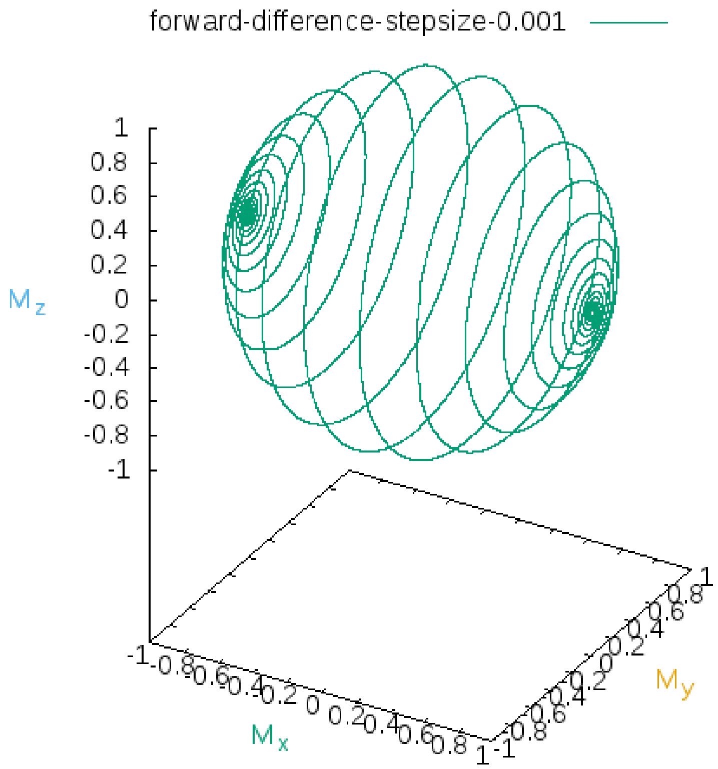
QUIZ 2

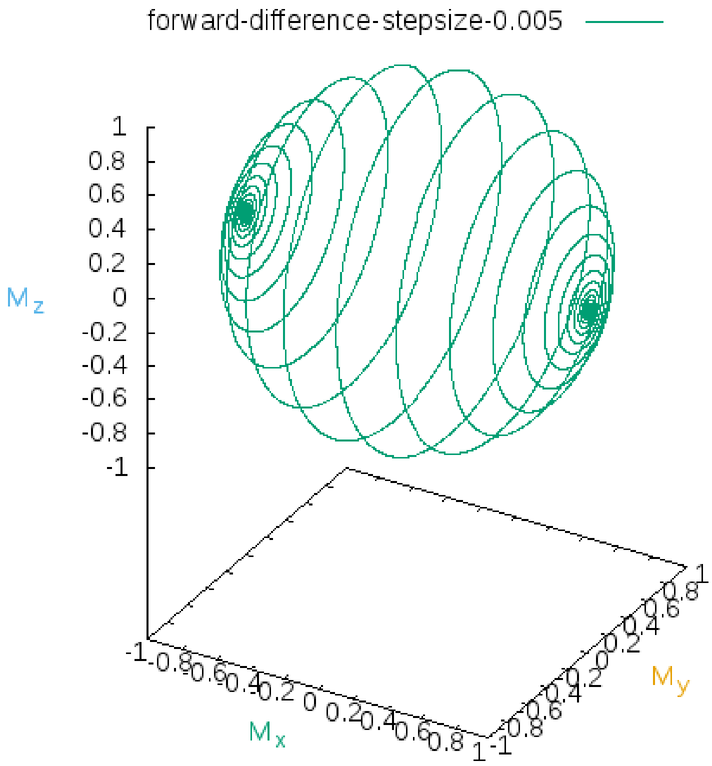
1. Forward Difference Method

By solving the differential equation using forward difference method for different stepsizes, we get the following graphs

