

# Simulating spin magnons using Runge-Kutta methods

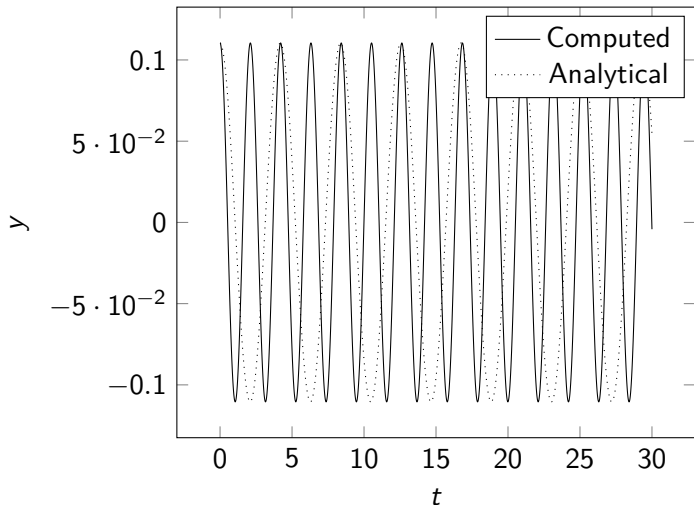
Jonas Bueie

May 7, 2021

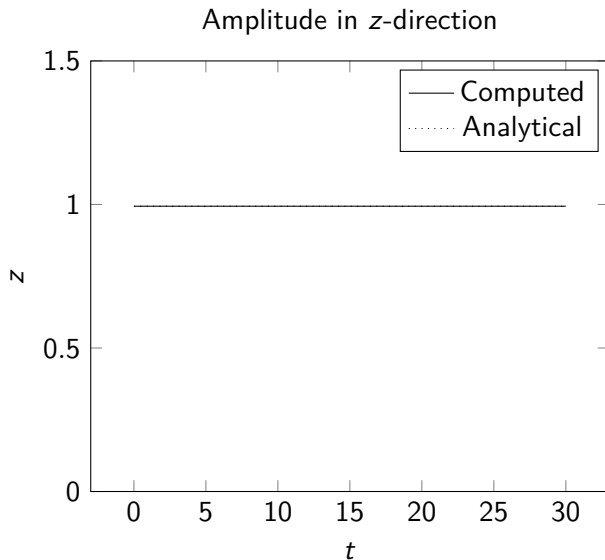
## Part one: Single spin

## Simplest case

Numerical vs. Analytical solution

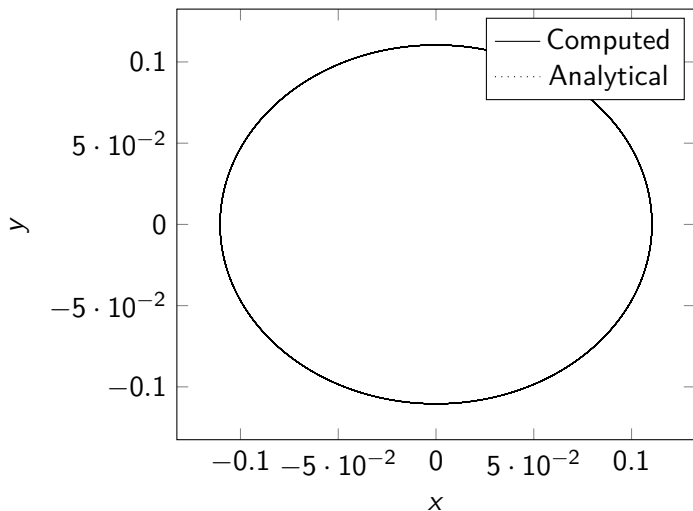


## Simplest case

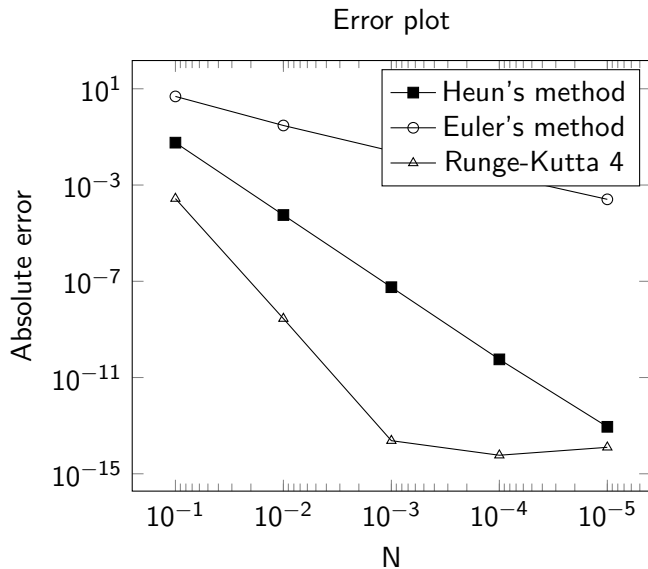


