Simulating spin magnons using Runge-Kutta methods
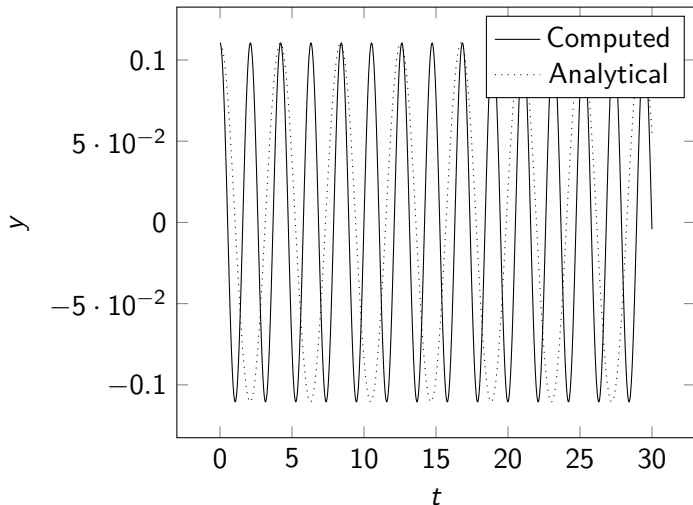
Jonas Bueie

May 7, 2021
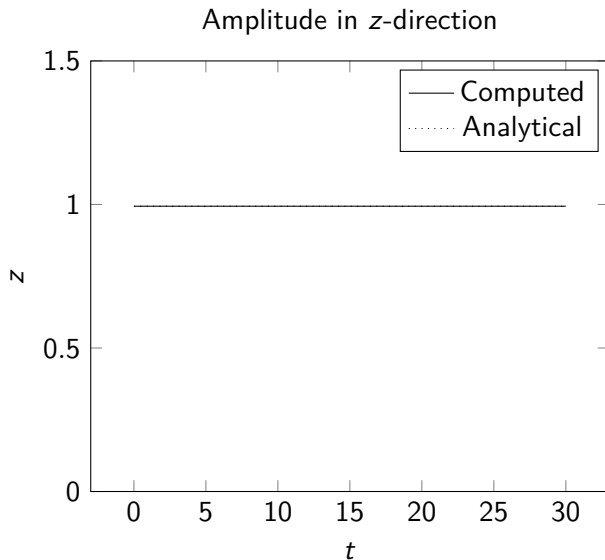
Part one: Single spin

Simplest case

Numerical vs. Analytical solution
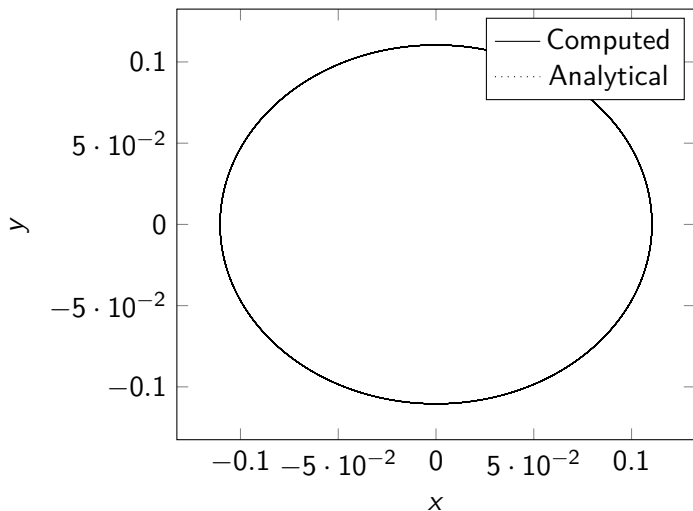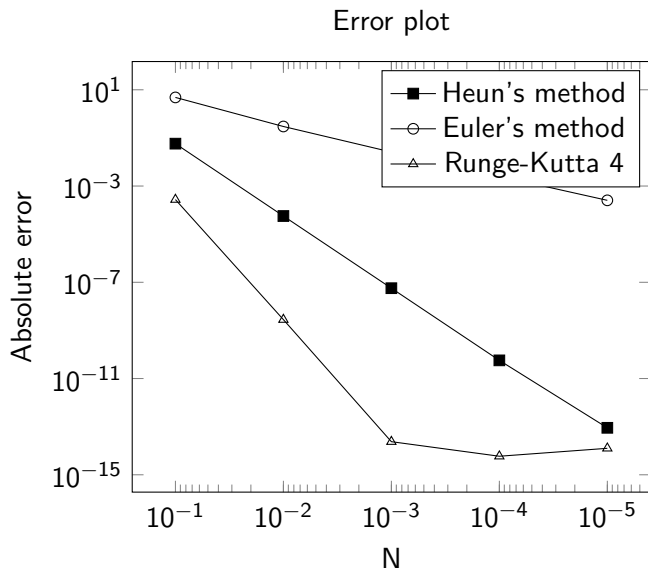
Simplest case