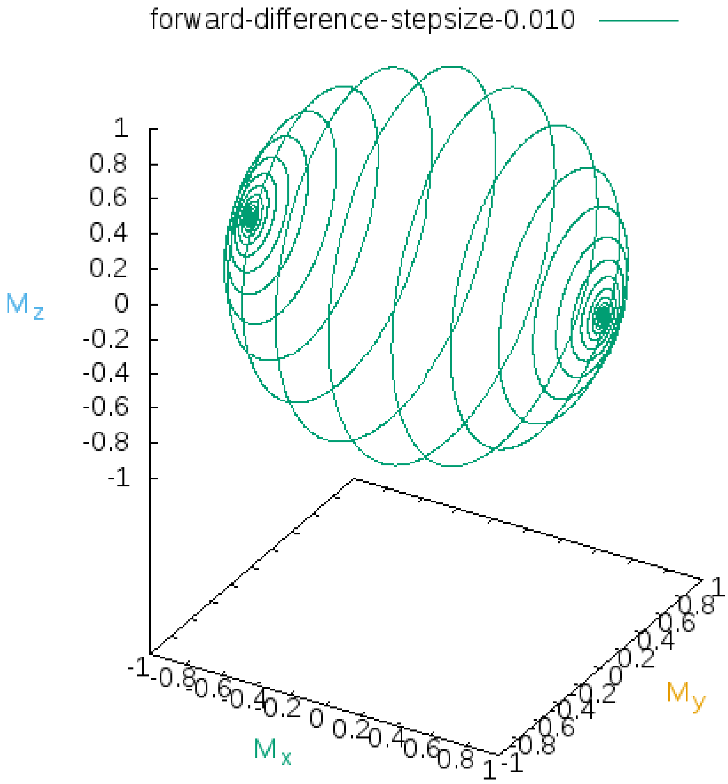
a) For stepsize=0.001



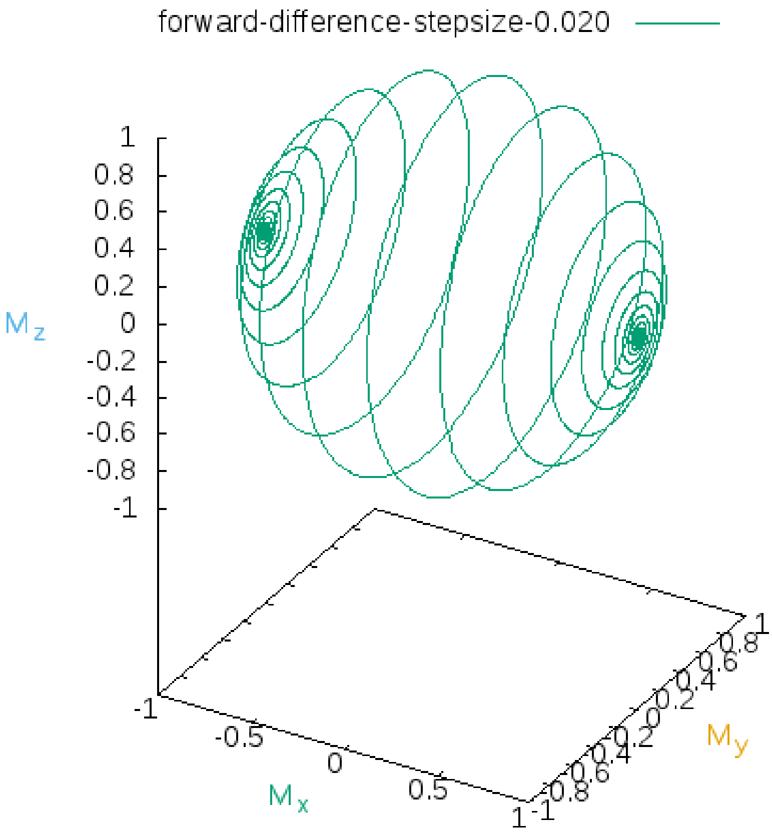
b) For stepsize=0.005



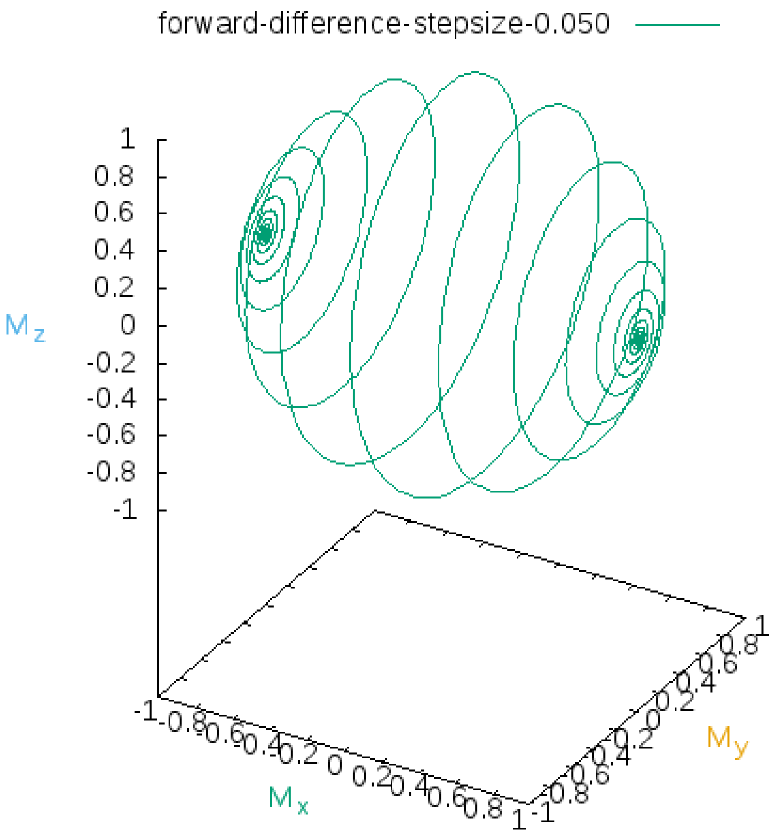
c) For stepsize=0.010



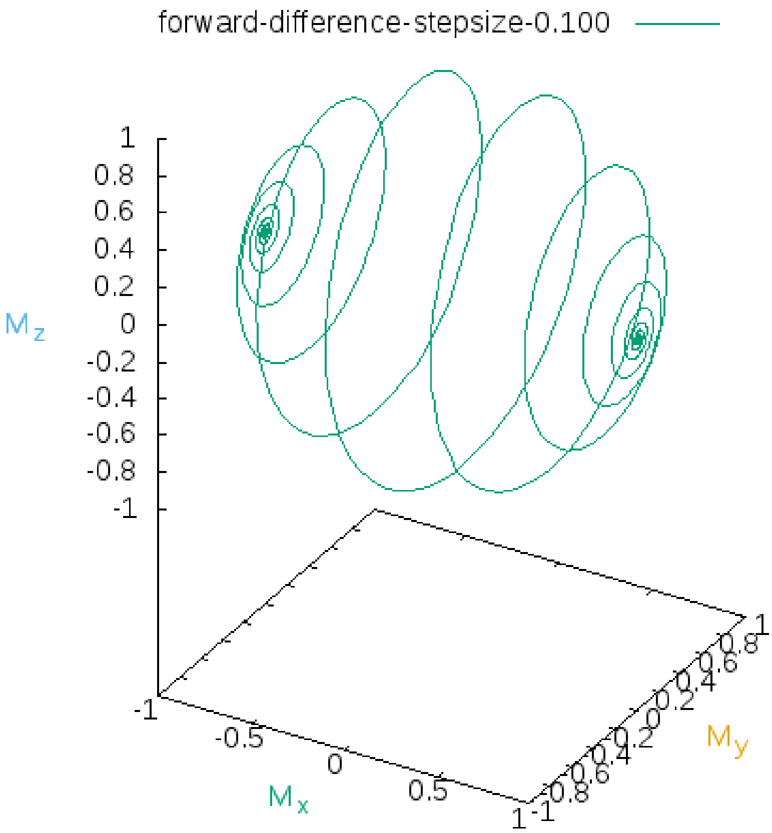
d) For stepsize=0.020



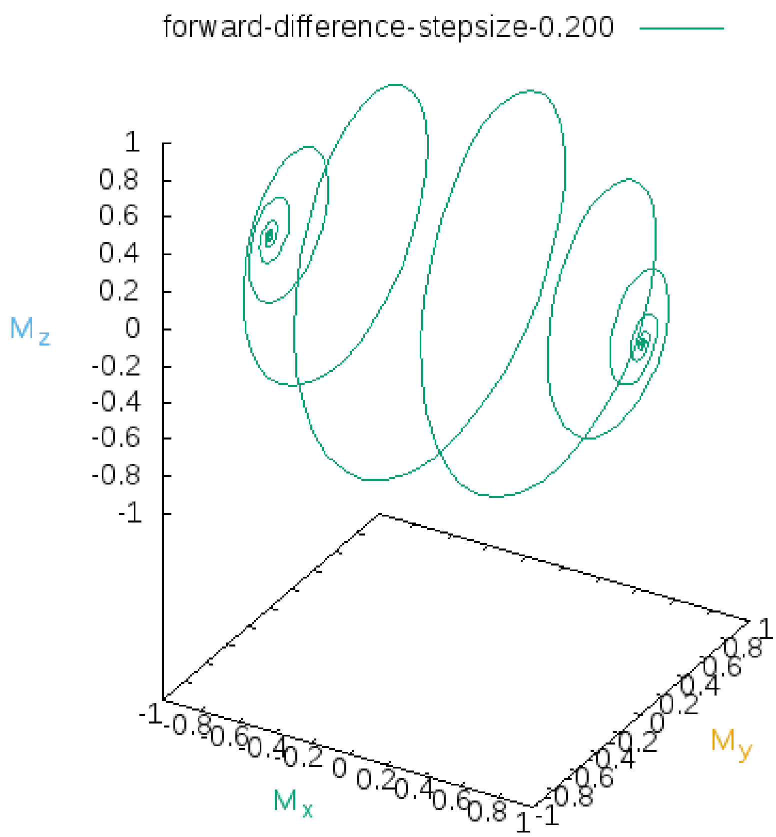
e) For stepsize=0.050



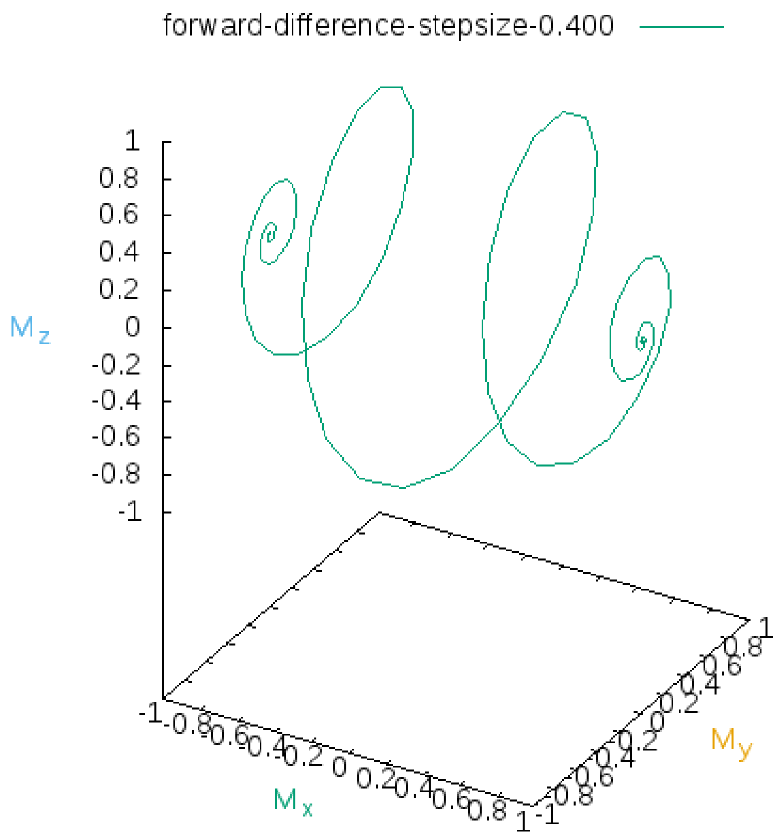
f) For stepsize=0.100



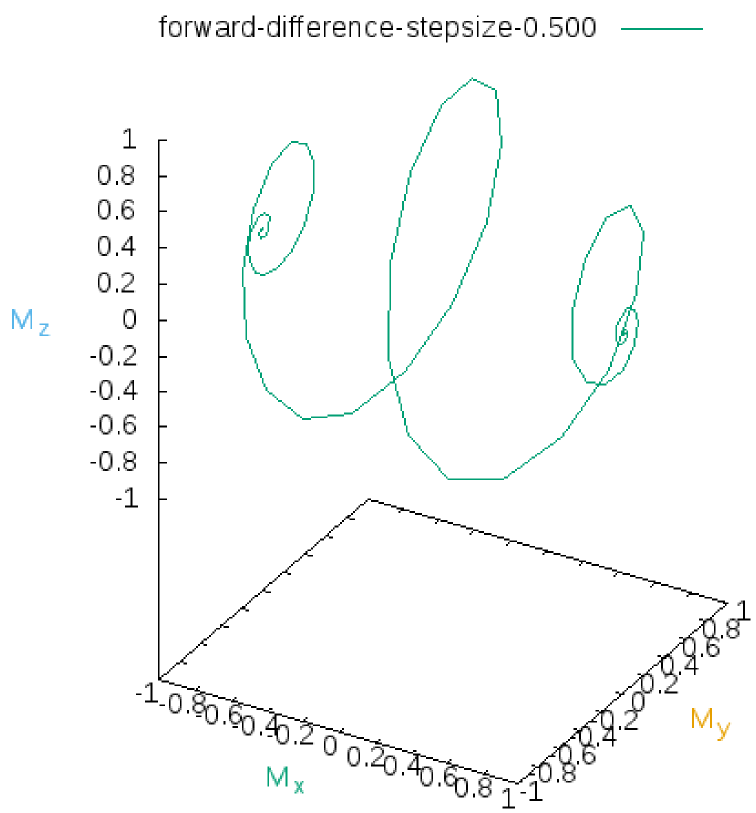
g) For stepsize=0.200



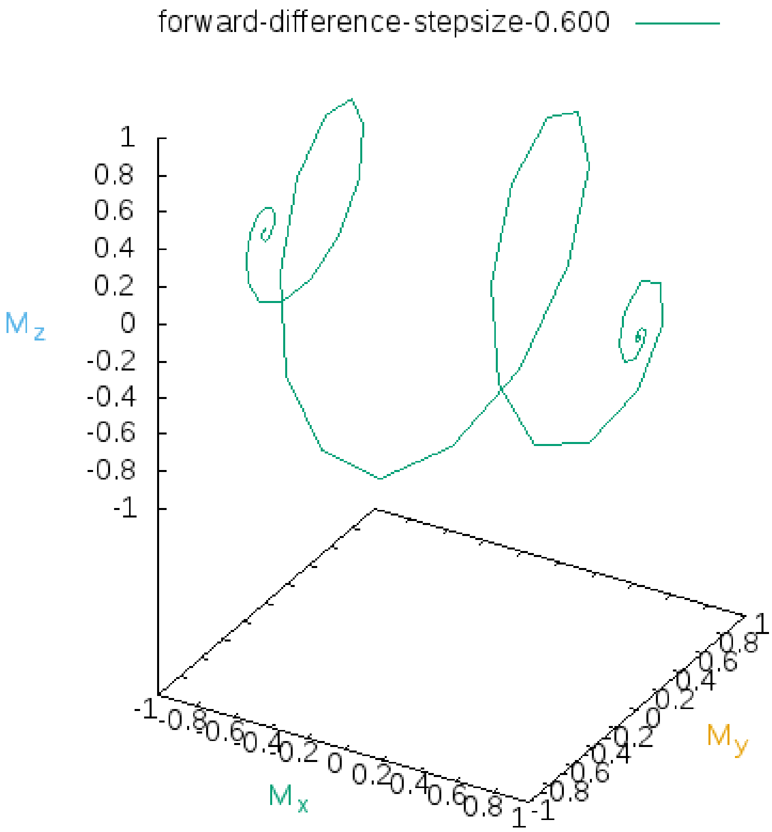
h) For stepsize=0.400



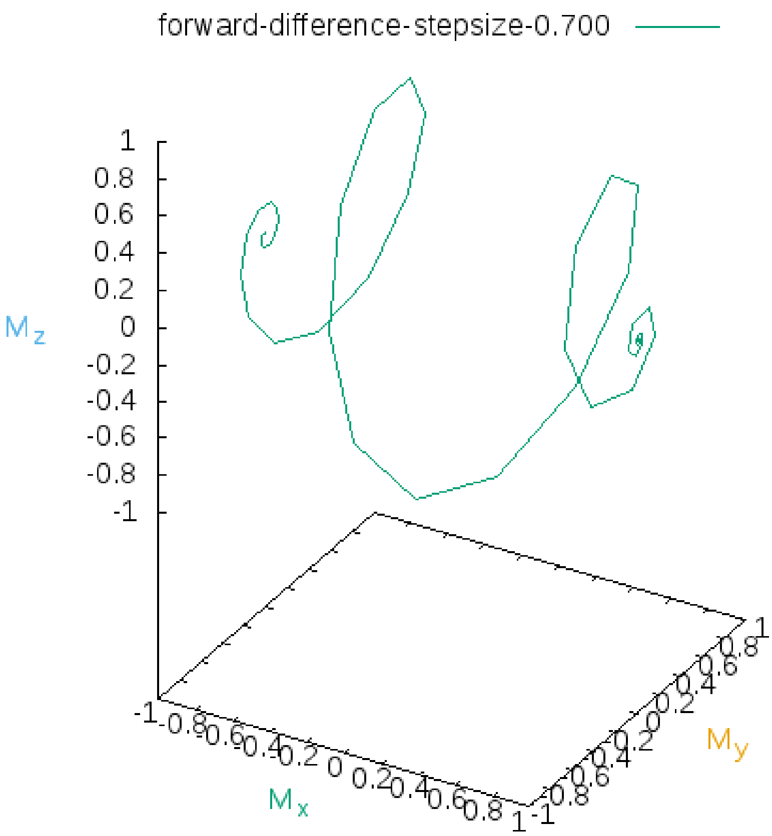
i) For stepsize=0.500