# Phase space

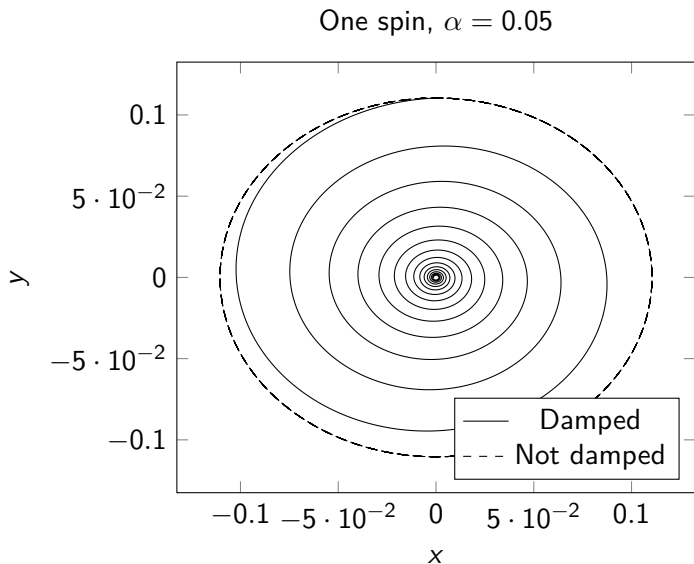
One spin, seen from above



# Convergence plot

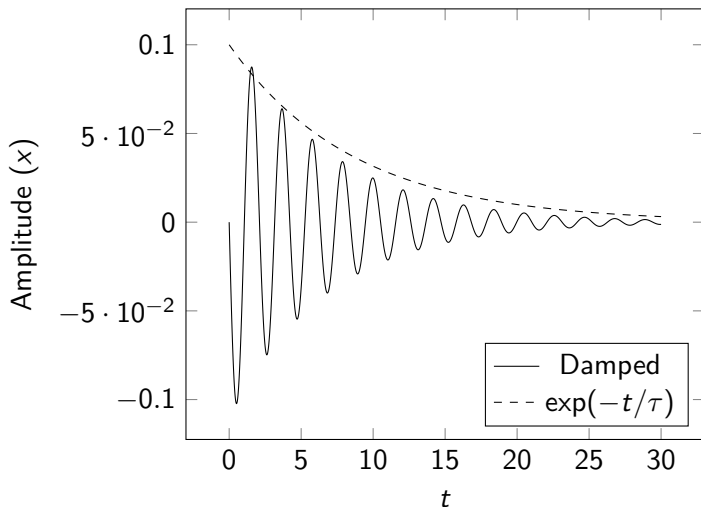


## With damping



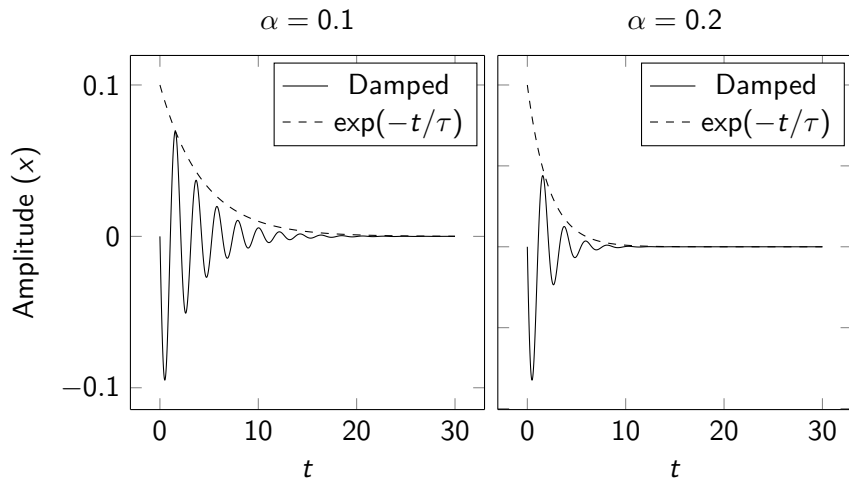
## Analyzing the damping

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





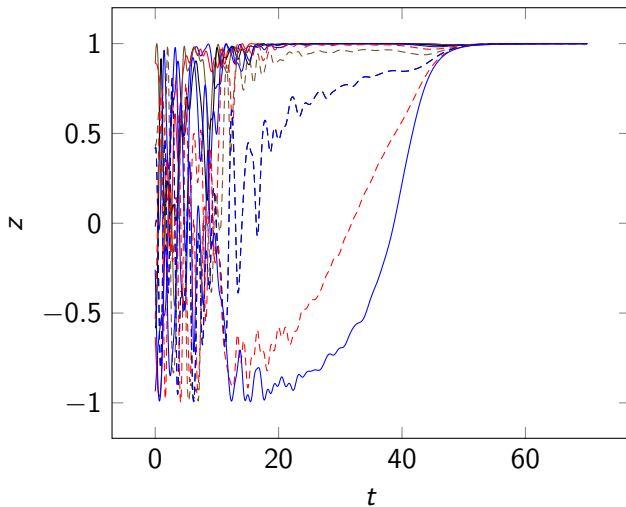
