Bonus Sheet ASM II - Matthias Werner

f) The potential implemented was of the form

$$V(x) = 20x^2 e^{-|x|} \tag{0.1}$$

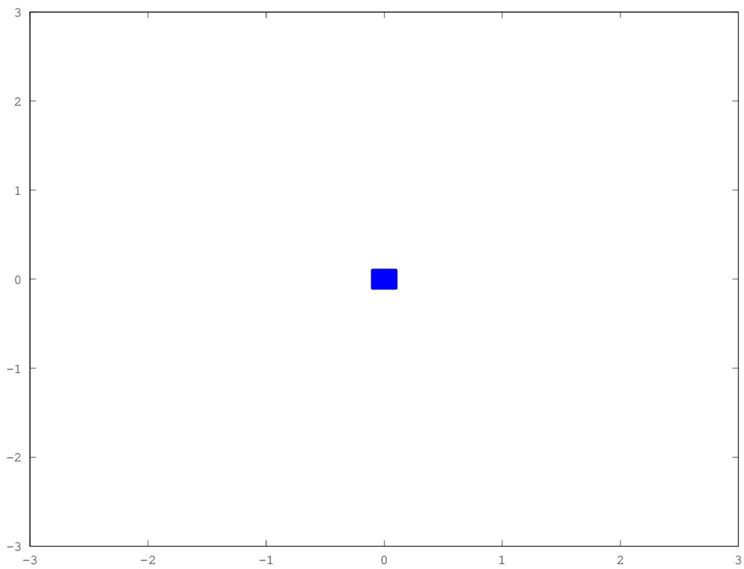
A few other potentials were tested as well, for example

$$V(x) = e^{-|x|}\cos(x) \tag{0.2}$$

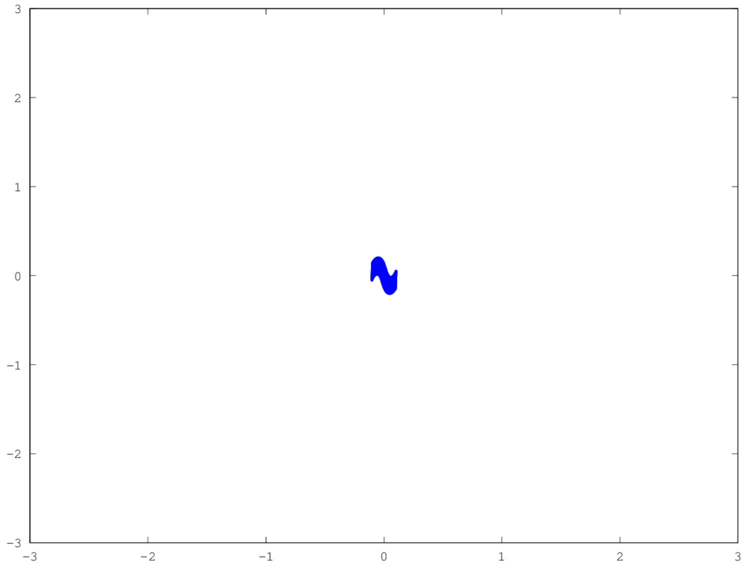
for which obviously the trajectories ran away and never came back, so this will not be discussed in more detail. Also an asymmetric potential was tested