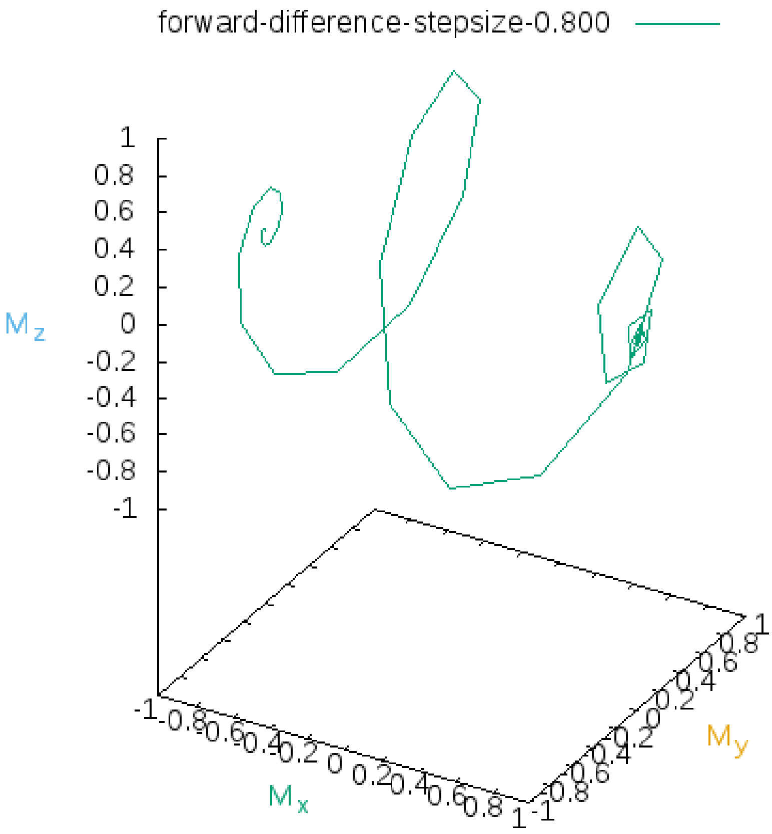
j) For stepsize=0.600



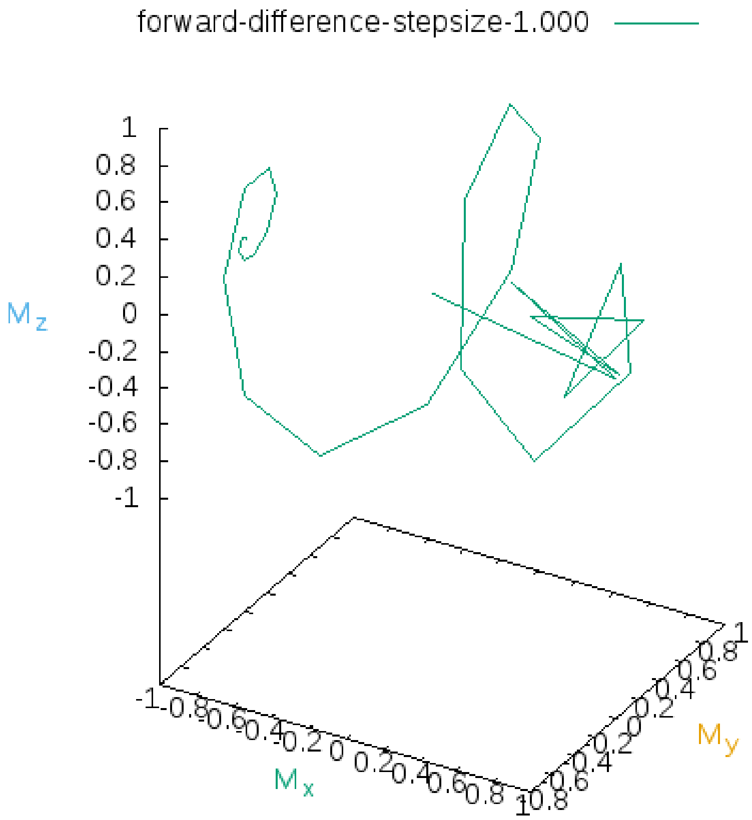
k) For stepsize=0.700



l) For stepsize=0.800



m) For stepsize=1.000



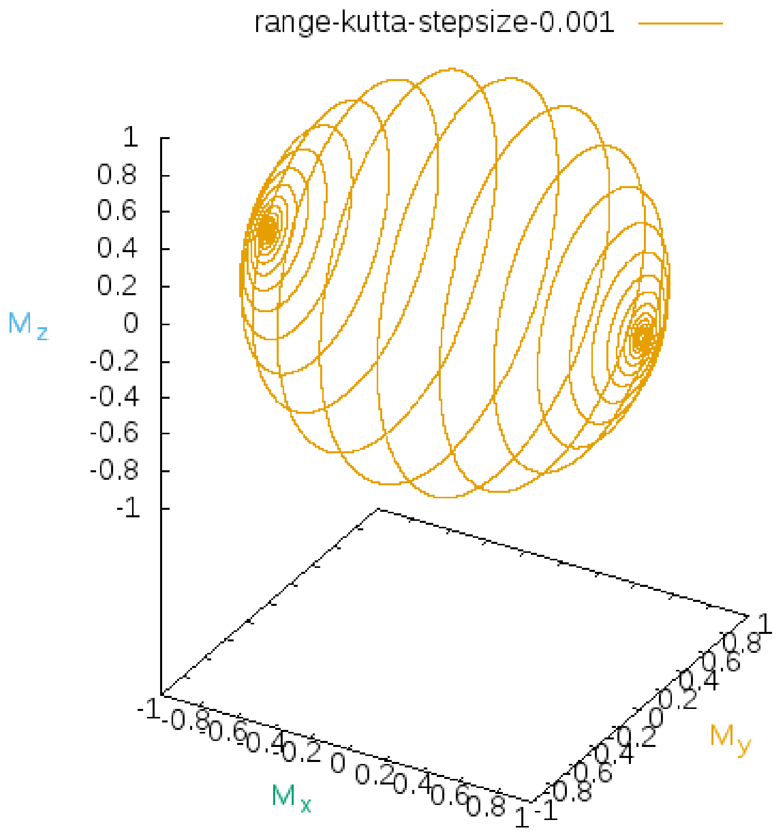
From these graphs we infer that a stable solution gives a spherical plot.

When we solve using the forward difference method, we get stable solutions for stepsizes less than or equal to 0.020.

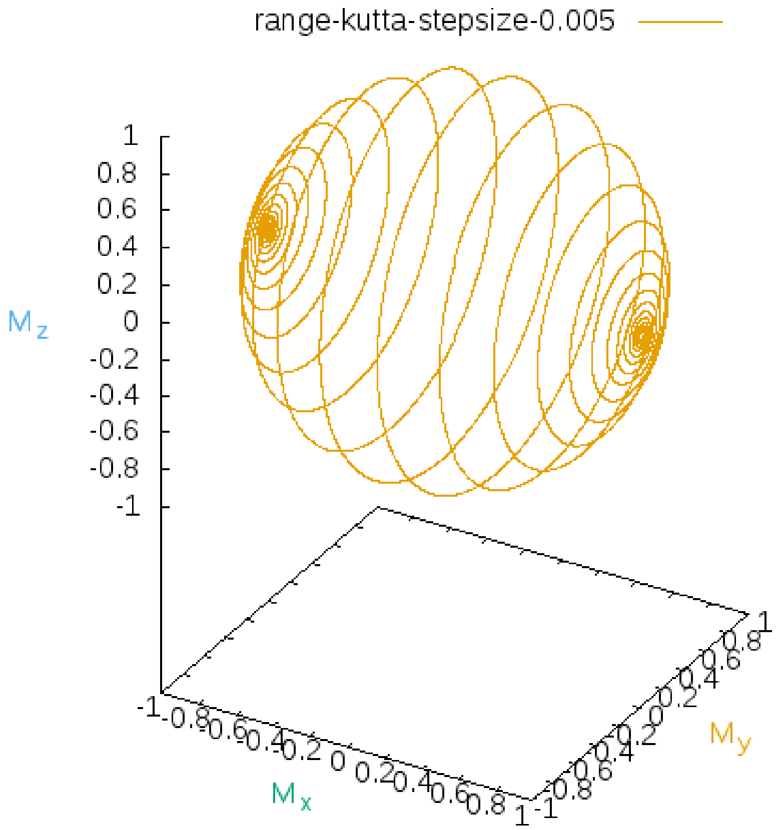
2. Fourth order Runge Kutta Method

By solving the differential equation using fourth order Runge Kutta method for different stepsizes, we get the following graphs