## Varying $\alpha$



## Part two: Spin chain

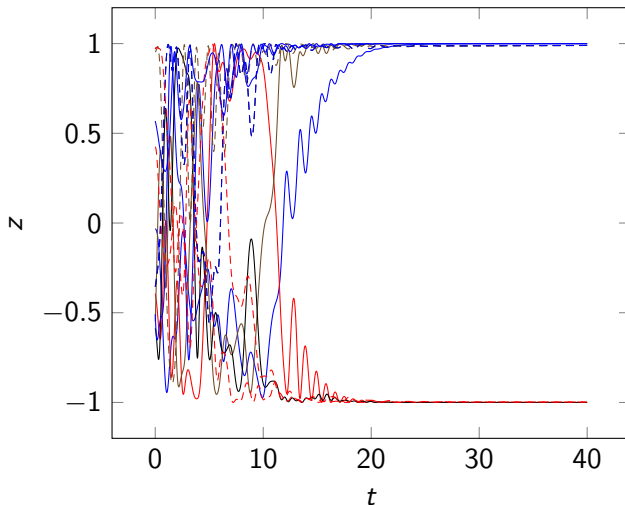
# Ferromagnetic coupling

Random initial directions,  $J = +1$



# Antiferromagnetic coupling

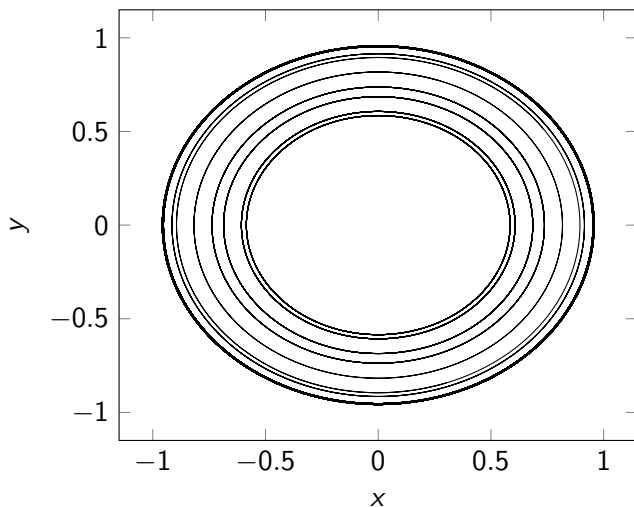
Random initial directions,  $J = -1$



# Magnons

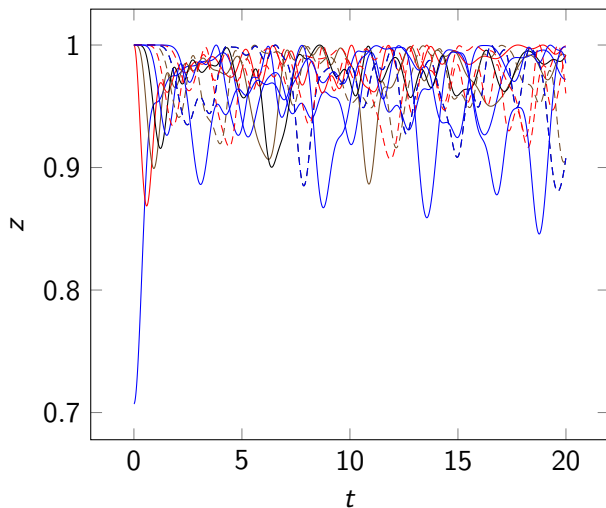
## No coupling

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