$$V(x) = 10x^2 + 10x^3 \tag{0.3}$$

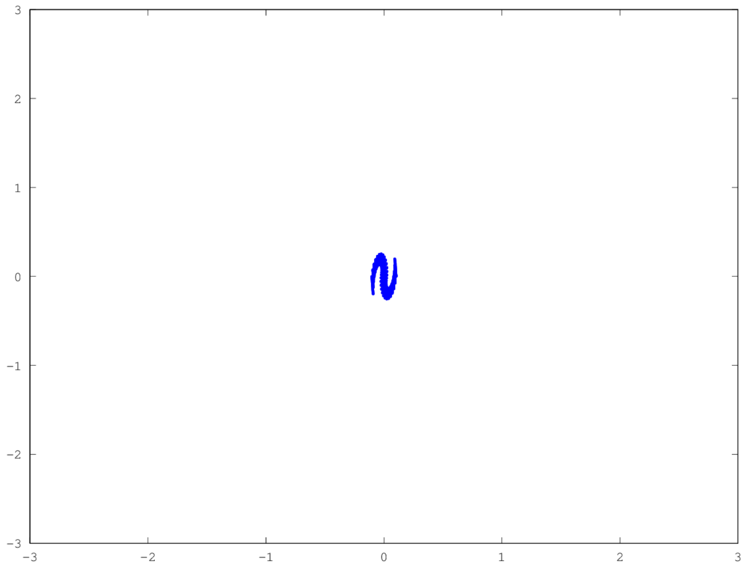
The rather large coefficients were chosen in order to make the effects more visible, since otherwise the trajectories would only stick very close to their original arrangement. The initial conditions seem always to be the same, as seen below



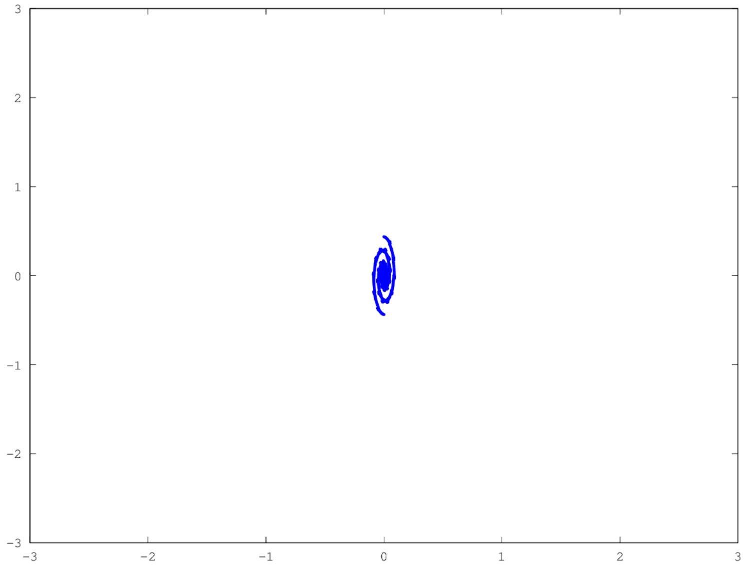
For potential 0.1 it takes roughly 6 frames for the bending of the blob to get out of shape as seen here



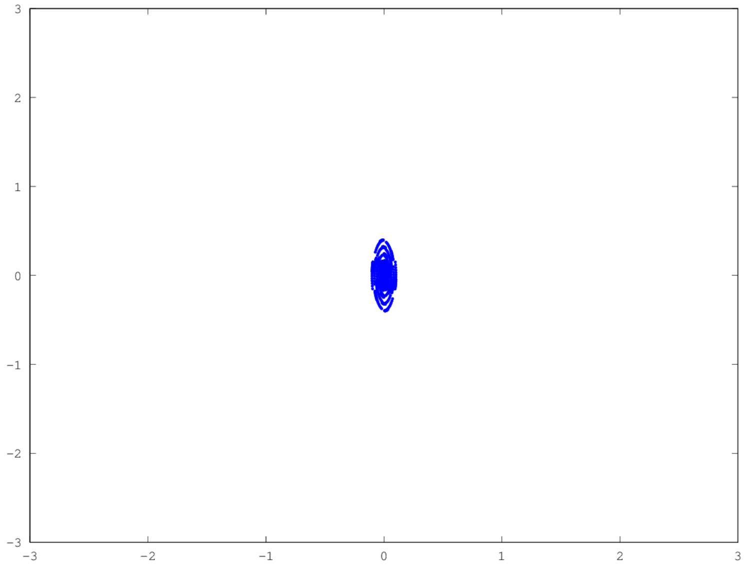
and at frame 17 the shape has transformed into a spiral