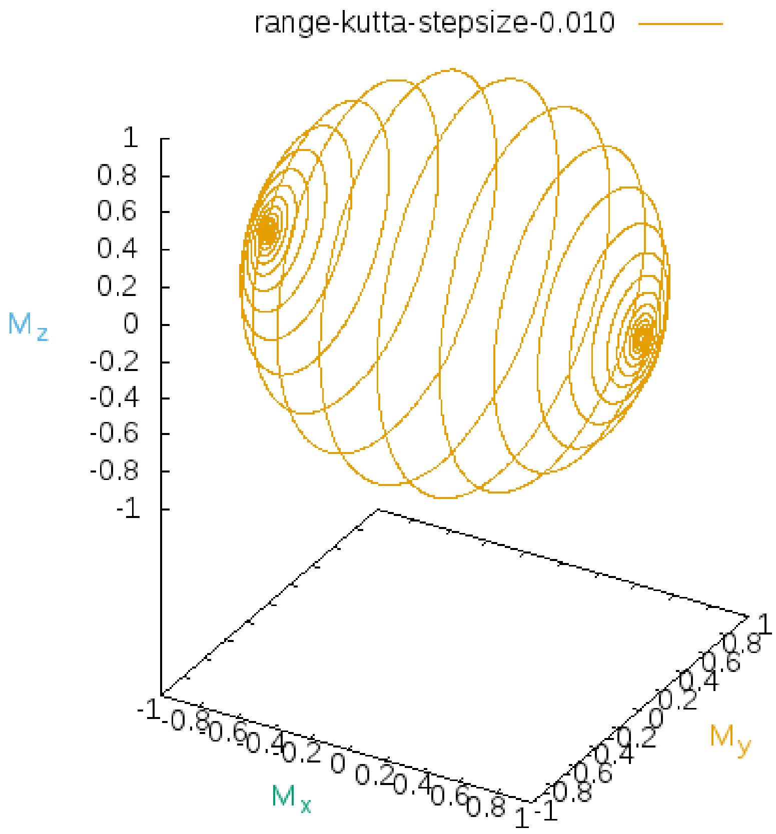
a) For stepsize=0.001



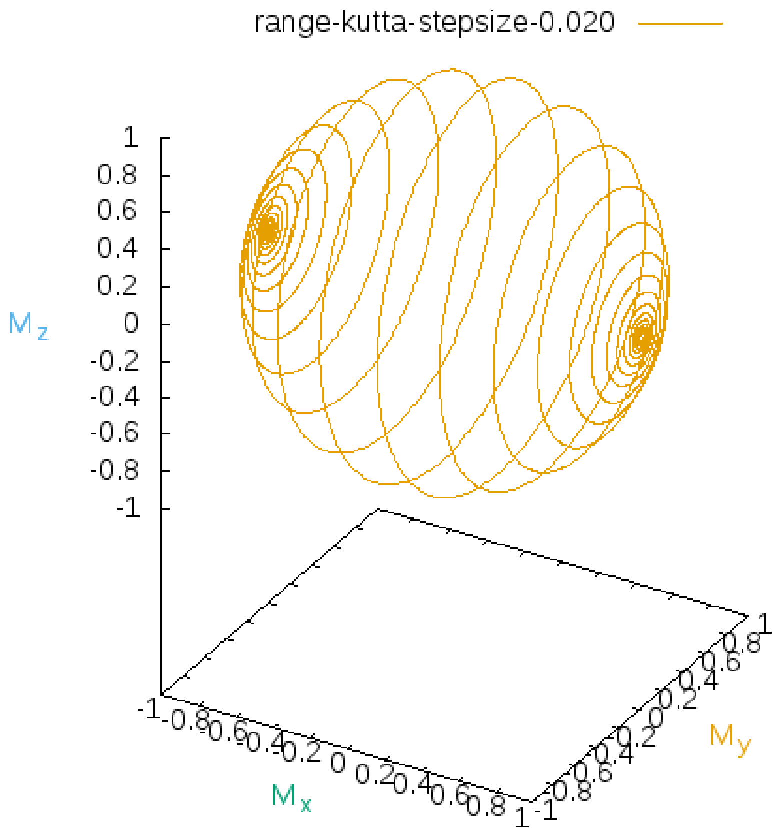
b) For stepsize=0.005



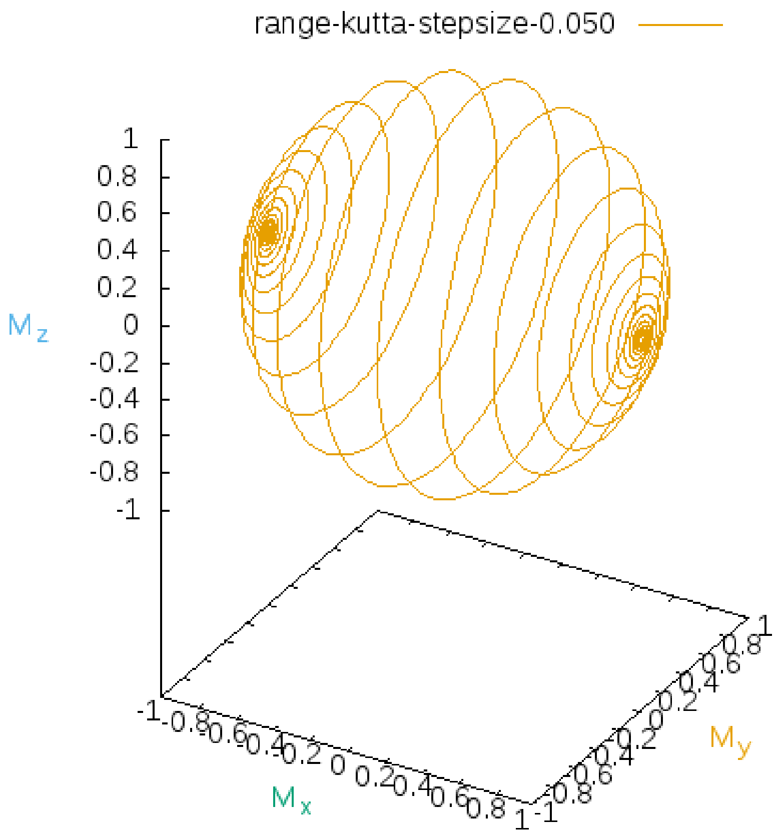
c) For stepsize=0.010



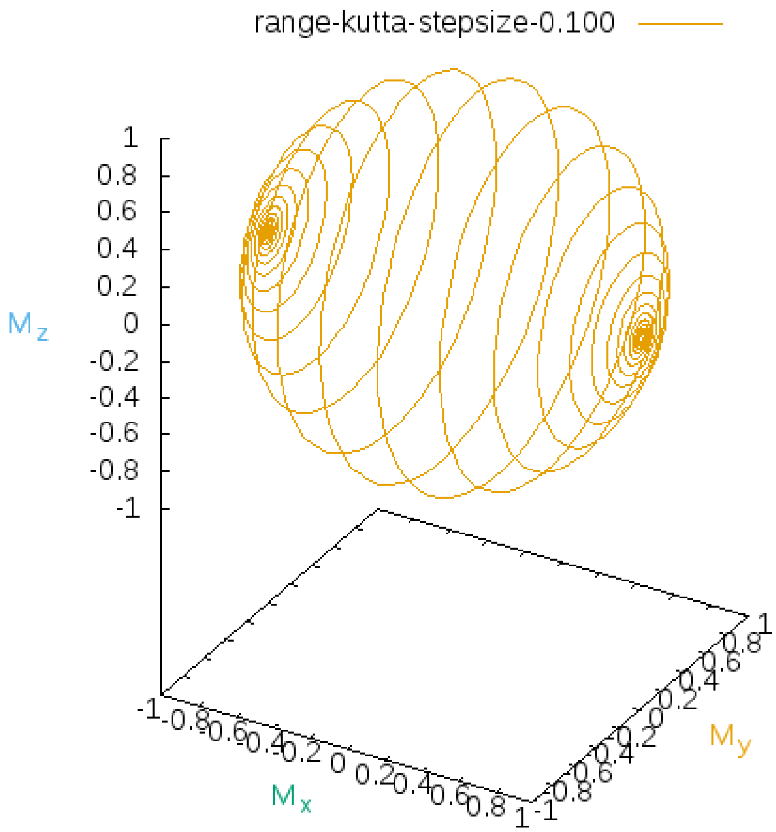
d) For stepsize=0.020



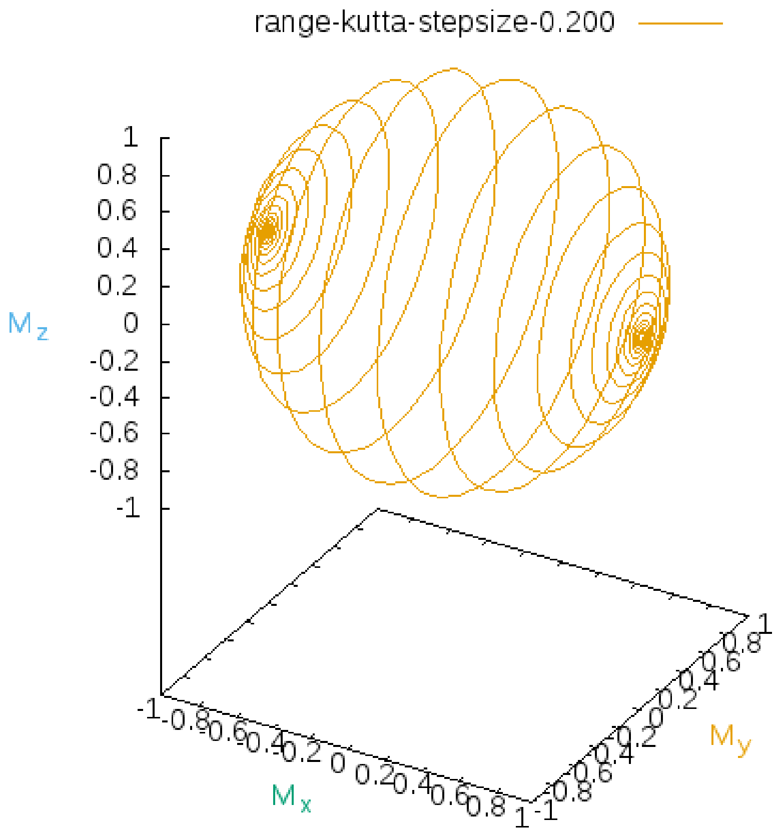
e) For stepsize=0.050



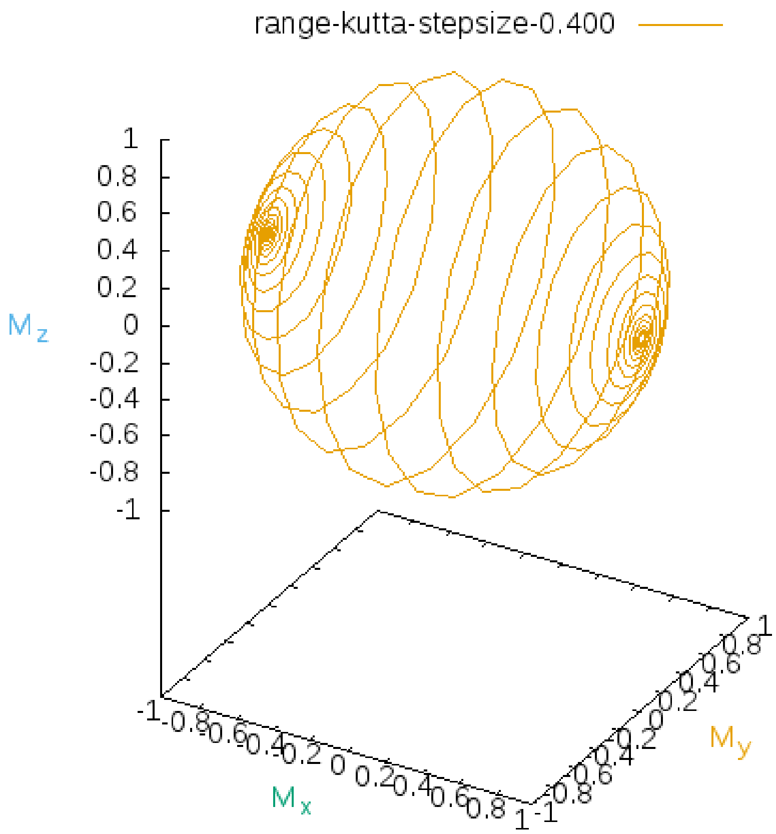
f) For stepsize=0.100



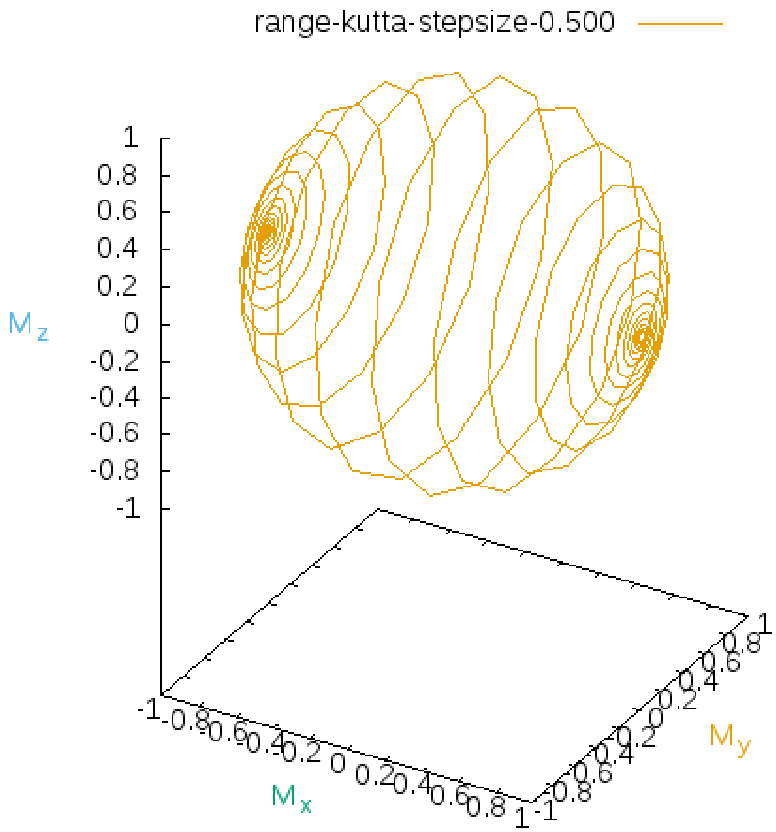
g) For stepsize=0.200



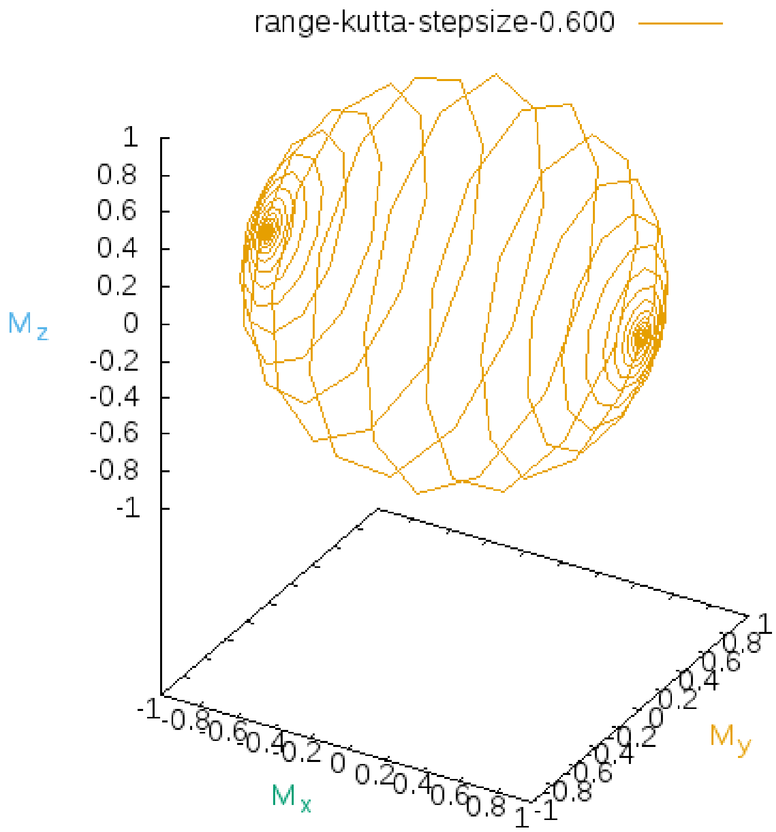
h) For stepsize=0.400



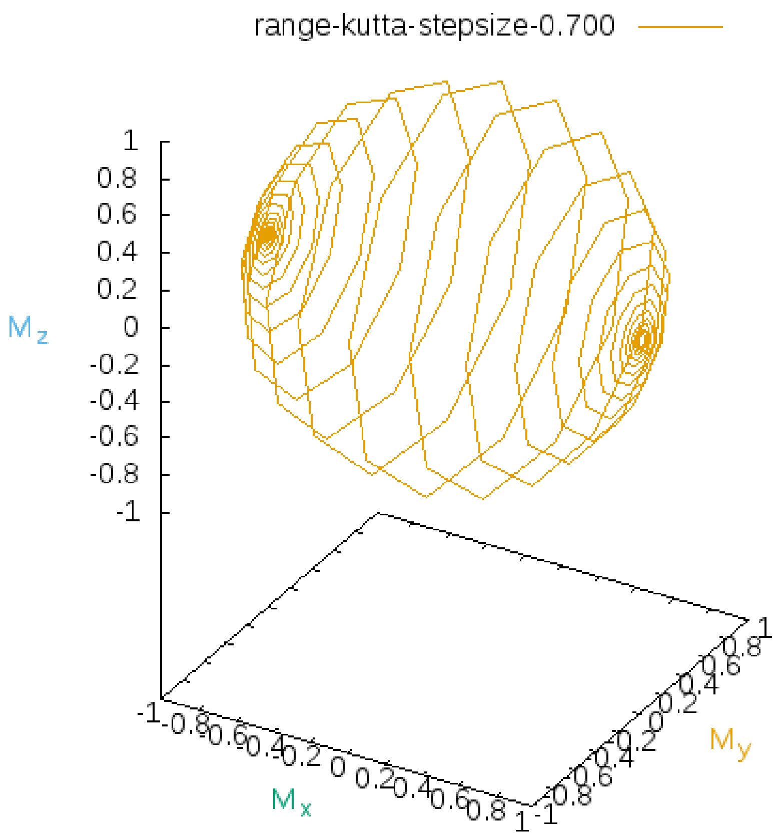
i) For stepsize=0.500



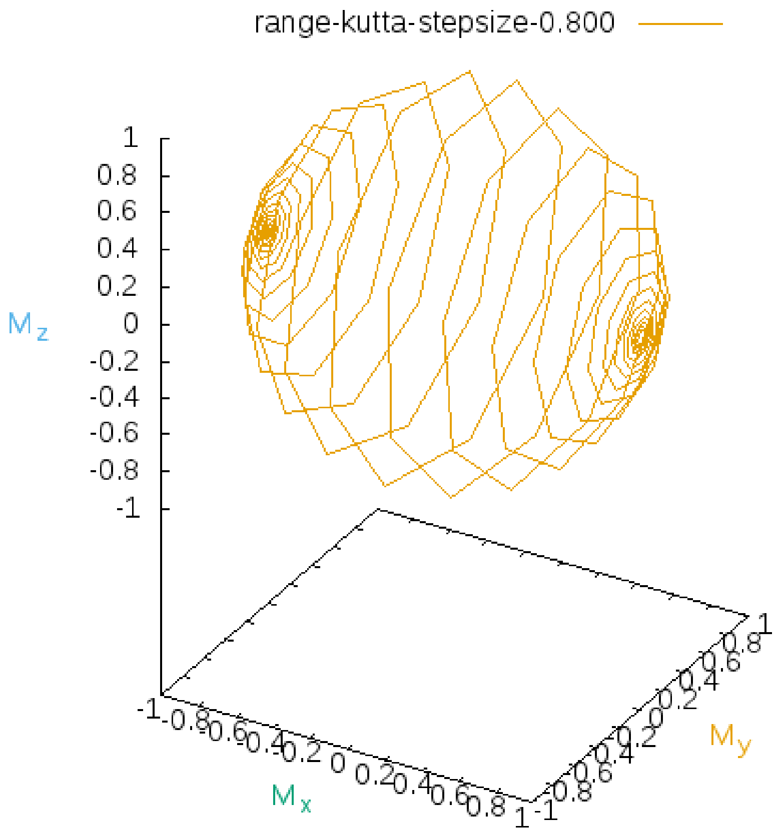
j) For stepsize=0.600