Amplitude in z-direction

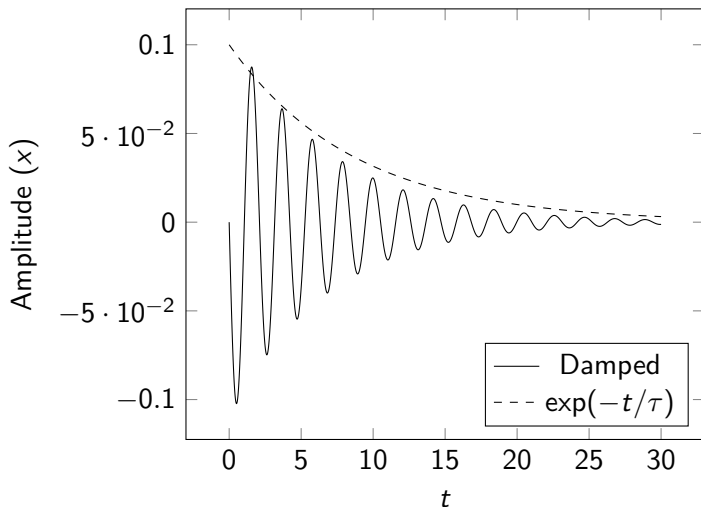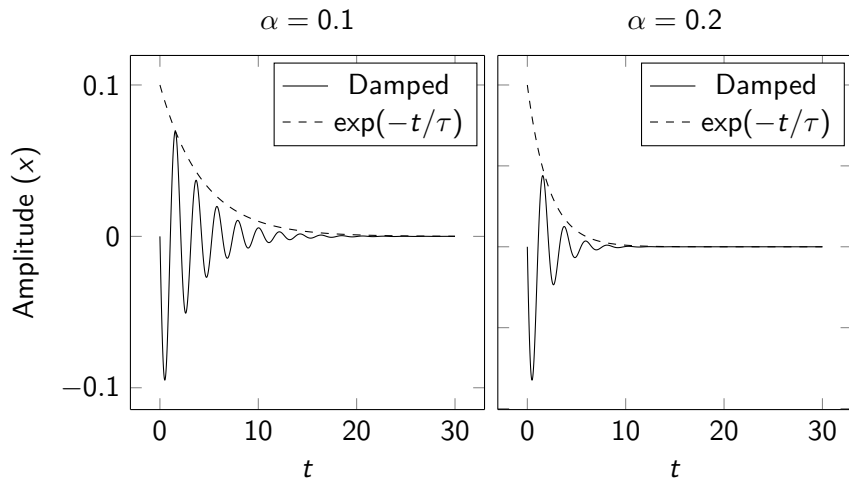# Phase space