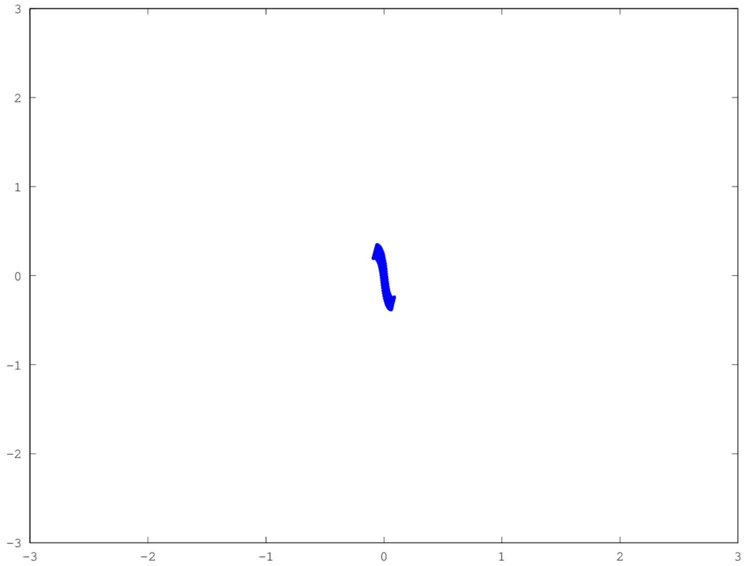
The spiral becomes more curved as it can be seen in the following 50th frame



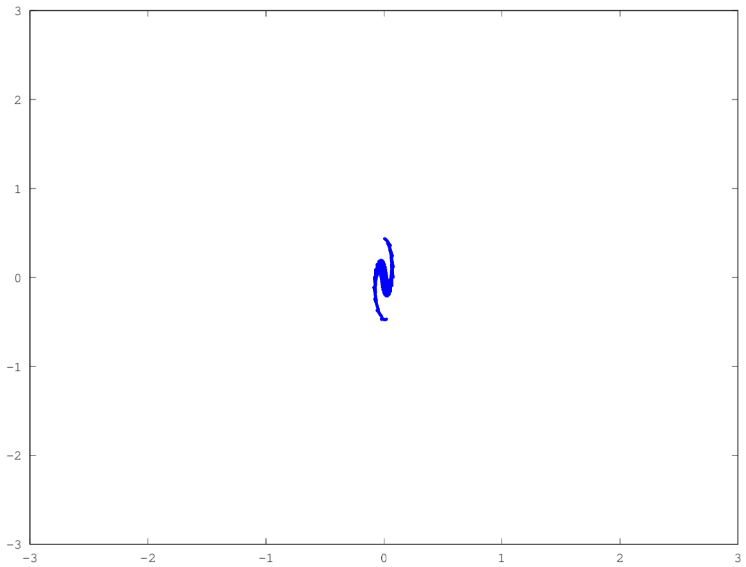
and ends in the 100th frame with



For potential (0.3) the transition is much slower. It also starts out as a rhombus, which gets bend and stretched. Here is frame 20



but the shape will also become a spiral (frame 100)



This spiral is not as curved, but it appears as if given enough time, this would also happen. For either potential there is obviously a directed time evolution from a rhombus shape to a spiral. The initial condition does not seem to be reached again. Since the potentials and thus the Hamiltonian of the system are independent of time, the energy and the phase space volume should be conserved. These phase space trajectories could be interpreted as an ideal gas subject to external forces, since neither potential has an interaction term. To model a van-der-Waals gas in a box, the potentials have to be the van-der-Waals potential, which includes an interaction term between each particle. Also the box would have to be parameterised by an infinitely tall potential wall.

g) /