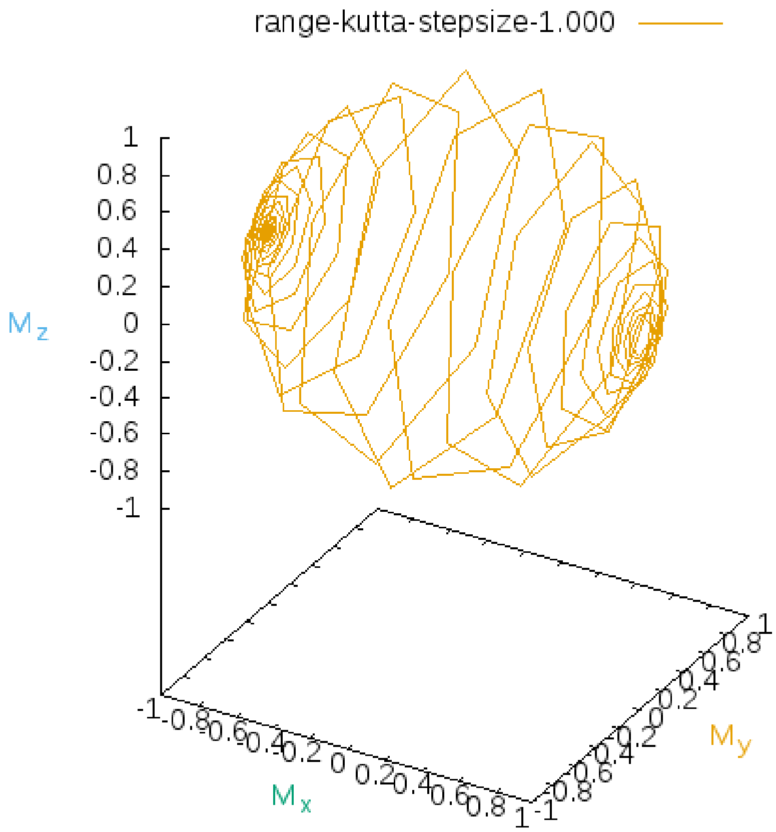
k) For stepsize=0.700



l) For stepsize=0.800



m) For stepsize=1.000



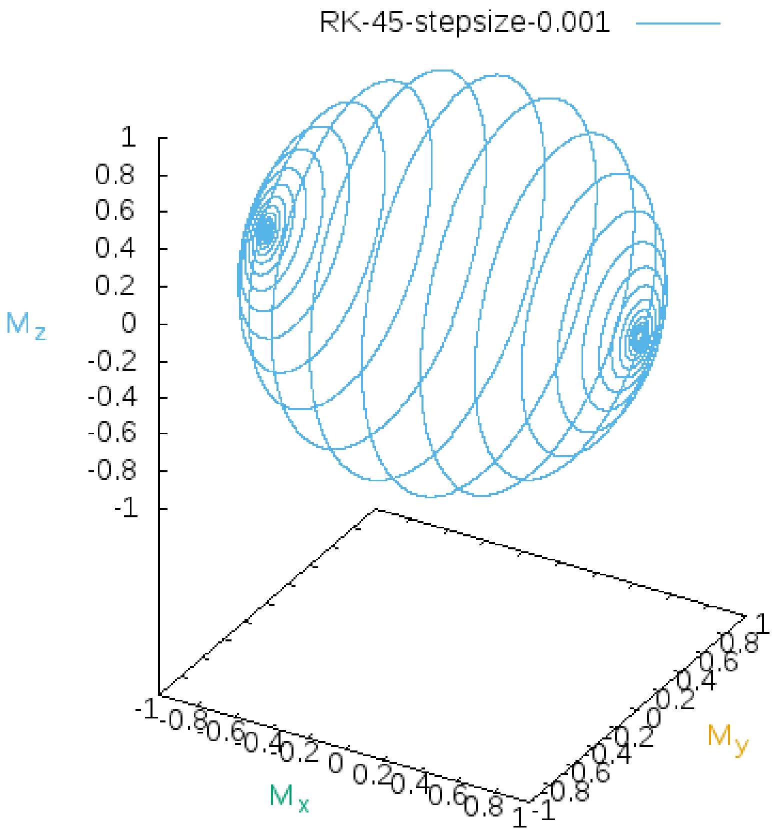
From these graphs we infer that the solutions derived from Runge Kutta are more stable. This is understood from observing that the graphs give stable solutions even for large stepsizes that the forward difference method was unable to achieve.

When we solve using the fourth order Runge Kutta method, we get stable solutions for stepsizes less than 0.400.

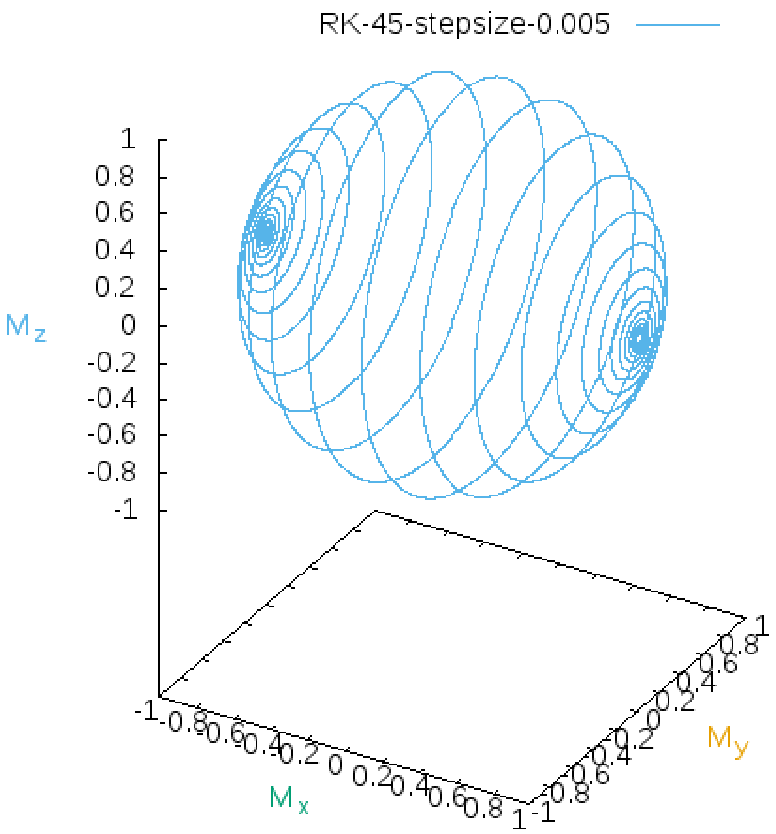
Using RK45

By solving the differential equation using RK45 method for different stepsizes, we get the following graphs