One spin, seen from above

Convergence plot

Error plot

With damping
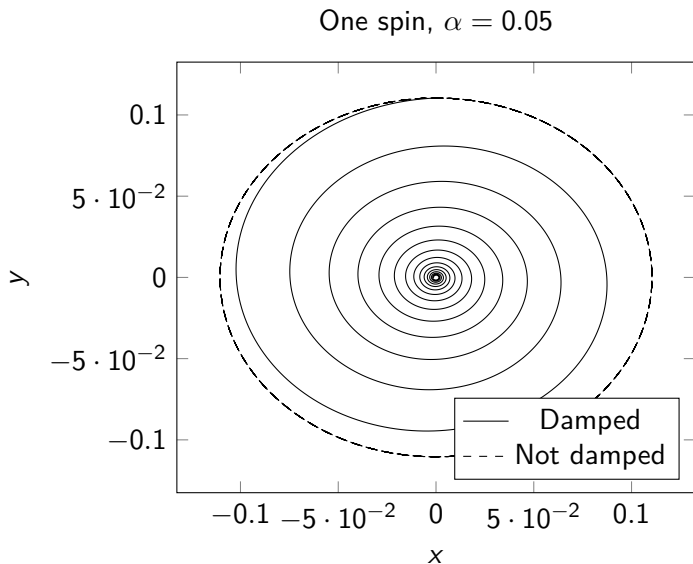
One spin, $\alpha = 0.05$

Analyzing the damping

One spin, $\alpha = 0.05$, $\omega = 30/13 \approx 2.3$

Varying α

$\alpha = 0.1$ $\alpha = 0.2$

Amplitude (x), t

Legend: Damped, $\exp(-t/\tau)$
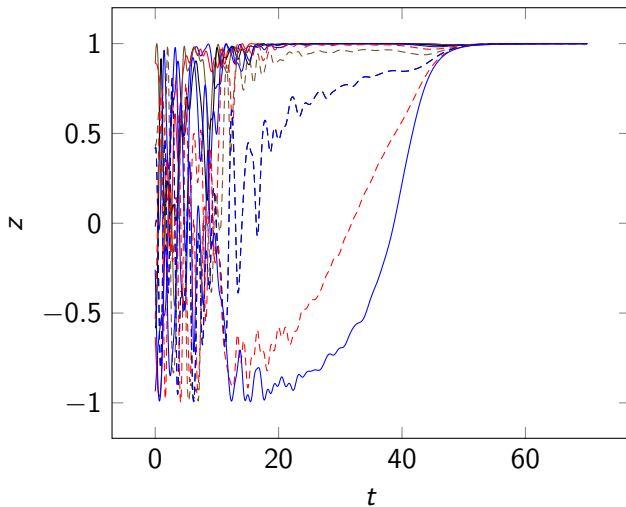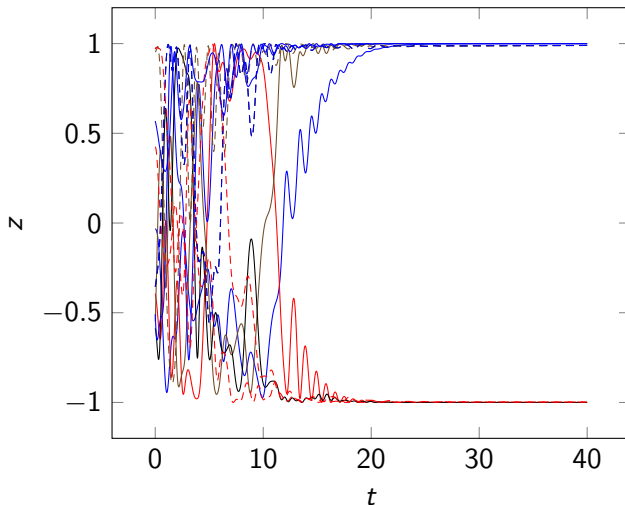
Part two: Spin chain

