Stationary Waves

Effect of fluid flow in a 1D liquid reaction-diffusion system

Advection has a huge effect on the propagation behavior of reaction-diffusion waves when an external force introduces flow in a system . Because reaction-diffusion waves propagate in a medium without actual mass transport of the medium itself, it is possible to create a "*stationary wave*" when creating a flow of the liquid medium opposite to the wave's propagation direction. This is similar to a person walking in the opposite direction on a ship deck but with the same speed and observed from the shore - he seems not to move at all.

We use the excitable Belousov–Zhabotinsky (BZ) reaction to investigate the effect in quasi-1D systems (e.g., capillaries with a diameter below 1.0 mm).

We have two simple pump systems available: 1) a precision glass syringe piston system and 2) a peristaltic pump which allow the outflow of a solution through a needle into a capillary with very defined fluid velocity (advection) in the capillary.

We also have an Arduino controlled five-pump system which enables the control of all five chemical components of the BZ reaction separately. **I would really like to get this system running if a student with Arduino experience becomes available.**

An example of a space-time plot with one wave moving to the right and fluid flow to the left (1D gray-value cut of the center of a capillary with subsequent images at Δt in y-direction) is shown in **Fig. 1**. After the wave propagated about 10 mm without fluid motion, advection started which resulted in a wave speed change (different slopes in the space-time plot with a nearly vertical, standing section).

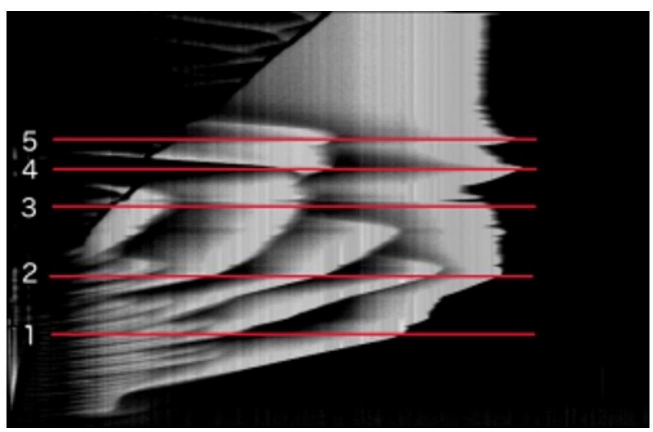

Figure 1: Time-space plot (time going up) of wave propagating in a capillary to the right with changing fluid flow rates in the opposite direction, resulting in wave speed changes and a 'nearly stationary wave' between $t = 600$ s and $t = 1000$ s.