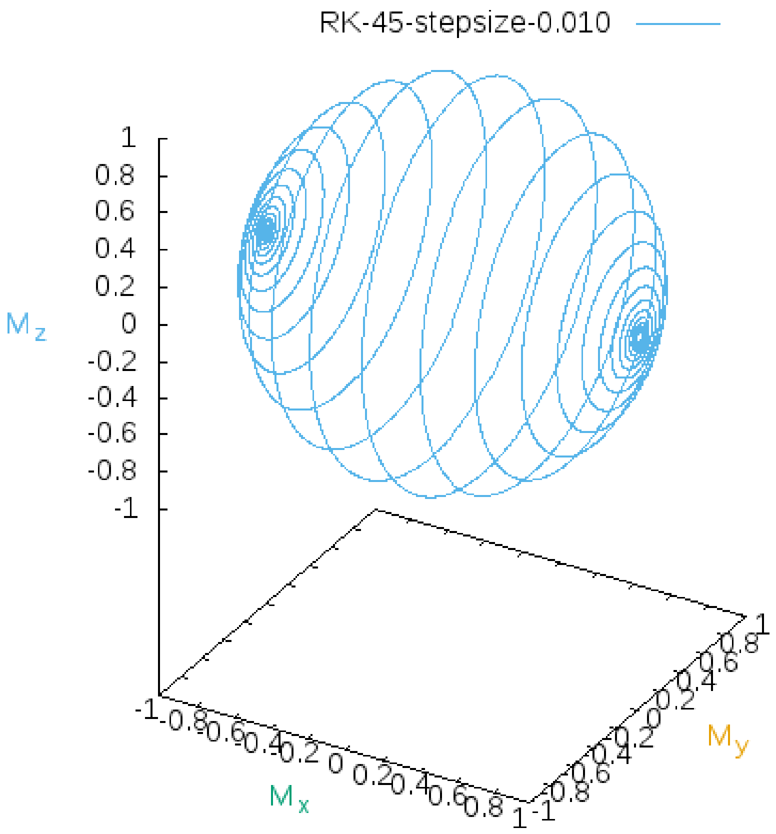
a) For stepsize=0.001



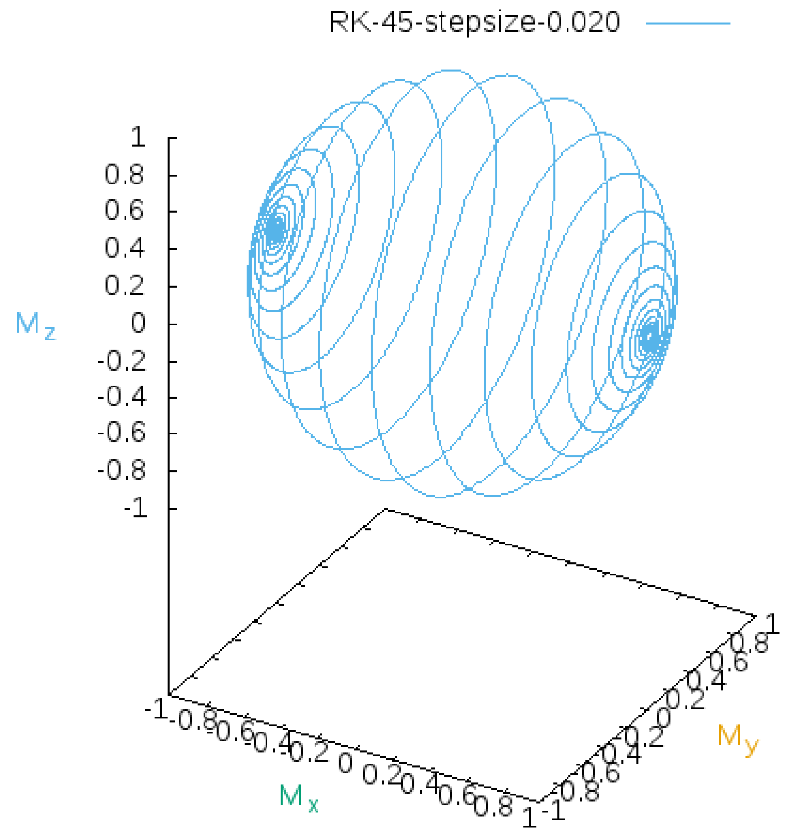
b) For stepsize=0.005



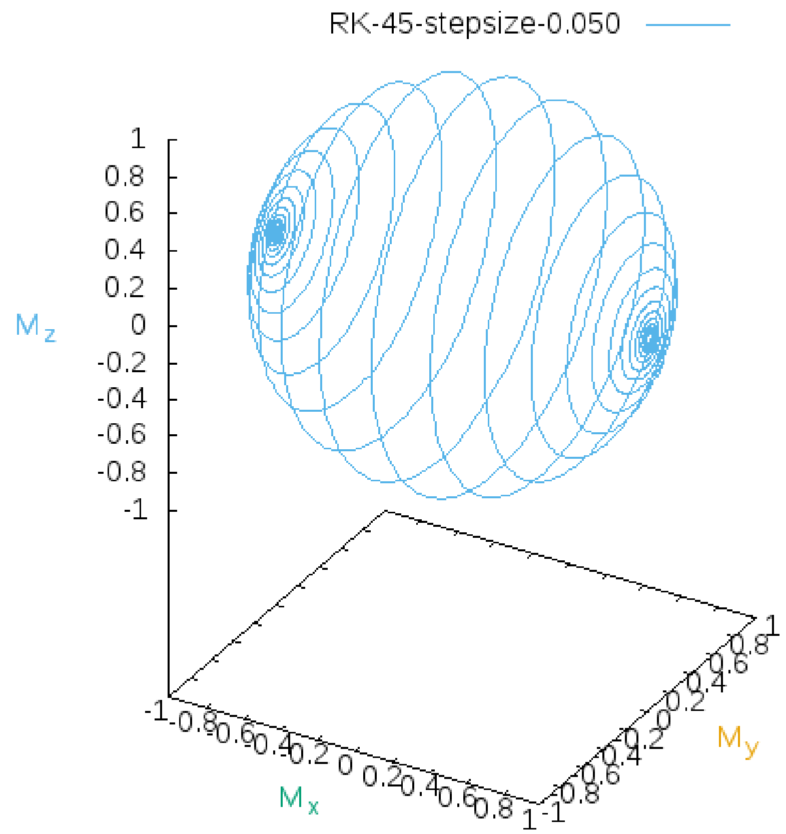
c) For stepsize=0.010



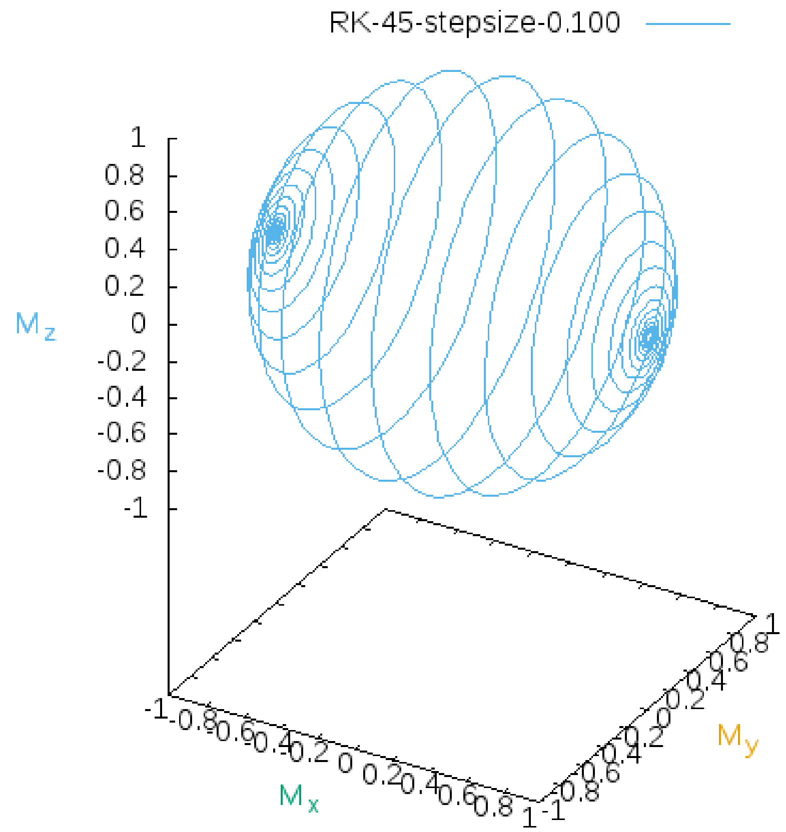
d) For stepsize=0.020



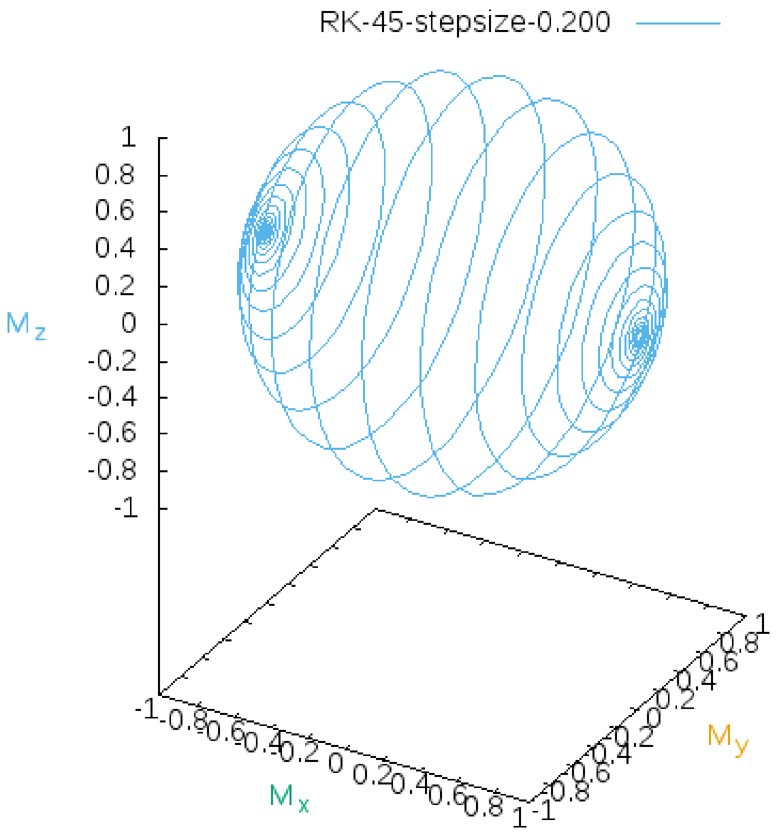
e) For stepsize=0.050



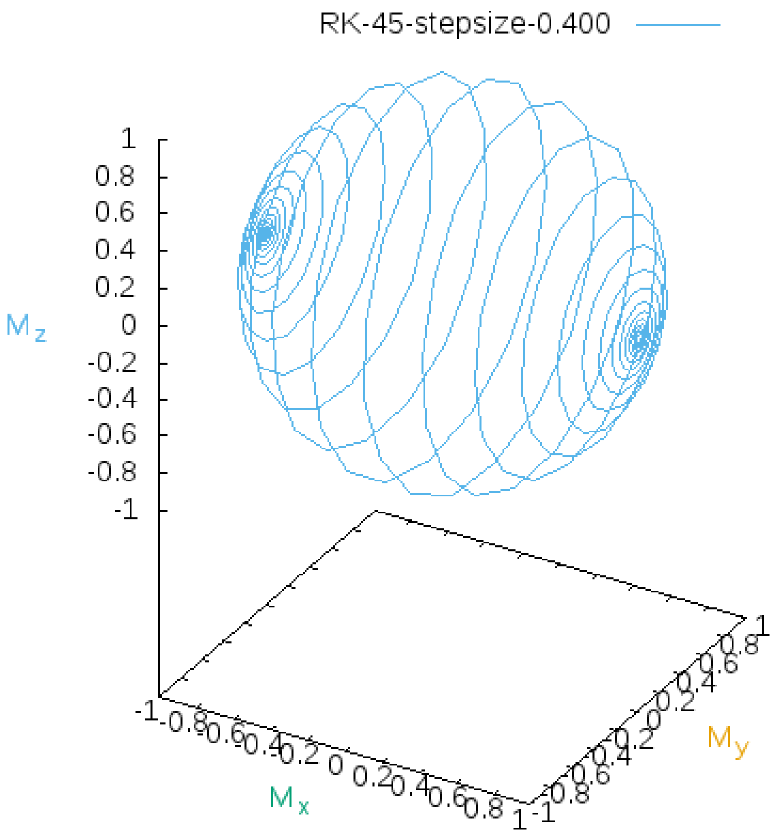
f) For stepsize=0.100



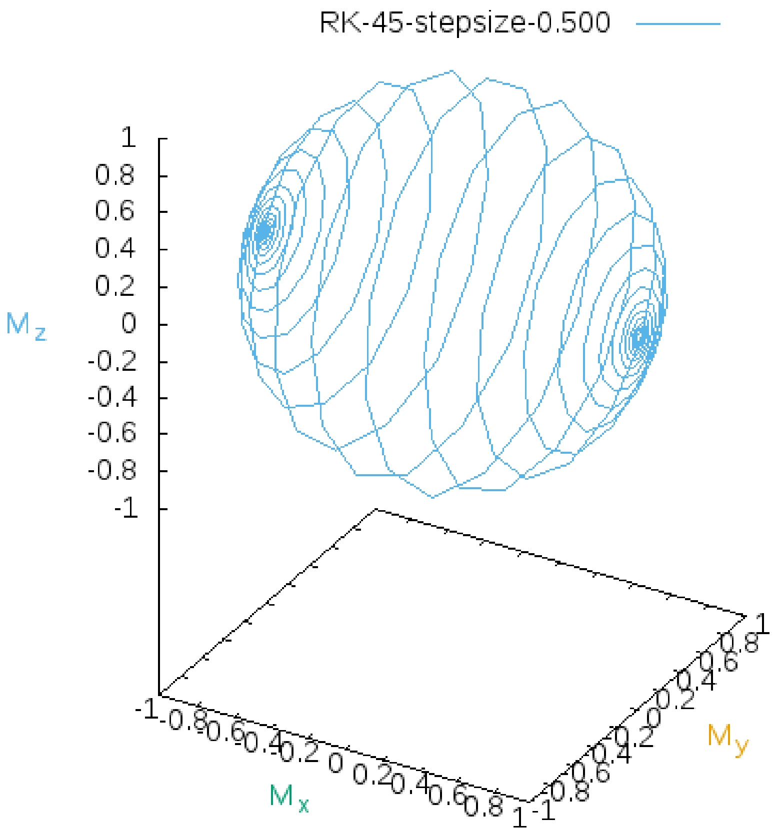
g) For stepsize=0.200



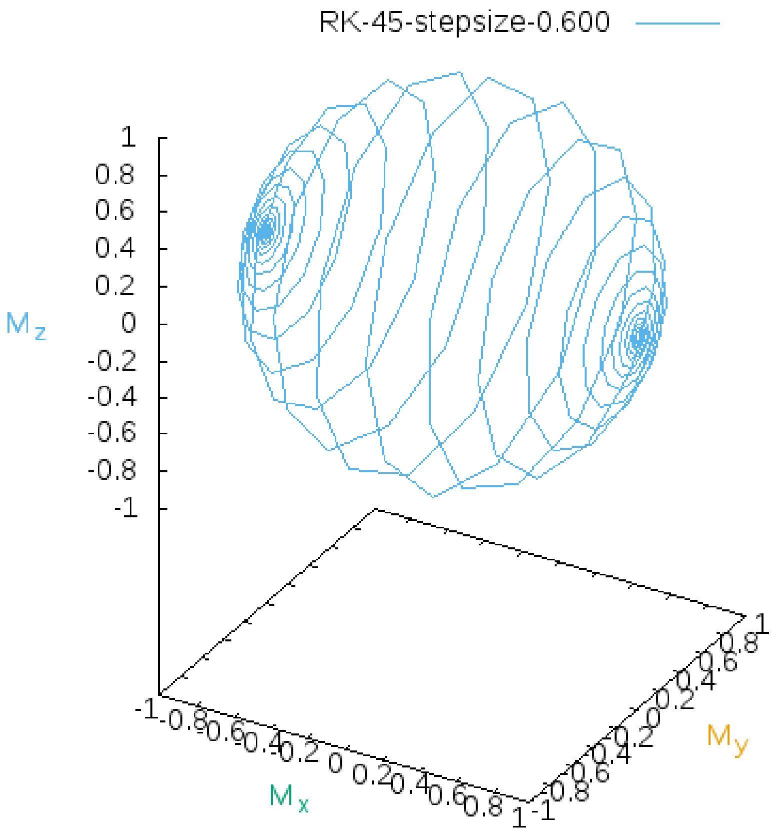
h) For stepsize=0.400



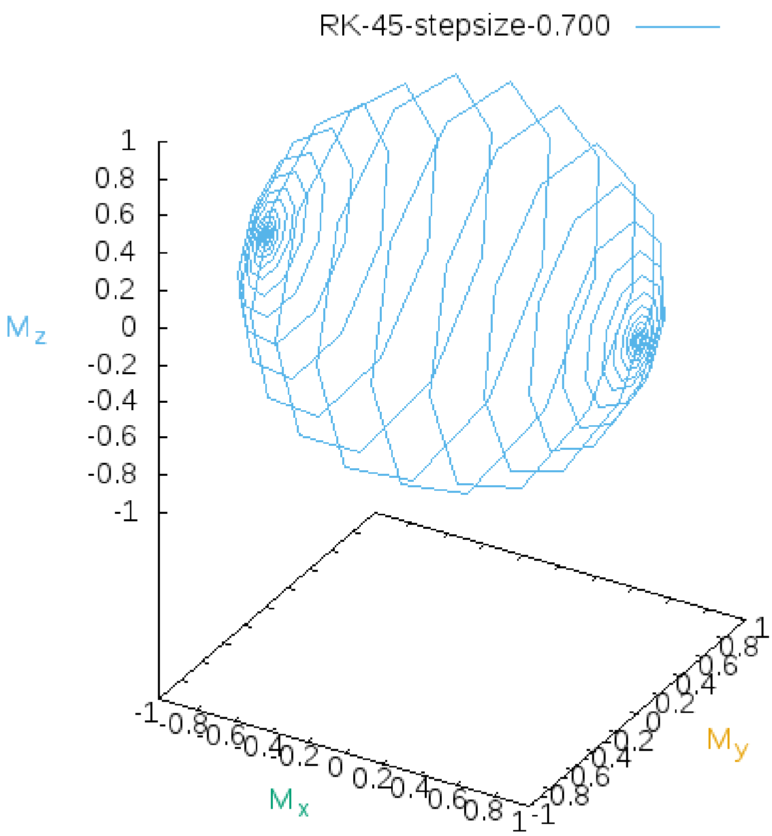
i) For stepsize=0.500



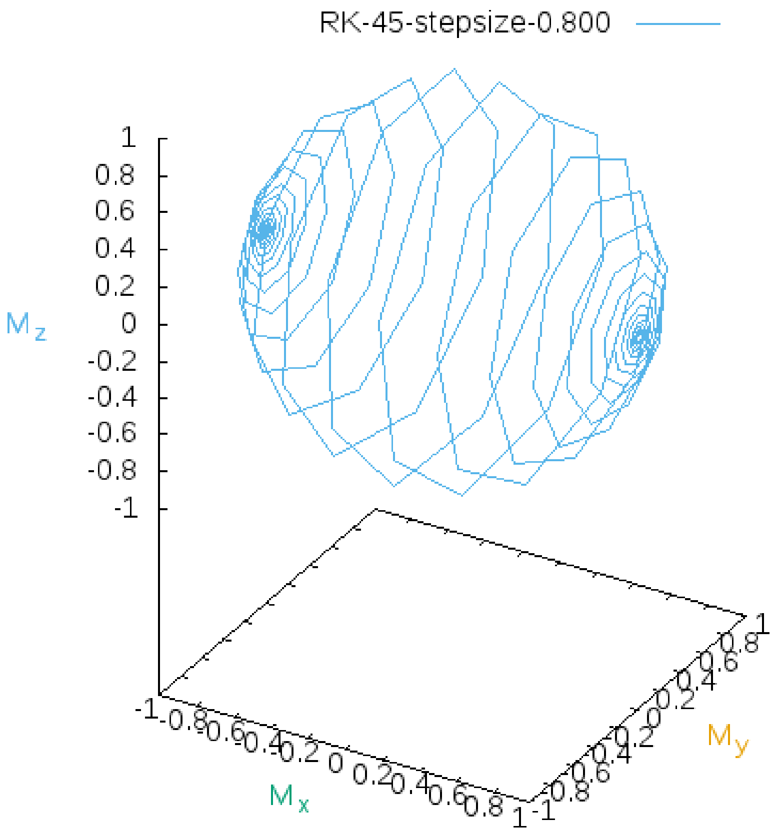
j) For stepsize=0.600



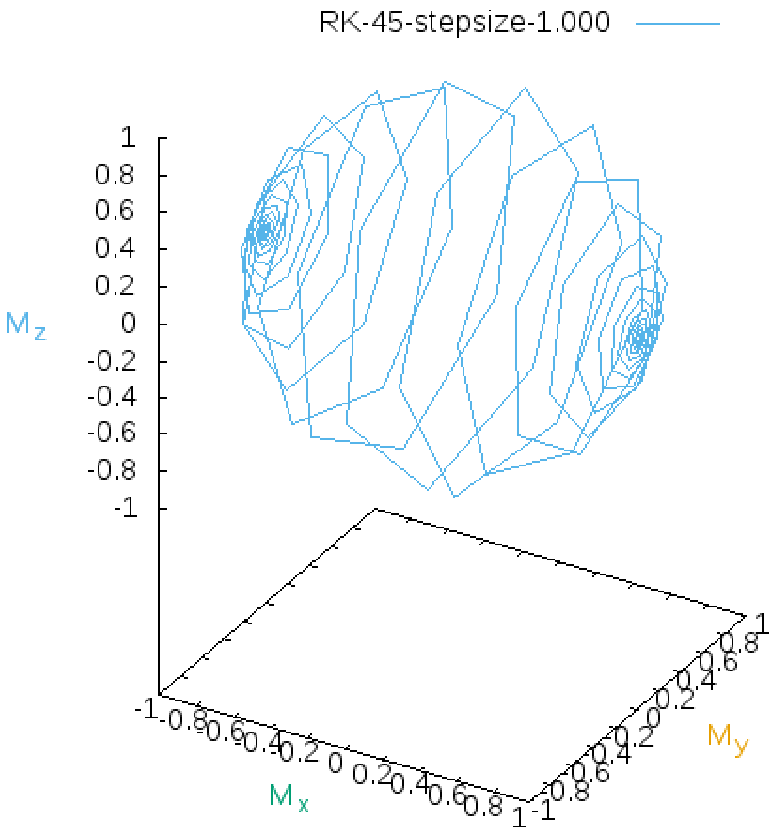
k) For stepsize=0.700



l) For stepsize=0.800



m) For stepsize=1.000



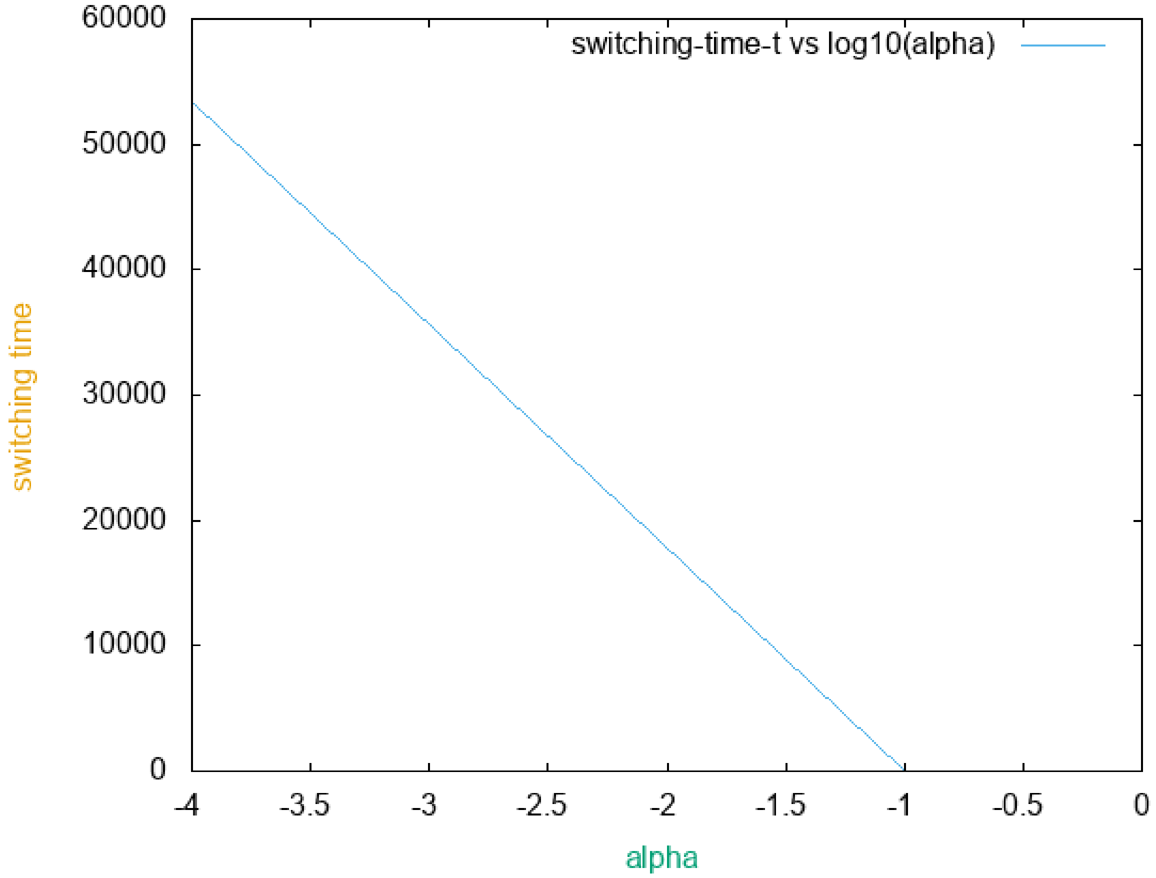