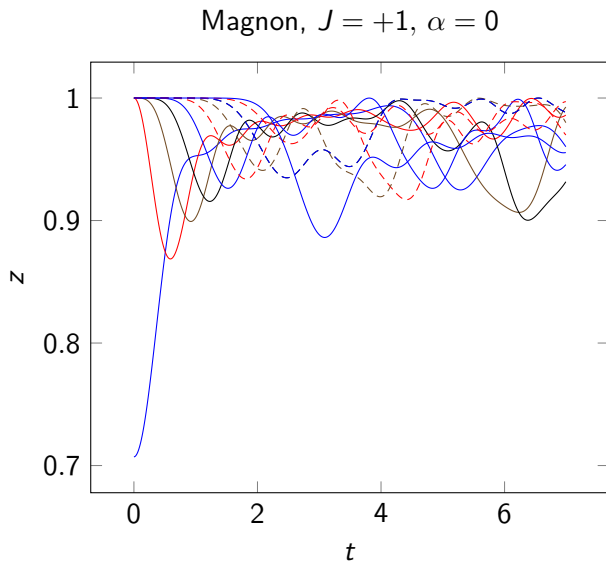


## No damping

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



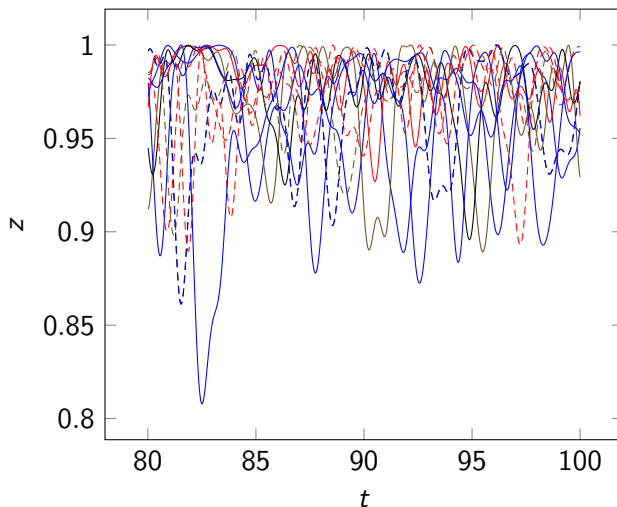
For small  $t$



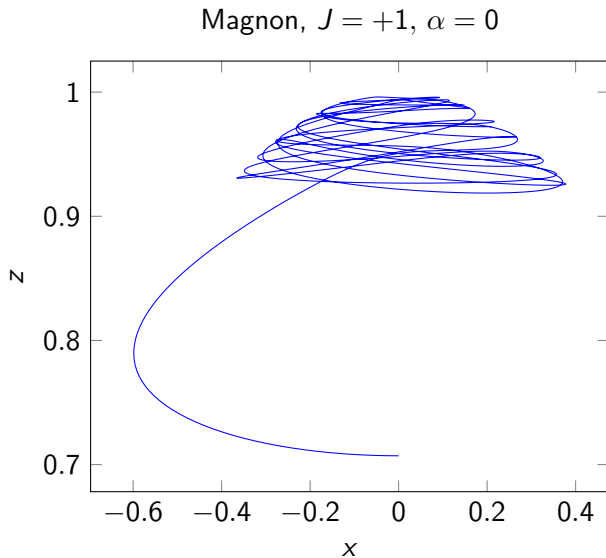


For large  $t$

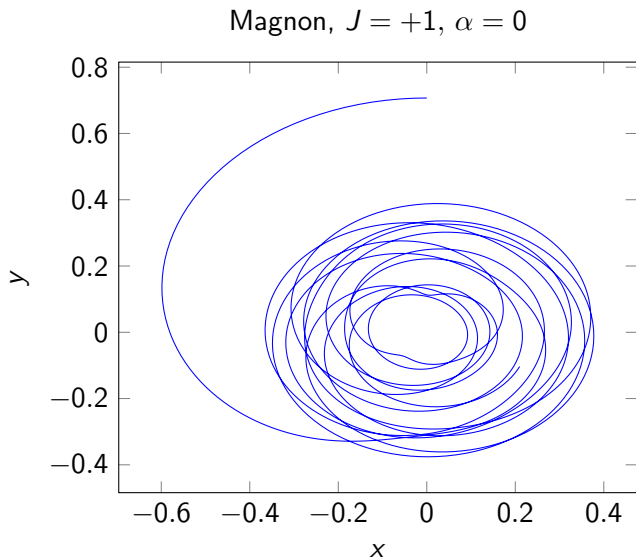
Magnon,  $J = +1$ ,  $\alpha = 0$



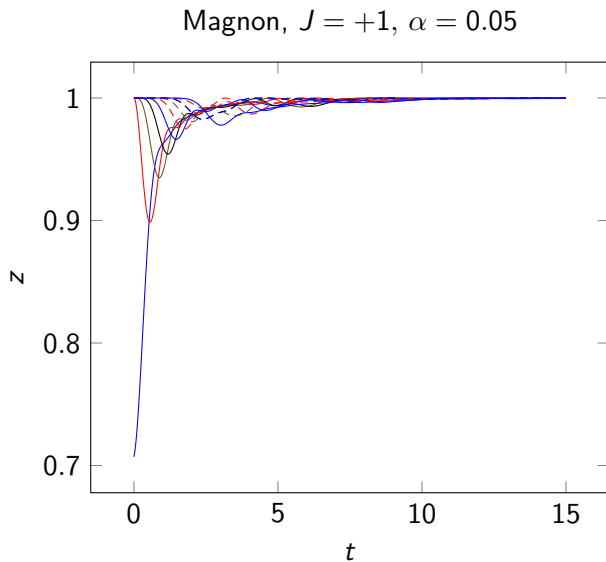
