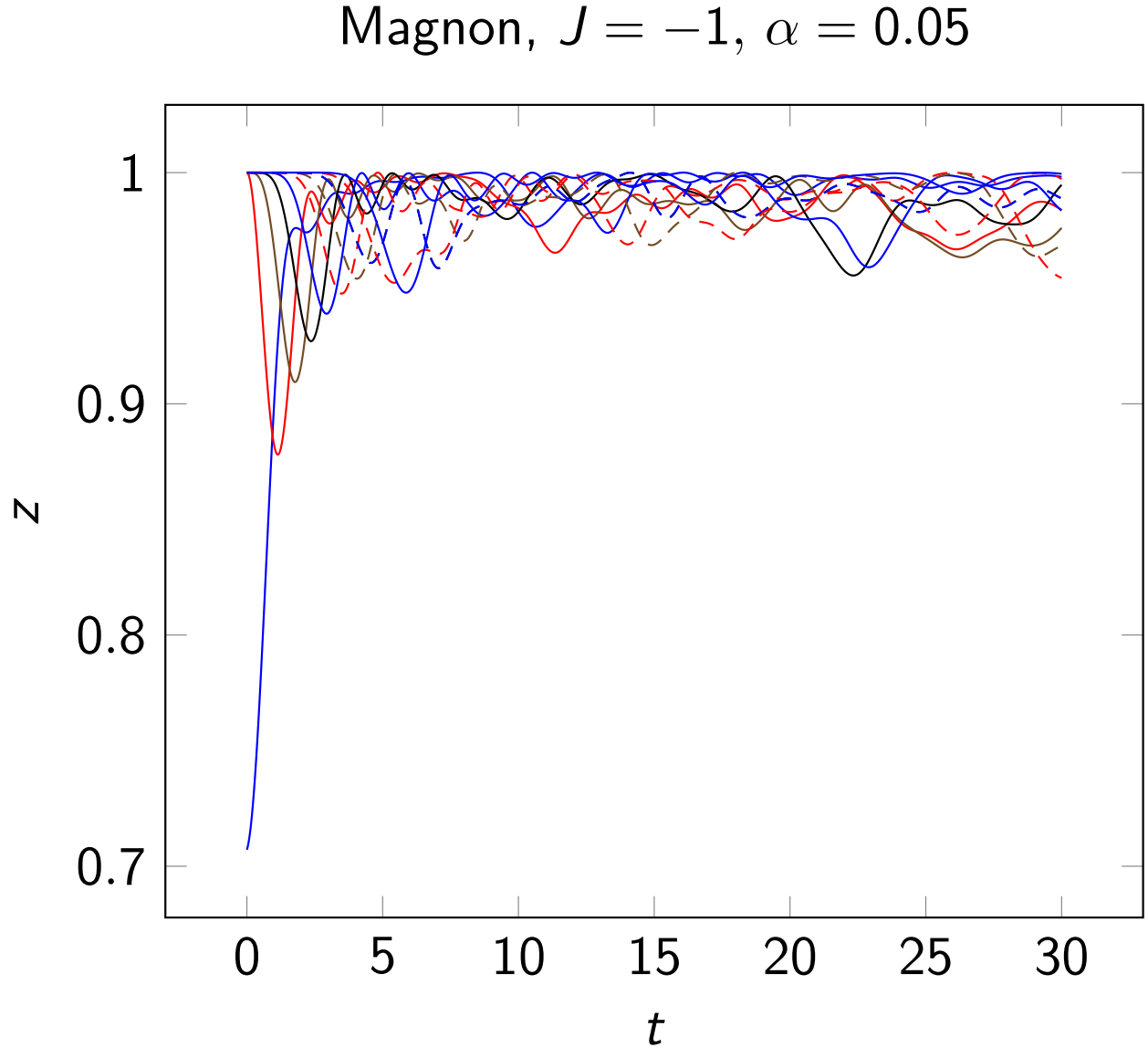
10 spins with random directions and no damping




Magnon, $J = +1$, $\alpha = 0$
1
0.9
0.8
0.7
z
0
5
10
15
20
25
30
t


Magnon, $J = +1$, $\alpha = 0.05$
1
0.9
0.8
0.7
z
0
5
10
15
20
25
30
t


Magnon, $J = -1$, $\alpha = 0$
1
0.9
0.8
0.7
z
0
5
10
15
20
25
30
t


Magnon, $J = -1$, $\alpha = 0.05$
1
0.9
0.8
0.7
z
0
5
10
15
20
25
30
t