From these graphs we infer that RK45 gives more stable solutions. It gives better plots tan the fourth order Range Kutta.

When we solve using the RK45 method, we get stable solutions for stepsizes less than 0.500.

For stepsize values beyond the maximum stepsize for which the method gives stable solution, the plot becomes increasingly distorted.

3. Switching time as a function of alpha

Switching time is given by the time at which magnetisation switches (here, value of Mx to change sign). This varies for different values of alpha. Given below is the plot of switching time t vs log alpha (log to the base 10).

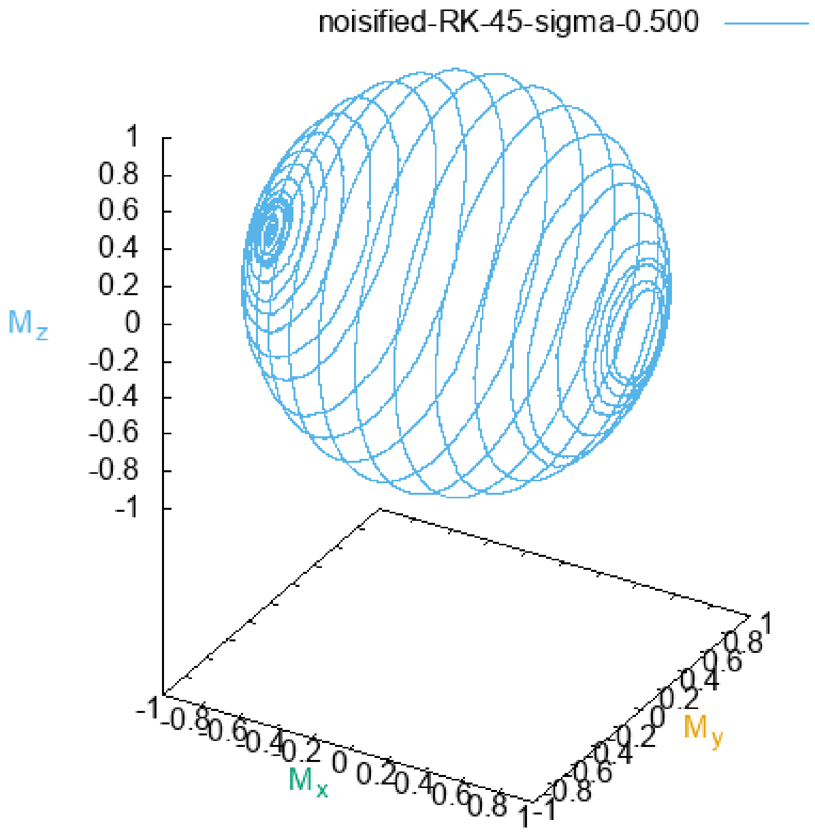


We get the plot to be straight line with a negative slope. Thus we observe that switching time is a logarithmic function of alpha and that as alpha increases, switching time decreases.