# Spatial movement of the spin



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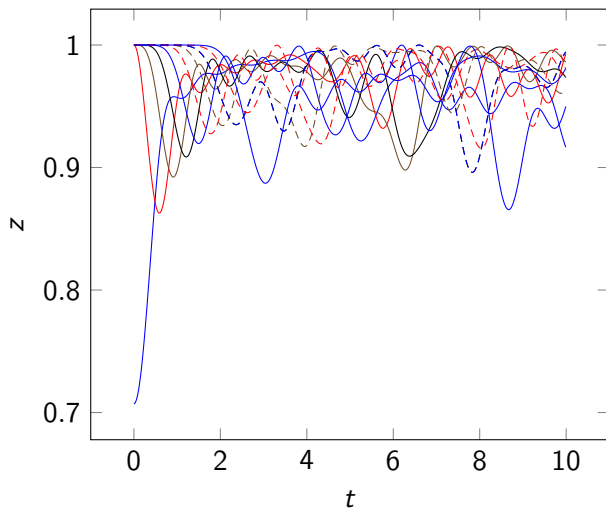
## With damping



# Magnons in antiferromagnetic chain

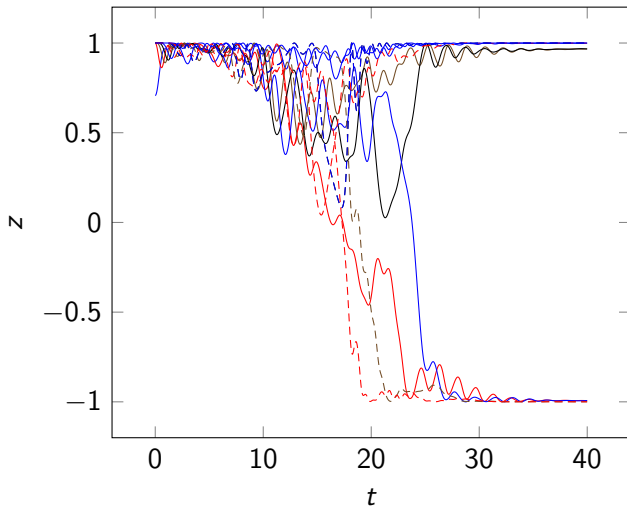
# No damping

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



## With damping

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



# Magnetization