Ferromagnetic coupling

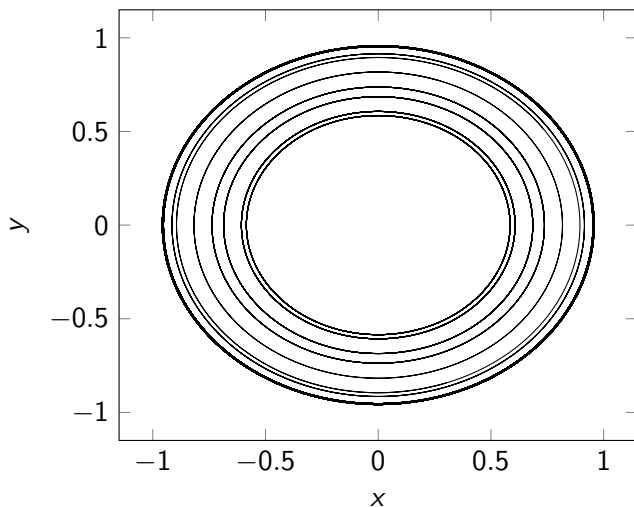Random initial directions, $J = +1$

Antiferromagnetic coupling

Random initial directions, $J = -1$

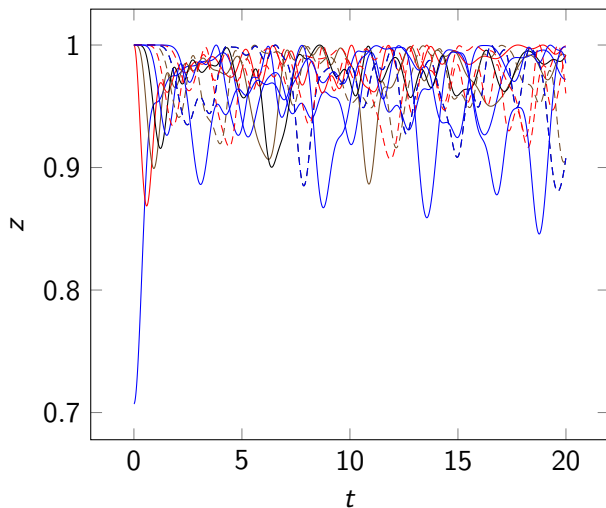Magnons

No coupling
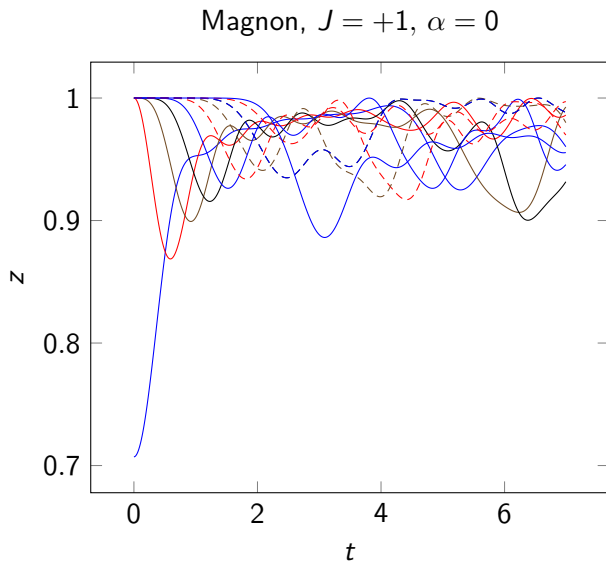

10 spins with random directions. $\alpha = 0$, $J = 0$

No damping

Magnon, $J = +1$, $\alpha = 0$
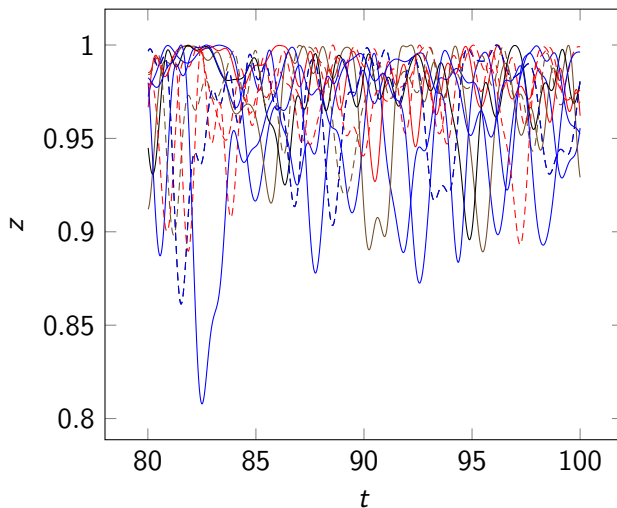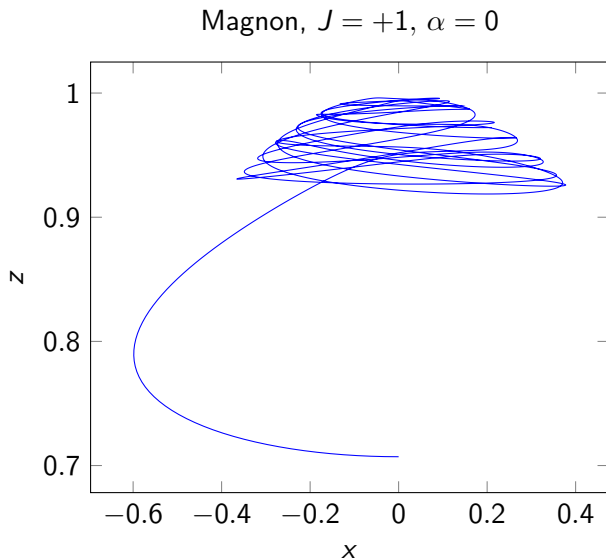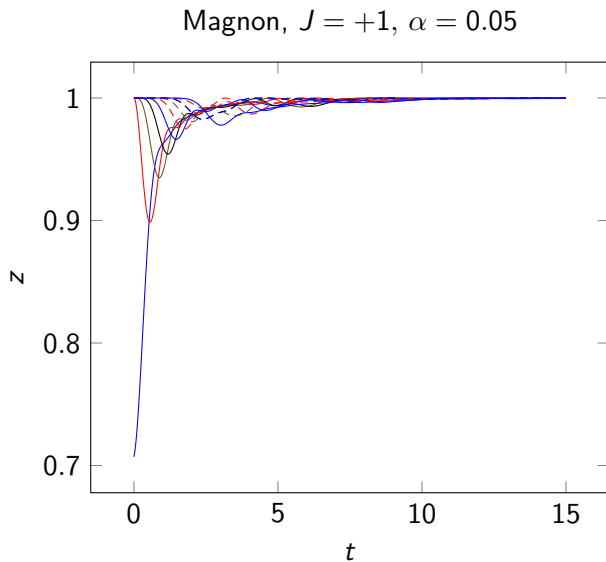
For small t