4. Adding Noise to the simulation

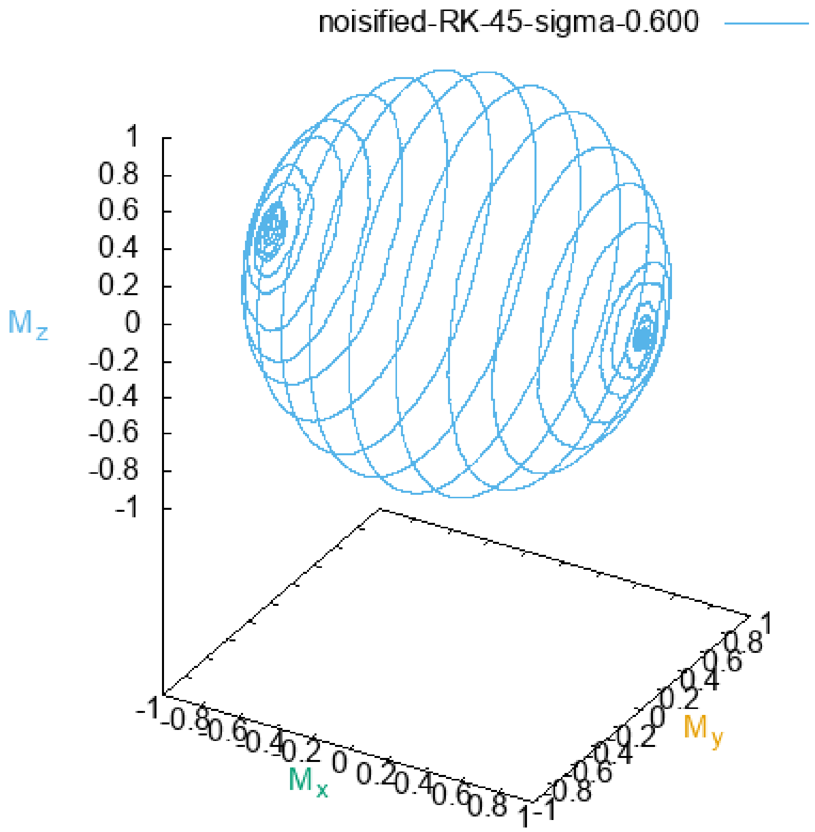
To add noise to the simulation, we add a small kick in a random direction, after each iteration in the RK solver. Here, we create three random numbers with mean 0 and variance sigma and add it to each component of magnetisation after each time step. We plot the trajectory of M after addition of noise for different values of sigma.

a) For sigma=0.500



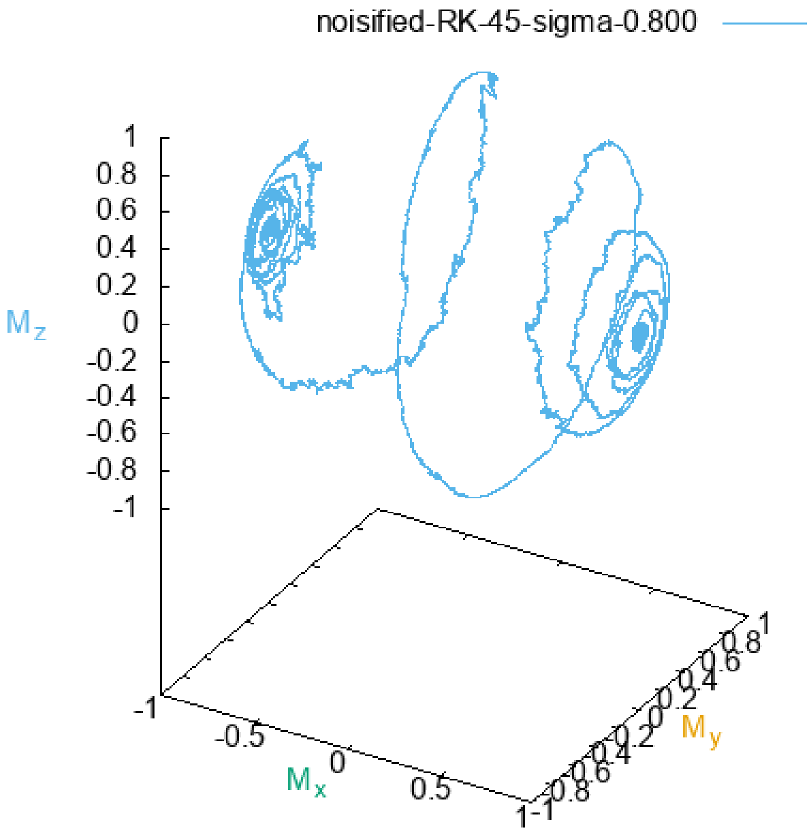
Root mean square error=0.5611711

b) For sigma=0.600



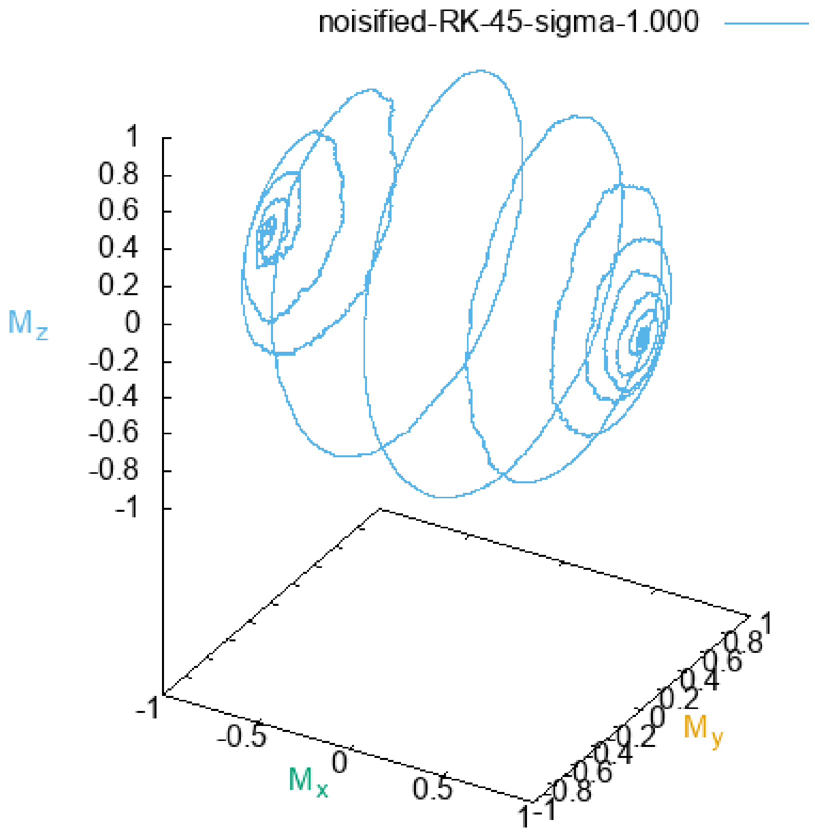
Root mean square error=0.564310

c) For sigma=0.800



Root mean square error=0.906756

d) For sigma=1.000



Root mean square error=1.1466911

We observe the distortion of the trajectory of M in these plots when we compare this with the one we got for stepsize=0.001 in RK45 solver.