

# Tutorial 1 Microfluidics (Claus-Dieter Ohl)

## Problem 1: Streamlines

Given is the following flow field:

$$\begin{aligned} u &= a x \\ v &= -a y \quad \text{where } a = \text{const} > 0 \end{aligned}$$

- a) Find an equation for the streamline that passes through a point  $(x_0, y_0)$ . In which direction moves a fluid particle? If it originates from a location  $y_0 > 0$  does the particle pass through the horizontal line  $y = 0$ . Where is the stagnation point? What kind of flow could that be?
- b) Plot the flow field (arrow or `plt.quiver` plot for  $x \geq 0$ ). For  $x_0 = 1$  and  $y_0 = 1$ , plot a streamline passing through this point. Then, plot through nearby points a few more streamlines to illustrate the flow field. Observe the density of streamlines in the plot? Can you connect the density of streamline with a local property of the flow?

## Problem 2: Streamline, Pathlines, Streaklines

- a) Find picture/video examples for streamlines, pathlines and streaklines.
- b) Use [interactive example \(Example%20of%20Stream-Streak-Pathlines.ipynb\)](#) to visualize the three lines. Explain, why all three lines are similar close to their starting point (grey dot)
- c) Study the program and find out how the three type of lines are calculated.
- d) Modify the program that the lines start from a different location. If you are a keen programmer, allow the user to choose the starting point.