Magnon, $J = +1$, $\alpha = 0$

For large t

Magnon, $J = +1$, $\alpha = 0$

Exploring other angles

Magnon, $J = +1$, $\alpha = 0$

Exploring other angles

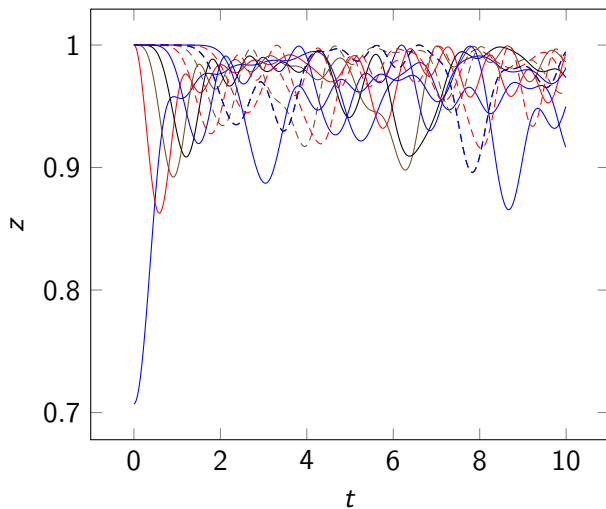Magnon, $J = +1$, $\alpha = 0$
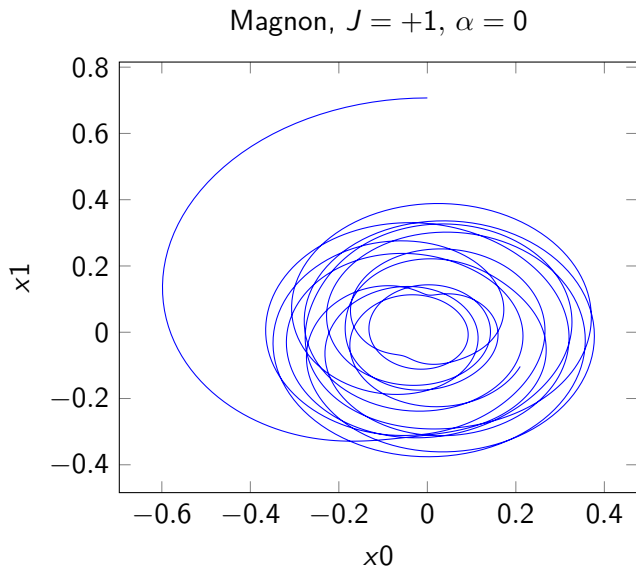
With damping

Magnon, $J = +1$, $\alpha = 0.05$
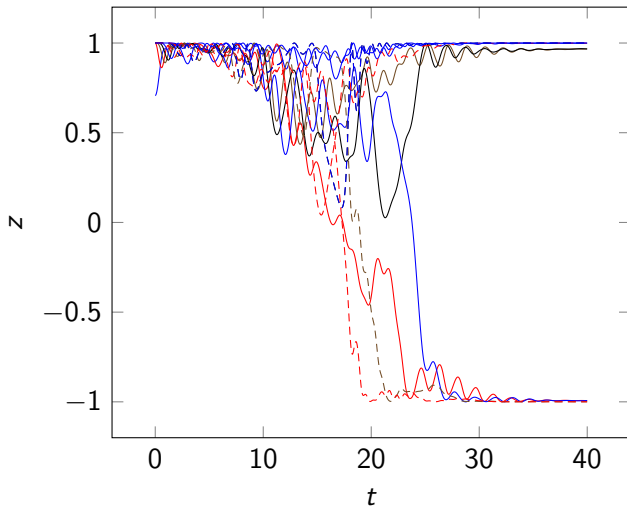
Magnons in antiferromagnetic chain

No damping

Magnon, $J = -1$, $\alpha = 0$

With damping

Magnon, $J = -1$, $\alpha = 0.05$

Magnetization

Magnetization of chain